ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 85, 86, 600, 1036, 1037, 1066, and 1068

[EPA–HQ–OAR–2022–0829; FRL–8953–04–OAR]

RIN 2060–AV49

Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: Under the Clean Air Act, the Environmental Protection Agency (EPA) is establishing new, more protective emissions standards for criteria pollutants and greenhouse gases (GHG) for light-duty vehicles and Class 2b and 3 (''medium-duty'') vehicles that will phase-in over model years 2027 through 2032. In addition, EPA is finalizing GHG program revisions in several areas, including off-cycle and air conditioning credits, the treatment of upstream emissions associated with zero-emission vehicles and plug-in hybrid electric vehicles in compliance calculations, medium-duty vehicle incentive multipliers, and vehicle certification and compliance. EPA is also establishing new standards to control refueling emissions from incomplete medium-duty vehicles, and battery durability and warranty requirements for light-duty and medium-duty electric and plug-in hybrid electric vehicles. EPA is also finalizing minor amendments to update program requirements related to aftermarket fuel conversions, importing vehicles and engines, evaporative emission test procedures, and test fuel specifications for measuring fuel economy.

DATES: This final rule is effective on June 17, 2024. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register beginning June 17, 2024. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of March 27, 2023.

ADDRESSES: EPA has established a docket for this action under Docket ID No. EPA–HQ–OAR–2022–0829. All documents in the docket are listed on the *https://www.regulations.gov* website. Although listed in the index, some information is not publicly available, *e.g.,* CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the internet and will be publicly available only in hard copy form. Publicly available docket materials are available electronically through *https://www.regulations.gov*.

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SUPPLEMENTARY INFORMATION:

A. Does this action apply to me?

Entities potentially affected by this rule include light-duty vehicle manufacturers, independent commercial importers, alternative fuel converters, and manufacturers and converters of medium-duty vehicles (*i.e.,* vehicles between 8,501 and 14,000 pounds gross vehicle weight rating (GVWR)). Potentially affected categories and entities include:

Category	NAICS codes [a]	Examples of potentially affected entities
Industry	336111 336112	Motor Vehicle Manufacturers.
Industry	811111 811112 811198 423110	Commercial Importers of Vehicles and Vehicle Components.
Industry	335312 811198	Alternative Fuel Vehicle Converters.
Industry	333618 336120 336211 336312	On-highway medium-duty engine & vehicle (8,501–14,000 pounds GVWR) manufacturers.

[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 affected by this action. To determine whether particular activities may be regulated by this action, you should carefully examine the regulations. You may direct questions regarding the applicability of this action to the person listed in **FOR FURTHER INFORMATION CONTACT.**

B. Did EPA conduct a peer review before issuing this action?

This regulatory action was supported by influential scientific information. EPA therefore conducted peer review in accordance with OMB's Final Information Quality Bulletin for Peer Review. Specifically, we conducted peer review on six analyses: (1) Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA 2.0), (2) Advanced Light-duty Powertrain and Hybrid Analysis (ALPHA3), (3) Motor Vehicle Emission Simulator (MOVES), (4) The Effects of New-Vehicle Price Changes on New- and Used-Vehicle Markets and Scrappage; (5) Literature Review on U.S. Consumer Acceptance of New Personally Owned Light-Duty Plug-in Electric Vehicles; (6) Cost and Technology Evaluation, Conventional Powertrain Vehicle Compared to an Electrified Powertrain Vehicle, Same Vehicle Class and OEM. All peer reviews were in the form of letter reviews conducted by a contractor. The peer review reports for each analysis are in the docket for this action and at EPA's Science Inventory (*https://cfpub.epa.gov/si/*).

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I. Executive Summary

A. Purpose of this Rule and Legal Authority

The Environmental Protection Agency (EPA) is finalizing multipollutant emissions standards for light-duty passenger cars and light trucks and for Class 2b and 3 vehicles (''medium-duty vehicles'' or MDVs) under its authority in section 202(a) of the Clean Air Act (CAA), 42 U.S.C. 7521(a). The program establishes new, more stringent vehicle emissions standards for criteria pollutant and greenhouse gas (GHG) emissions from motor vehicles for model years (MYs) 2027 through 2032 and beyond.

Section 202(a) requires EPA to establish standards for emissions of air pollutants from new motor vehicles which, in the Administrator's judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. Standards under section 202(a) take effect ''after such period as the Administrator finds necessary to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period.'' Thus, in establishing or revising section 202(a) standards designed to reduce air pollution that endangers public health and welfare, EPA also must consider issues of technological feasibility, the cost of compliance, and lead time. EPA also considers safety, consistent with CAA section 202(a)(4), and may consider other factors, and in previous vehicle standards rulemakings as well as in this rule, has considered impacts on the automotive industry, impacts on vehicle purchasers/consumers, oil conservation, energy security, and other relevant considerations.

This final rule follows a Notice of Proposed Rulemaking published on May 5, 2023.[1] EPA has conducted extensive engagement with the public, including a wide range of interested stakeholders to gather input which we considered in developing both the proposal and this final rule. In developing this final rule, EPA considered comments received during the public comment process, including the public hearings. EPA held three days of virtual public hearings on May 9–11, 2023, and heard from approximately 240 speakers. During the public comment period that ended on July 5, 2023, EPA received more than 250,000 written comments. Through the public comment process, we received comments, data and analysis from a variety of stakeholders including auto manufacturers, state and local governments, non-governmental organizations (NGOs), labor organizations, environmental justice groups, suppliers, consumer groups, academics, and others.

1. Need for Continued Emissions Reductions Under 202(a) of the Clean Air Act

Since 1971, EPA has, at Congress' direction, been setting emissions standards for motor vehicles. The earliest standards were for light-duty vehicles for hydrocarbons, nitrogen oxides (NO_X), and carbon monoxide (CO), requiring a 90 percent reduction in emissions. Since then, EPA has continued to set standards for the full range of vehicle classes (including light-duty, medium-duty and heavy-duty vehicles and passenger, cargo and vocational vehicles) to reduce emissions of pollutants for which the Administrator has made an endangerment finding pursuant to CAA section 202. In 2009, EPA made an endangerment finding for GHG, and in 2010 issued the initial light-duty GHG standards. More recently, in 2014, EPA finalized criteria pollutant standards for light-duty vehicles (''Tier 3'') that were designed to be implemented alongside the GHG standards for light-duty vehicles that EPA had adopted in 2012

[1] 88 FR 29184, May 5, 2023.

for model years 2017–2025.[2] In 2020, EPA revised the GHG standards that had previously been adopted for model years 2021–2026,[3] and in 2021, EPA conducted a rulemaking (the ''2021 rulemaking'')[4] that again revised GHG standards for light-duty passenger cars and light trucks for MYs 2023 through 2026, setting significantly more stringent standards for those MYs than had been set by the 2020 rulemaking, and somewhat more stringent than the standards adopted in 2012.

Despite the significant emissions reductions achieved by these and other rulemakings, air pollution from motor vehicles continues to impact public health, welfare, and the environment. Motor vehicle emissions contribute to ozone, particulate matter (PM), and air toxics, which are linked with premature death and other serious health impacts, including respiratory illness, cardiovascular problems, and cancer. This air pollution affects people nationwide, as well as those who live or work near transportation corridors. In addition, the effects of climate change represent a rapidly growing threat to human health and the environment, and are caused by GHG emissions from human activity, including motor vehicle transportation. Addressing these public health and welfare needs will require substantial additional reductions in criteria pollutants and GHG emissions from the transportation sector. Recent trends and developments in vehicle technologies that reduce emissions indicate that more stringent emissions standards are feasible at reasonable cost and would lead to significant improvements in public health and welfare.

Addressing the public health impacts of criteria pollutants (including particulate matter (PM), ozone, and NO_X) will require continued reductions in these pollutants (and their precursors) from the transportation sector. In 2023, mobile sources accounted for approximately 54 percent of anthropogenic NO_X emissions, 5 percent of anthropogenic direct $PM_{2.5}$ emissions, and 23 percent of anthropogenic volatile organic compound (VOC) emissions nationwide.[5 6 7] Light- and medium-duty vehicles accounted for approximately 23 percent, 20 percent, and 52 percent of 2023 mobile source NO_X, $PM_{2.5}$, and VOC emissions, respectively.[6 7 7] The benefits of reductions in criteria pollutant emissions accrue broadly across many populations and communities. As of November 30, 2023, there are 12 $PM_{2.5}$ nonattainment areas with a population of more than 32 million people[8] and 54 ozone nonattainment areas with a population of more than 119 million people. The importance of continued reductions in these emissions is detailed at length in section II of this preamble.

The transportation sector is the largest U.S. source of GHG emissions, representing 29 percent of total GHG emissions.[9] Within the transportation sector, light-duty vehicles are the largest contributor, at 58 percent, and thus comprise 16.5 percent of total U.S. GHG emissions,[10] even before considering the contribution of medium-duty Class 2b and 3 vehicles which are also included under this rule. GHG emissions have significant impacts on public health and welfare as evidenced by the well-documented scientific record and as set forth in EPA's Endangerment and Cause or Contribute Findings under CAA section 202(a).[11] Additionally, major scientific assessments continue to be released that further advance our understanding of the climate system and the impacts that GHGs have on public health and welfare both for current and future generations, as discussed in section II.A of this preamble, making it clear that continued GHG emission reductions in the motor vehicle sector are needed to protect public health and welfare.

In addition to and separate from this final rule, the Administration has recognized the need for action to address climate change. Executive Order 14008 (''Tackling the Climate Crisis at Home and Abroad,'' January 27, 2021) recognizes the need for a government-wide approach to addressing the climate crisis, directing Federal departments and agencies to facilitate the organization and deployment of such an effort. On April 22, 2021, the Administration announced a new target for the United States to achieve a 50 to 52 percent reduction from 2005 levels in economy-wide net greenhouse gas pollution in 2030, consistent with the goal of limiting global warming to no more than 1.5 degrees Celsius by 2050 and representing the U.S. Nationally Determined Contribution (NDC) under the Paris Agreement. These actions, while they do not inform the standards established here, serve to underscore the importance of EPA acting pursuant to its Clean Air Act authority to address pollution from motor vehicles.

EPA is establishing both criteria pollutant and GHG standards in this rulemaking given the need for additional reductions in emissions of these air pollutants to protect public health and welfare and based on EPA's assessment of the suite of available control technologies for those pollutants, some of which are effective in controlling both GHGs and criteria pollutant emissions. Under these performance-based emissions standards, manufacturers have the discretion to choose the mix of technologies that achieve compliance across their fleets. EPA's modeling provides information about several potential compliance paths manufacturers could use to comply with the standards, based on multiple inputs and assumptions (*e.g.,* in what we have termed the central case, that manufacturers will seek the lowest cost compliance path). EPA's central analysis shows that both within the product lines of individual manufacturers and for different manufacturers across the industry, manufacturers will make use of a diverse range of technologies, including advanced gasoline engines (reducing engine-out emissions), improvements to tailpipe controls, additional electrification of gasoline powertrains, and electric powertrains. EPA recognizes that, although it has modeled individual compliance paths for each manufacturer, manufacturers will make their own assessment of the vehicle market and their own decisions about which technologies to apply to which vehicles for any given model year. The standards are performance-based, and while EPA finds modeling useful in evaluating the feasibility of the standards, it is manufacturers who will decide the ultimate mix of vehicle

[2] 79 FR 23414, April 28, 2014, ''Control of Air Pollution From Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards.

[3] 85 FR 24174, April 30, 2020, ''The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks.''

[4] 86 FR 74434, December 30, 2021, ''Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards.''

[5] U.S. Environmental Protection Agency (2021). 2016v1 Platform (*https://www.epa.gov/air-emissions-modeling/2016v1-platform*).

[6] U.S. Environmental Protection Agency (2021). 2017 National Emissions Inventory (NEI) Data. *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data*.

[7] U.S. Environmental Protection Agency (2023). MOVES 4.0.0. *https://www.epa.gov/moves*.

[8] The population total is calculated by summing, without double counting, the 1997, 2006 and 2012 $PM_{2.5}$ nonattainment populations contained in the Criteria Pollutant Nonattainment Summary report (*https://www.epa.gov/green-book/green-book-data-download*).

[9] Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021 (EPA–430–R–23–002, published April 2023).

[10] *Ibid.*

[11] 74 FR 66496, December 15, 2009; 81 FR 54422, August 15, 2016.

technologies to comply. Although EPA cannot model every possible compliance scenario, EPA did model several sensitivity analyses which identify a number of example alternative compliance scenarios for the industry. EPA has evaluated these alternative scenarios and has concluded that the lead time and estimated costs to manufacturers under each of these alternative compliance scenarios are reasonable and appropriate for standards under CAA 202(a). Furthermore, EPA finds that it would be technologically feasible to meet these standards without additional zero-emission vehicles beyond the volumes already sold today.[12] Although our modeling projects that such a fleet would not be the lowest cost alternative for complying with the standards, the fact that it would comply underscores both the feasibility and the flexibility of the standards, and confirms that manufacturers are likely to continue to offer vehicles with a diverse range of technologies, including advanced gasoline technologies as well as zero- and near-zero emission vehicles for the duration of these standards and beyond.

The Administrator finds that the standards herein are consistent with EPA's responsibilities under the CAA and appropriate under CAA section 202(a). EPA has carefully considered the statutory factors, including technological feasibility and cost of the standards and the available lead time for manufacturers to comply with them. Our analysis for this action supports the conclusion that the final standards are technologically feasible and that the costs of compliance for manufacturers will be reasonable. The standards will result in significant reductions in emissions of criteria pollutants, GHGs, and air toxics, resulting in significant benefits for public health and welfare. We also estimate that the standards will result in reduced vehicle operating costs for consumers and that the benefits of the program will exceed the costs. Based on EPA's analysis, it is the agency's assessment that the standards are appropriate and justified under CAA section 202(a).

2. Recent and Ongoing Advancements in Technology Enable Further Emissions Reductions

Over five decades of setting standards, EPA has developed extensive expertise in assessing the availability of new and existing technologies to control pollution from motor vehicles. In some cases, EPA has adopted standards based on its judgment that the industry could further develop and commercialize technologies. In others, EPA has based standards on the further deployment of existing technologies, rather than on the further development of new technologies. Both approaches are consistent with EPA's general authority for emissions standards under section 202(a)(1)–(2), although Congress has specified under 202(a)(3) that for heavy-duty criteria standards the Administrator should identify the greatest degree of emissions reduction achievable, taking into consideration certain factors.

In 2000, EPA adopted the Tier 2 standards, which required passenger vehicles to be 77 to 95 percent cleaner (and encouraged certification of zero-emitting vehicles through the establishment of ''Bin 1'', which is now referred to as ''Bin 0'').[13] More recently, in 2014, EPA adopted Tier 3 emissions standards, which required a further reduction of 60 to 80 percent of emissions (depending on pollutant and vehicle class).[14] Similar to the prior Tier 2 standards, Tier 3 established ''bins'' of Federal Test Procedure (FTP) standards, including bins for zero-emitting vehicles.

EPA has also consistently set GHG emission standards applicable to light-duty vehicles pursuant to CAA section 202(a), beginning with the 2010 rule, and continuing through subsequent rulemakings in 2012, and 2021.[15] These rules achieved very significant reductions of GHGs (with significant anticipated impacts on liquid fuel consumption and costs to manufacturers which were, in some cases, comparable to or greater than the impacts anticipated under this rule).

In designing the scope, structure, and stringency of these standards, the Administrator again considered a comprehensive array of updated, real-world information related to advancements in vehicle emissions control technologies. These include previous standards and their impacts on emissions control technologies; the activities, investments, and plans of manufacturers and other entities regarding the adoption of new technologies related to vehicle emissions control; trends in technology adoption by vehicle owners and operators, including individual consumers and fleets; and related legal requirements and government incentives, including most notably Congress's recent actions in the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA). This action continues EPA's longstanding approach of establishing an appropriate and achievable trajectory of emissions reductions by means of performance-based standards, for both criteria pollutant and GHG emissions, that can be achieved by employing feasible and available emissions-reducing vehicle technologies for the model years for which the standards apply.

CAA section 202(a) directs EPA to regulate emissions of air pollutants from new motor vehicles and engines, which in the Administrator's judgment cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. While standards promulgated pursuant to CAA section 202(a) are based on application of technology, the statute does not specify a particular technology or technologies that must be used to set such standards; rather, Congress has authorized and directed EPA to adapt its standards to emerging technologies. Thus, as with prior rules, EPA has assessed the feasibility of the standards considering current and anticipated progress by automakers in developing and deploying new technologies. The levels of stringency for the standards established in this rule continue the trend of increased emissions reductions which have been adopted by prior EPA rules. For example, the Clean Air Act of 1970 required a 90 percent reduction in emissions, which drove development of entirely new engine and emission control technologies such as exhaust gas recirculation and catalytic converters, which in turn required a switch to unleaded fuel and the development of major new infrastructure to support the delivery and segregated distribution of a different fuel. Similarly, the 2014 Tier 3 standards achieved reductions of up to 80 percent in tailpipe criteria pollutant emissions by requiring cleaner fuel as well as improved catalytic emissions control systems.

Compliance with the EPA GHG standards over the past decade has been achieved through both the application of advanced technologies to internal combustion engine (ICE) vehicles as well as the increasing adoption of electrification technologies. Notably, as the EPA GHG standards have increased in stringency, automakers have relied to

[12] EPA has analyzed this scenario as an illustrative scenario, which we refer to as the ''No additional BEVs above base year fleet'' scenario. For further details, please refer to Section IV.H of this preamble.

[13] 65 FR 6698 (Feb. 10, 2000).

[14] 79 FR 23414 (Apr. 28, 2014).

[15] See 75 FR 25324 (May 7, 2010) (setting GHG standards applicable to model year 2012–2016 LD vehicles); 77 FR 62624 (Oct. 15, 2012) (setting GHG standards for model year 2017–2025 LD vehicles and ''building on the success of the first phase of the National program for these vehicles''); 86 FR 774434 (Dec. 30, 2021) (revising GHG standards for model year 2023 and later light-duty vehicle).

a greater degree on a range of electrification technologies,[16] including idle stop-start, mild hybrid electric vehicles with a belt integrated starter-generator, hybrid electric vehicles (HEVs) and, in recent years, plug-in electric vehicles (PEVs), which include plug-in hybrid electric vehicles (PHEVs) and battery-electric vehicles (BEVs). As these technologies have been advancing rapidly in the past several years, becoming more popular with consumers and benefiting from continued declines in battery costs, automakers are now including PEVs as an integral and growing part of their current and future product lines. This has also led to an increasing diversity of PEVs already available and with an increasing array of makes and models planned for the market. As a result, zero- and near-zero emission technologies are more feasible and cost-effective now than at the time of prior rulemakings and, together with advanced gasoline technologies, offer manufacturers a wider array of compliance technologies.

Separately from this final rule, the Administration has recognized the recent industry advancements in zero-emission vehicle technologies and their potential to bring about dramatic reductions in emissions. Executive Order 14037 (''Strengthening American Leadership in Clean Cars and Trucks,'' August 5, 2021) identified a goal for 50 percent of U.S. new vehicle sales to be zero-emission [17] vehicles by 2030.[18] Congress passed the Bipartisan Infrastructure Law [19] in 2021, and the Inflation Reduction Act [20] in 2022, which together provide further support for a government-wide approach to reducing emissions by providing significant funding and support for emissions reductions across the economy, including specifically, for the component technology and infrastructure for the manufacture, sales, and use of zero- and near-zero emission vehicles.

As an important addition to the suite of control technologies that can reduce emissions, zero- and near-zero emission cars and trucks can simultaneously reduce both criteria pollutant and GHG emissions by a large margin. Production and sale of these vehicles is already occurring both domestically and globally, due to significant investments from automakers, increased acceptance by consumers, added support from Congress and state governments, and emissions regulations in other countries. EPA recognizes that these industry advancements, along with the additional support provided by the BIL and the IRA, represent an important opportunity for achieving the public health goals of the Clean Air Act. Recognizing that these technologies reduce both criteria pollutant and GHG emissions and are already forming an increasing portion of the fleet, EPA finds it appropriate to coordinate new standards for both criteria pollutants and GHG in a single rulemaking, rather than continuing its prior approach of coordinating the standards but setting them in separate regulatory actions.[21]

In the U.S., recent trends in PEV production and sales show that demand continues to increase. Even under current standards, BEVs and PHEVs are becoming a rapidly increasing part of the new vehicle fleet. On a production basis, PEVs are growing steadily, expected to be 11.8 percent [22] of U.S. light-duty vehicle production for MY 2023,[23] up from 6.7 percent in MY 2022, 4.4 percent in MY 2021 and 2.2 percent in MY 2020.[24] On a sales basis, U.S. new PEV sales in calendar year 2023 alone surpassed 1.4 million,[25 26] an increase of more than 50 percent over the 807,000 sales that occurred in 2022.[27] This represents 9.3 percent of new light-duty passenger vehicle sales in 2023, up from 6.8 percent in 2022 [28] and 3.2 percent the year before.[29] As depicted in Figure 1, this continues the growth trend seen in previous years. In California, new light-duty zero-emission vehicle sales have reached 25.1 percent through the third quarter of 2023, after reaching 18.8 percent in 2022, up from 12.4 percent in 2021.[30 31]

[16] Electrification technologies can range from electrification of specific accessories (for example, electric power steering to reduce engine loads by eliminating parasitic loss) to hybrid electric vehicles, which use a combination of batteries and an engine for propulsion energy, to electrification of the entire powertrain (as in the case of a battery electric vehicle).

[17] The Executive Order (E.O.) defines zero-emission vehicles to include battery electric, plug-in hybrid and fuel cell vehicles. In this Preamble we refer to these vehicles collectively as zero-emission and near-zero-emission vehicles.

[18] This Executive Order does not delegate any legal authority to EPA and this final rule is promulgated under and consistent with EPA's CAA section 202(a)(1)–(2) authority.

[19] Public Law 117–58, November 15, 2021.

[20] Public Law 117–169, August 16, 2022.

[21] We emphasize, however, as discussed further in Section X of this preamble, that the standards are severable.

[22] At time of this publication, MY 2023 production data is not yet final. Manufacturers will be confirming production volumes delivered for sale in MY 2023 later in calendar year 2024.

[23] Environmental Protection Agency, ''The 2023 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–23–033, December 2023.

[24] Environmental Protection Agency, ''The 2022 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–22–029, December 2022.

[25] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates,'' January 30, 2024. Accessed on March 7, 2024 at *https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates.*

[26] Department of Energy, ''FOTW #1327, January 29, 2024: Annual New Light-Duty EV Sales Topped 1 Million for the First Time in 2023,'' January 29, 2024. Accessed on February 2, 2024 at *https://www.energy.gov/eere/vehicles/articles/fotw-1327-january-29-2024-annual-new-light-duty-ev-sales-topped-1-million.*

[27] Colias, M., ''U.S. EV Sales Jolted Higher in 2022 as Newcomers Target Tesla,'' Wall Street Journal, January 6, 2023.

[28] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates,'' January 30, 2024. Accessed on March 7, 2024 at *https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates.*

[29] Colias, M., ''U.S. EV Sales Jolted Higher in 2022 as Newcomers Target Tesla,'' Wall Street Journal, January 6, 2023.

[30] California Energy Commission, ''New ZEV Sales in California'' online dashboard, viewed on February 13, 2023 at *https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/new-zev-sales.*

[31] California Energy Commission, ''New ZEV Sales in California'' online dashboard, viewed on December 15, 2023 at *https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/new-zev-sales.*

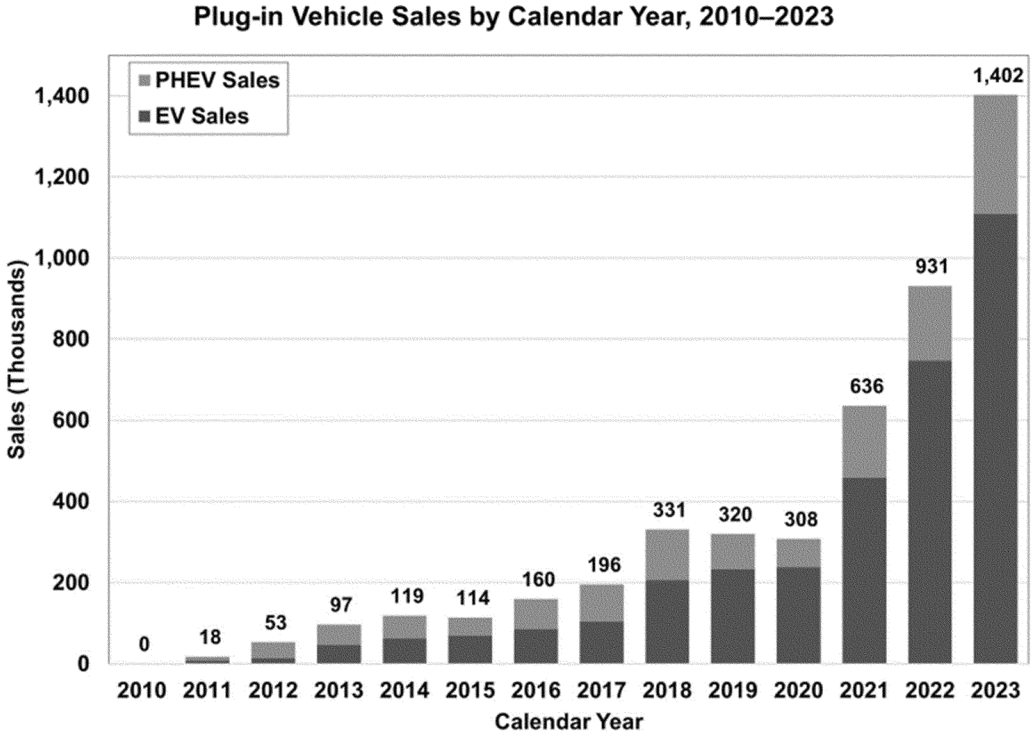

Figure 1: U.S. PEV Sales by Calendar Year, 2010–2023 (Department of Energy) [32]

Before the IRA became law, analysts were already projecting that significantly increased sales of PEVs would occur in the United States and in global markets. For example, in 2021, IHS Markit predicted a nearly 40 percent U.S. PEV share by 2030.[33] Projections made in 2022 by Bloomberg New Energy Finance suggested that under then-current policy and market conditions, and prior to the IRA and this final rule, the U.S. was on pace to reach 43 percent PEVs by 2030 and when adjusted for the effects of the IRA, this estimate increased to 52 percent.[34 35] Another study by the International Council on Clean Transportation (ICCT) and Energy Innovation that includes the effect of the IRA estimates that the share of BEVs will increase to 56 to 67 percent by 2032.[36] These projections typically are based on assessment of a range of existing and developing factors, including state policies (such as the California Advanced Clean Cars II program and its adoption by section 177 states); although the assumptions and other inputs to these forecasts vary, they point to greatly increased penetration of electrification across the U.S. light-duty fleet in the coming years, without specifically considering the effect of increased emission standards under this rule.

Recent analyses of the market penetration of plug-in electric vehicles have been completed that include the effects of the IRA. Researchers from Harvard University, MIT, and Cornell University examined the effects of subsidies and tax incentives provided by the BIL and the IRA to promote plug-in electric vehicle sales and the deployment of charging infrastructure. This study predicted plug-in electric vehicle sales shares of 55 to 58 percent in 2030 when both sales and infrastructure subsidies and incentives were considered.[37] In addition, the U.S. Department of Energy, Office of Policy provided updated economy-wide analysis that represents IRA and BIL impacts in which they project 49 to 65 percent zero emissions light-duty vehicle sales shares in 2030.[38] Bloomberg's EV Outlook for 2023 projects that ''a major push from the Inflation Reduction Act means EVs make up nearly 28 percent of passenger vehicle sales by 2026.'' Finally, the International Energy Agency estimates U.S. PEV sales share of approximately 50 percent in 2030 in both stated policies and announced pledges scenarios.[39] As with earlier analyses that EPA cited in the proposal, assumptions and inputs vary across forecasts. However, all of these recent studies point to greatly increased penetration of PEVs across the U.S. light-duty fleet in the coming years,

[32] Department of Energy, ''FOTW #1327, January 29, 2024: Annual New Light-Duty EV Sales Topped 1 Million for the First Time in 2023,'' January 29, 2024. Accessed on February 2, 2024 at *https://www.energy.gov/eere/vehicles/articles/fotw-1327-january-29-2024-annual-new-light-duty-ev-sales-topped-1-million.*

[33] IHS Markit, ''US EPA Proposed Greenhouse Gas Emissions Standards for Model Years 2023–2026; What to Expect,'' August 9, 2021. Accessed on March 9, 2023 at *https://www.spglobal.com/mobility/en/research-analysis/us-epa-proposed-greenhouse-gas-emissions-standards-my2023-26.html.* The table indicates 32.3 percent BEVs and combined 39.7 percent BEV, PHEV, and range-extended electric vehicle (REX) in 2030.

[34] Bloomberg New Energy Finance (BNEF), ''Electric Vehicle Outlook 2022,'' from chart labeled ''Global long-term EV share of new passenger vehicle sales by market—Economic Transition Scenario.''

[35] Tucker, S., ''Study: More Than Half of Car Sales Could Be Electric By 2030,'' Kelley Blue Book, October 4, 2022. Accessed on February 24, 2023 at *https://www.kbb.com/car-news/study-more-than-half-of-car-sales-could-be-electric-by-2030/.*

[36] International Council on Clean Transportation, ''Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the US,'' ICCT White Paper, January 2023. Available at *https://theicct.org/wp-content/uploads/2023/01/ira-impact-evs-us-jan23.pdf.*

[37] Cole, C., Droste, M., Knittel, C., Li, S., and James, J.H., ''Policies for Electrifying the Light-Duty Vehicle Fleet in the United States,'' AEA Papers and Proceedings 2023, 113 (pp.316–322).

[38] U.S. Department of Energy, Office of Policy, ''Investing in American Energy: Significant Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Energy Economy and Emissions Reductions,'' August 16, 2023. Accessed on November 30, 2023 at *https://www.energy.gov/policy/articles/investing-american-energy-significant-impacts-inflation-reduction-act-and.*

[39] International Energy Agency, ''Global EV Outlook 2023,'' p. 114, 2023. Accessed on November 30, 2023 at *https://www.iea.org/reports/global-ev-outlook-2023.*

even more so when the IRA and BIL are considered, and before considering the effect of the revised emissions standards under this rule. As discussed in detail in section IV.C.1 of this preamble, these trends echo an ongoing global shift toward electrification and indicate that an increasing share of new vehicle buyers are concluding that a PEV is the best vehicle to meet their needs.

Accompanying this trend has been a proliferation of announcements by automakers in the past several years, signaling a rapidly growing shift in product development focus toward electrification. For example, in January 2021, General Motors announced plans to become carbon neutral by 2040, including an effort to shift its light-duty vehicles entirely to zero-emissions by 2035.[40] In March 2021, Volvo announced plans to make only electric cars by 2030,[41] and Volkswagen announced that it expects half of its U.S. sales will be all-electric by 2030.[42] In April 2021, Honda announced a full electrification plan to take effect by 2040, with 40 percent of North American sales expected to be fully electric or fuel cell vehicles by 2030, 80 percent by 2035 and 100 percent by 2040.[43] In May 2021, Ford announced that they expect 40 percent of their global sales will be all-electric by 2030.[44] In June 2021, Fiat announced a move to all electric vehicles by 2030, and in July 2021 its parent corporation Stellantis announced an intensified focus on electrification, including both BEVs and PHEVs, across all of its brands.[45] [46] Also in July 2021, Mercedes-Benz announced that all of its new architectures would be electric-only from 2025, with plans to become ready to go all-electric by 2030 where possible.[47] In December 2021, Toyota announced plans to introduce 30 BEV models by 2030.[48] In August 2023, Subaru announced that its previous plan to target 40 percent combined HEVs and BEVs was being revised to 50 percent BEVs globally by 2030.[49] Some automakers have also indicated a strong role for PHEVs in their product planning. For example, Toyota continues to anticipate PHEVs forming an increasing part of their offerings,[50] and Stellantis will be introducing a plug-in version of its Ram pickup for MY 2024.[51] As discussed in more detail in section IV.C.1 of this preamble, the number of PHEV and BEV models has steadily grown and manufacturer announcements signal the potential for significant growth in the years to come.

On August 5, 2021, many major automakers including Ford, GM, Stellantis, BMW, Honda, Volkswagen, and Volvo, as well as the Alliance for Automotive Innovation, expressed continued commitment to their announcements of a shift to electrification, and expressed their support for the goal of achieving 40 to 50 percent sales of zero-emission vehicles by 2030.[52] In September 2022, jointly with the Environmental Defense Fund (EDF), General Motors (GM) announced a set of recommendations including a recommendation that EPA establish standards to achieve at least a 60 percent reduction in GHG emissions (compared to MY 2021), and that the standards be consistent with eliminating tailpipe pollution from new passenger vehicles by 2035. These announcements have been accompanied by continued major investments across the automotive industry in manufacturing facilities for PEVs, production capacity for batteries, and sourcing of critical minerals, as described further in sections IV.C.1 and IV.C.7 of this preamble.

In comments on the proposal, submitted in July 2023, manufacturers reiterated their continued commitment to electrification. Ford, for example, stated ''Ford is all-in on electrification. We are investing more than $50 billion through 2026 to deliver breakthrough electric vehicles (EVs)'' and expressed their support for a 2032 endpoint of approximately 67 percent PEVs.[53] GM's comments ''reiterate[ ] our commitment'' to sell 50 percent EVs by 2030 as ''the appropriate path toward all EVs by 2035.'' [54] Stellantis stated it ''is unwavering in its commitment to an all-electric portfolio and building an EV dominated market'' including a 50 percent EV mix for passenger cars and light trucks by 2030.[55] Volkswagen expressed its goal of 20 percent BEV sales globally by 2025, and more than 50 percent by 2030.[56] Other OEMs also restated their own significant commitments to electrification, with Honda restating its commitment to selling 40 percent zero-emitting vehicles by 2030 and 80 percent by 2035 [57] and Hyundai noting their support for selling 50 percent PEVs in 2030.[58] In addition there were automakers supporting stronger standards that would lead to somewhat higher levels of BEVs in 2032,[59] and some making commitments to significantly reduce vehicle emissions without identifying a particular level of PEVs they intend to sell.[60]

In the second half of 2023, some automakers announced changes to previously announced investment plans and made statements suggesting increased attention to PHEVs or HEVs in their future product plans. For example, in mid-2023, Ford paused construction (and then restarted construction in

[40] General Motors, ''General Motors, the Largest U.S. Automaker, Plans to be Carbon Neutral by 2040,'' Press Release, January 28, 2021.

[41] Volvo Car Group, ''Volvo Cars to be fully electric by 2030,'' Press Release, March 2, 2021.

[42] Volkswagen Newsroom, ''Strategy update at Volkswagen: The transformation to electromobility was only the beginning,'' March 5, 2021. Accessed June 15, 2021 at *https://www.volkswagen-newsroom.com/en/stories/strategy-update-at-volkswagen-the-transformation-to-electromobility-was-only-the-beginning-6875*.

[43] Honda News Room, ''Summary of Honda Global CEO Inaugural Press Conference,'' April 23, 2021. Accessed June 15, 2021 at *https://global.honda/newsroom/news/2021/c210423eng.html*.

[44] Ford Motor Company, ''Superior Value From EVs, Commercial Business, Connected Services is Strategic Focus of Today's 'Delivering Ford+' Capital Markets Day,'' Press Release, May 26, 2021.

[45] Stellantis, ''World Environment Day 2021—Comparing Visions: Olivier Francois and Stefano Boeri, in Conversation to Rewrite the Future of Cities,'' Press Release, June 4, 2021.

[46] Stellantis, ''Stellantis Intensifies Electrification While Targeting Sustainable Double-Digit Adjusted Operating Income Margins in the Mid-Term,'' Press Release, July 8, 2021.

[47] Mercedes-Benz, ''Mercedes-Benz prepares to go all-electric,'' Press Release, July 22, 2021.

[48] Toyota Motor Corporation, ''Video: Media Briefing on Battery EV Strategies,'' Press Release, December 14, 2021. Accessed on December 14, 2021 at *https://global.toyota/en/newsroom/corporate/36428993.html*.

[49] Subaru Corporation, ''Briefing on the New Management Policy,'' August 2, 2023. Accessed on December 5, 2023 at *https://www.subaru.co.jp/pdf/news-en/en2023_0802_1_2023-08-01-193334.pdf*.

[50] Toyota Motor Corporation, ''New Management Policy & Direction Announcement,'' April 7, 2023. Accessed on December 5, 2023 at *https://global.toyota/en/newsroom/corporate/39013233.html*.

[51] Stellantis, ''All-new 2025 Ram 1500 Ramcharger Unveiled With Class-shattering Unlimited Battery-electric Range,'' Press Release, November 7, 2023. Accessed on December 5, 2023 at *https://media.stellantisnorthamerica.com/newsrelease.do?id=25436*.

[52] The White House, ''Statements on the Biden Administration's Steps to Strengthen American Leadership on Clean Cars and Trucks,'' August 5, 2021. Accessed on October 19, 2021 at *https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/05/statements-on-the-biden-administrations-steps-to-strengthen-american-leadership-on-clean-cars-and-trucks/*.

[53] Ford Motor Company, EPA–HQ–OAR–2022–0829–0605 at p. 1.

[54] General Motors, LLC, EPA–HQ–OAR–2022–0829–0700 at p. 3–4.

[55] Stellantis, EPA–HQ–OAR–2022–0829–0678 at p. 2.

[56] Volkswagen Group of America, Inc., EPA–HQ–OAR–2022–0829–0669 at p. 2.

[57] American Honda Motor Co. Inc., EPA–HQ–OAR–2022–0829–0652 at p. 3.

[58] Hyundai Motor America, EPA–HQ–OAR–2022–0829–0599 at p. 2

[59] Tesla, Inc., EPA–HQ–OAR–2022–0829–0792, at 2 (supporting greater than 69% BEV penetration in 2032).

[60] Toyota Motor North America, EPA–HQ–OAR–2022–0829–0620 at 1 (plan to reduce average CO_2 emissions for all new vehicles worldwide by 33% by 2030 and by 50% by 2035, as compared to 2019).

November 2023, as discussed below) of their recently announced battery plant in Marshall, Michigan,[61] and in November 2023 announced a reduction in the size of the plant from 50 GWh to 20 GWh.[62] In 2024, Ford also signaled a growing interest in producing HEVs and a shift from large BEV SUVs toward smaller BEVs.[63 64 65 66] Similarly, General Motors indicated increased attention toward producing PHEVs in addition to BEVs,[67 68] and in an earnings call Mercedes suggested that it would reach 50 percent ''xEVs'' in ''the second half of the decade.'' [69 70] Some industry analysts have commented on the possibility that these developments indicated a drop in PEV demand or a weakening of manufacturer interest in investing in PEV technology.[71 72 73 74]

EPA acknowledges these recent announcements regarding investment plans. We have carefully considered these announcements, in light of the larger universe of information about manufacturer plans including comments submitted by the manufacturers on this rulemaking and our ongoing engagement with the manufacturers. Overall, EPA finds that these recent announcements do not reflect a significant change in manufacturer intentions regarding PEVs generally or specifically through the 2027–2032 timeframe of this rule. We also take into consideration that sales of PEVs have increased dramatically in recent years so periods where demand and supply of vehicles are temporarily misaligned (either creating shortages or an over-supply of vehicles) is not unexpected. Ford has since restarted construction of its plant; [75] at about the same as time Ford announced the delay, Toyota announced an $8 billion increase in investment in its North Carolina plant.[76] Nor are U.S. PEV sales data for 2023 (presented previously in Figure 1) consistent with a reduction in PEV demand,[77 78] with sales up by 50 percent from 2022 to 2023, consistent with and slightly larger than the 46 percent increase from 2021 to 2022 and in line with the average year-over-year increase of 52 percent from 2012 to 2023.[79] Both Ford and GM have characterized their recent moves as complementary to their continued plans to electrify an increasing portion of their product lines. For example, GM stated that it is ''deploying plug-in technology in strategic segments,'' and that ''for calendar year 2024, EV is our focus,'' [80] while Ford stated that its next generation of BEVs ''will be profitable and return their cost of capital.'' [81] It is also difficult to draw conclusions about industry-wide PEV demand or investment from only these two examples. Specific factors have been active during the same period, such as the 2023 United Auto Workers strike,[82] and an increase in inventories for light-duty vehicles of all types,[83] which may be related to economic conditions such as high interest rates and higher average transaction prices.[84 85 86] Economic conditions across the industry have also been cited in relation to manufacturers' recent investment decisions.[87 88 89] For

[61] Reuters, ''Ford pauses work on $3.5 bln battery plant in Michigan,'' September 25, 2023. Accessed on December 15, 2023 at *https://www.reuters.com/business/autos-transportation/ford-pauses-work-35-billion-battery-plant-michigan-2023-09-25/.*

[62] New York Times, ''Ford Resumes Work on E.V. Battery Plant in Michigan, at Reduced Scale,'' November 21, 2023. Accessed on December 15, 2023 at *https://www.nytimes.com/2023/11/21/business/ford-ev-battery-plant-michigan.html.*

[63] CNBC, ''Ford is reassessing its EV plans, including vertical battery integration,'' February 6, 2024. Accessed on February 7, 2024 at *https://www.cnbc.com/2024/02/06/ford-reassessing-ev-plans-including-vertical-battery-integration.html.*

[64] Reuters, ''Ford slows EVs, sends a truckload of cash to investors,'' February 7, 2024. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/ford-offer-regular-supplemental-dividend-2024-02-06/.*

[65] Green Car Reports, ''Ford CEO: Hybrids will play 'increasingly important role' alongside EVs,'' February 7, 2024. Accessed on February 9, 2024 at *https://www.greencarreports.com/news/1142233_ford-ceo-hybrids-alongside-evs.*

[66] Green Car Reports, ''Ford seeks smaller, lower-cost EVs to rival $25,000 Tesla, China,'' February 7, 2024. Accessed on February 9, 2024 at *https://www.greencarreports.com/news/1142232_ford-smaller-lower-cost-ev-platform-tesla-china.*

[67] Forbes, ''GM Does a U-Turn: Plug-In Hybrids are Coming Back,'' January 31, 2024. Accessed on February 14, 2024 at *https://www.forbes.com/sites/michaelharley/2024/01/31/gm-does-a-u-turn-plug-in-hybrids-are-coming-back/.*

[68] Detroit Free Press, ''General Motors to bring back hybrid vehicles in North America, stay focused on EVs,'' January 30, 2024. Accessed on February 14, 2024 at *https://www.freep.com/story/money/cars/general-motors/2024/01/30/gm-hybrid-vehicles-north-america/72406811007/.*

[69] Reuters, ''Mercedes-Benz delays electrification goal, beefs up combustion engine line-up,'' February 22, 2024. Accessed on March 6, 2024 at *https://www.reuters.com/business/autos-transportation/mercedes-benz-hits-cars-returns-forecast-inflation-supply-chain-costs-bite-2024-02-22/.*

[70] Mercedes-Benz Group, ''Outlook,'' February 22, 2024. Accessed on March 6, 2024 at *https://group.mercedes-benz.com/investors/share/outlook/.*

[71] Reuters, ''US EV market struggles with price cuts and rising inventories,'' July 11, 2023. Accessed on December 15, 2023 at *https://www.reuters.com/business/autos-transportation/slow-selling-evs-are-auto-industrys-new-headache-2023-07-11/.*

[72] Marketplace, ''Electric vehicles face reality check as automakers dial back production targets,'' November 2, 2023. Accessed on December 15, 2023 at *https://www.marketplace.org/2023/11/02/ev-demand-production-reality-check/.*

[73] The Wall Street Journal, ''EV Makers Turn to Discounts to Combat Waning Demand,'' November 7, 2023. Accessed on December 15, 2023 at *https://www.wsj.com/business/autos/ev-makers-turn-to-discounts-to-combat-waning-demand-3aa77535.*

[74] The Wall Street Journal, ''The Six Months That Short-Circuited the Electric-Vehicle Revolution,'' February 14, 2024. Accessed on February 15, 2024 at *https://www.wsj.com/business/autos/ev-electric-vehicle-slowdown-ford-gm-tesla-b20a748e.*

[75] CBS News, ''Ford resuming construction of Michigan EV battery plant delayed by strike, scaling back jobs,'' November 21, 2023. Accessed on December 15, 2023 at *https://www.cbsnews.com/detroit/news/ford-resuming-construction-of-michigan-ev-battery-plant-delayed-by-strike-scaling-back-jobs/.*

[76] Toyota Newsroom, ''Toyota Supercharges North Carolina Battery Plant with New $8 Billion Investment,'' Press Release, October 31, 2023. Available at *https://pressroom.toyota.com/toyota-supercharges-north-carolina-battery-plant-with-new-8-billion-investment/.*

[77] Fortune, ''EV sales expected to hit new U.S. record in 2023—but Germany, China and Norway still lead the way,'' November 23, 2023. Accessed on December 11, 2023 at *https://fortune.com/2023/11/23/us-electric-vehicle-sales-2023-record/.*

[78] BloombergNEF, ''Four Takeaways on the Future of the Global EV Market,'' June 8, 2023. Accessed on December 8, 2023 at *https://www.bloomberg.com/news/articles/2023-06-08/global-ev-sales-have-soared-as-overall-new-car-sales-sag.*

[79] Derived from the yearly sales depicted in Figure 1.

[80] Detroit Free Press, ''General Motors to bring back hybrid vehicles in North America, stay focused on EVs,'' January 30, 2024. Accessed on February 14, 2024 *at https://www.freep.com/story/money/cars/general-motors/2024/01/30/gm-hybrid-vehicles-north-america/72406811007/.*

[81] Reuters, ''Ford slows EVs, sends a truckload of cash to investors,'' February 7, 2024. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/ford-offer-regular-supplemental-dividend-2024-02-06//.*

[82] CBS News, ''Ford resuming construction of Michigan EV battery plant delayed by strike, scaling back jobs,'' November 21, 2023. Accessed on December 15, 2023 at *https://www.cbsnews.com/detroit/news/ford-resuming-construction-of-michigan-ev-battery-plant-delayed-by-strike-scaling-back-jobs/.*

[83] National Automobile Dealers Association, ''NADA Market Beat,'' November 2023. Accessed on December 11, 2023 at *https://www.nada.org/nada/nada-headlines/nada-market-beat-new-light-vehicle-inventory-reaches-20-month-high.*

[84] Reuters, ''More alarm bells sound on slowing demand for electric vehicles,'' October 25, 2023. Accessed on December 15, 2023 at *https://www.reuters.com/business/autos-transportation/more-alarm-bells-sound-slowing-demand-electric-vehicles-2023-10-25/.*

[85] CNBC, ''Sparse inventory drives prices for new, used vehicles higher,'' October 17, 2023. Accessed on December 15, 2023 at *https://www.cnbc.com/2023/10/17/sparse-inventory-drives-prices-for-new-used-cars-higher.html.*

[86] San Diego Union-Tribune, ''Has enthusiasm for electric cars waned?,'' October 27, 2023. Accessed on December 15, 2023 at *https://www.sandiegouniontribune.com/business/story/2023-10-27/has-enthusiasm-for-electric-cars-waned.*

[87] Reuters, ''Hyundai, Kia see strong demand for EVs, despite rivals' concerns,'' November 17, 2023. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/hyundai-kia-see-strong-demand-evs-despite-rivals-concerns-2023-11-17/.*

[88] Reuters, ''Mexico gives Tesla land-use permits for gigafactory, says state government,'' December 12, 2023. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/mexico-gives-tesla-land-use-permits-gigafactory-says-state-government-2023-12-13/.*

[89] Mexico Now, ''Taxes and global economy stop Tesla plant in Nuevo Leon,'' October 23, 2023.

Continued

example, Mercedes-Benz cited slower economic growth, 48-volt component shortages, European policy uncertainty, lower than expected demand in China, and trade tensions with China as all affecting its earnings outlook.[90] [91] Meanwhile, some other manufacturers have seen strong BEV demand and have reaffirmed their plans, for example, Hyundai and Kia have indicated strong demand and are maintaining or accelerating investment plans,[92] [93] and Stellantis reported making a profit on EVs globally and stated that it is ''keeping full speed on electrification.'' [94] [95] At the same time, automakers continue to compete in a global market where emission reduction targets and PEV demand continue to spur investments in these technologies. Given the unprecedented rate and size of recent investment activity in PEV technology, adjustments to previously announced plans would ordinarily be expected to occur, and to date have included both reductions and increases in investment amounts and pacing. Our assessment of the feasibility of the standards is based on our assessment of the full record as discussed in sections III and IV of this preamble and in the RIA, and EPA does not consider such adjustments to be indicative of any broad trend that would change our assessment of PEV feasibility as an emission control technology. Further, the rulemaking establishes performance-based standards, which manufacturers can meet using a variety of technologies, including ICE vehicles across a range of electrification, and the sensitivity analyses confirm that the standards are feasible and appropriate under a range of future circumstances. At the same time, the final standards incorporate a reduced rate of stringency increase in the early years as compared to the proposed standards, providing additional lead time which supports the kinds of product planning changes described in these recent announcements.[96]

Electrification plans are not limited to light-duty vehicles. Electrification of MDVs is also increasing rapidly, primarily within the area of last-mile delivery. MDV delivery vans using dedicated battery-electric vehicle (BEV) architectures are beginning to enter the U.S. market, with the first mass-produced models having become available for MY 2023 and additional production volume and models announced for MY 2024. Initial dedicated BEV van chassis have been predominantly targeted towards parcel delivery and include the GM BrightDrop Zevo 400 and Zevo 600; and the Rivian EDV 500 and EDV 700.[97] [98]

Numerous commitments to purchase all-electric medium-duty delivery vans have also been announced by large fleet owners including FedEx,[99] Amazon,[100] and Walmart,[101] in partnerships with various OEMs. For example, Amazon has deployed thousands of electric delivery vans in over 100 cities, with the goal of 100,000 vans by 2030. Many other fleet electrification commitments that include large numbers of medium-duty and heavier vehicles have been announced by large corporations in many sectors of the economy, including not only retailers like Amazon and Walmart but also consumer product manufacturers with large delivery fleets (*e.g.,* IKEA, Unilever), large delivery firms (*e.g.,* DHL, FedEx, USPS), and numerous firms in many other sectors including power and utilities, biotech, public transportation, and municipal fleets across the country.[102] As another example, Daimler Trucks North America announced in 2021 that it expected 60 percent of its sales in 2030 and 100 percent of its sales by 2039 would be zero-emission.[103]

Investments in PEV charging infrastructure have likewise grown rapidly in recent years and are expected to continue to climb. According to BloombergNEF, total cumulative global investment in PEV charging reached almost $55 billion in 2022 and was estimated to reach nearly $93 billion in 2023.[104] U.S. infrastructure spending has also grown significantly over the past several years with estimated public charging investments of $2.7 billion in 2023 alone.[105]

As described in the next section, the U.S. government is making large investments in infrastructure through the Bipartisan Infrastructure Law [106] and the Inflation Reduction Act.[107] However, we expect that private investments will also play a critical role in meeting future infrastructure needs. Private charging companies have already attracted billions globally in venture capital and mergers and acquisitions indicating strong interest in the future of the charging industry.[108] And Bain projects that by 2030, the U.S. market for electric vehicle charging will be ''large and profitable'' with both revenue and profits estimated to grow

Accessed on February 14, 2024 at *https://mexico-now.com/taxes-and-global-economy-stop-tesla-plant-in-nuevo-leon/.*

[90] Mercedes-Benz Group, ''Outlook,'' February 22, 2024. Accessed on March 6, 2024 at *https://group.mercedes-benz.com/investors/share/outlook/.*

[91] Seeking Alpha, ''Mercedes-Benz Group AG (MBGAF) Q4 2023 Earnings Call Transcript,'' February 22,2024. Accessed on March 6, 2024 at *https://seekingalpha.com/article/4672324-mercedes-benz-group-ag-mbgaf-q4-2023-earnings-call-transcript.*

[92] Reuters, ''Hyundai sticks to EV rollout plans, sees solid growth this year,'' October 26, 2023. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/hyundai-motors-q3-net-profit-rises-151-beats-forecasts-2023-10-26/.*

[93] Reuters, ''Hyundai, Kia see strong demand for EVs, despite rivals' concerns,'' November 17, 2023. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/hyundai-kia-see-strong-demand-evs-despite-rivals-concerns-2023-11-17/.* We note that Hyundai submitted a late comment on November 1, 2023 reiterating its support for a mechanism to potentially revise the stringency of the standards in future years in light of developments (EPA–HQ–OAR–2022–0829–5102) but neither Hyundai nor any other automaker submitted additional comments after the close of the comment period indicating they were adjusting their plans for future PEV products and sales.

[94] CNN, ''A traditional automaker just turned a profit on EVs,'' February 15, 2024. Accessed on February 15, 2024 at *https://www.cnn.com/2024/02/15/business/stellantis-earnings-electric-vehicles/index.html.*

[95] The Wall Street Journal, ''Chrysler-Parent Stellantis Staying the Course on EVs, Despite Slowdown,'' February 15, 2024. Accessed on February 16, 2024 at *https://www.wsj.com/livecoverage/stock-market-today-dow-jones-02-15-2024/card/chrysler-parent-stellantis-staying-the-course-on-evs-despite-slowdown-pCHVXXe6Igo4do3pBFoQ.*

[96] Of course, as with any rulemaking, the Administrator has the discretion to propose modifications to the program through the public notice and comment process, in the case that modifications are found to be appropriate in the future to address any constraints that might have developed.

[97] *https://www.gobrightdrop.com/.*

[98] *https://rivian.com/fleet.*

[99] BrightDrop, ''BrightDrop Accelerates EV Production with First 150 Electric Delivery Vans Integrated into FedEx Fleet,'' Press Release, June 21, 2022.

[100] Amazon Corporation, ''Amazon's Custom Electric Delivery Vehicles from Rivian Start Rolling Out Across the U.S.,'' Press Release, July 21, 2022.

[101] Walmart, ''Walmart To Purchase 4,500 Canoo Electric Delivery Vehicles To Be Used for Last Mile Deliveries in Support of Its Growing eCommerce Business,'' Press Release, July 12, 2022.

[102] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer Commitments and Public Policy Initiatives Supporting Electric Mobility in the U.S. and Worldwide,'' September 2022.

[103] Carey, N., ''Daimler Truck 'all in' on green energy as it targets costs,'' May 20, 2021.

[104] BloombergNEF, ''Zero-Emission Vehicles Factbook, A BloombergNEF special report prepared for COP28,'' December 2023, at *https://assets.bbhub.io/professional/sites/24/2023-COP28-ZEV-Factbook.pdf.*

[105] BloombergNEF, ''Zero-Emission Vehicles Factbook, A BloombergNEF special report prepared for COP28,'' December 2023, at *https://assets.bbhub.io/professional/sites/24/2023-COP28-ZEV-Factbook.pdf.*

[106] *https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf.*

[107] *https://www.congress.gov/117/plaws/publ169/PLAW-117publ169.pdf.*

[108] Hampleton, ''Autotech & Mobility M&A market report 1H2023''. Accessed March 4, 2023, at *https://www.hampletonpartners.com/fileadmin/user_upload/Report_PDFs/Hampleton-Partners-Autotech-Mobility-Report-1H2023-FINAL.pdf.*

by a factor of twenty relative to 2021.[109] The White House estimates over $25 billion in commitments to expand the U.S. charging network has been announced as of January 2024.[110] This includes more than $10 billion in private sector investments from automakers, charging companies, and retailers among others. See section IV.C.4 of this preamble and Chapter 5 of the Regulatory Impact Analysis (RIA)[111] for a discussion of public and private infrastructure investments.

Taken together, these developments indicate that proven technologies such as BEVs and PHEVs are already poised to become a rapidly growing segment of the U.S. fleet, as manufacturers continue to invest in these technologies and integrate them into their product plans, and infrastructure continues to be developed. Accordingly, EPA considers these technologies to be available and feasible for controlling motor vehicle emissions, and expects that these technologies will likely play a significant role in meeting the standards for both criteria pollutants and GHGs.

At the same time, EPA anticipates that a compliant fleet under the final performance-based emissions standards will include a diverse range of technologies. The advanced gasoline technologies that have played a fundamental role in meeting previous standards will continue to play an important role going forward[112 113 114] as they remain key to reducing the criteria and GHG emissions of ICE, mild HEV, strong HEV and PHEV powertrains. PHEVs also provide a technology option that combines the benefits of both electric and ICE technology. EPA's standards are performance-based and allow each manufacturer to choose the array of technologies it wishes to use, without requiring any particular technology for any particular vehicle category. The final standards will also provide regulatory certainty to support the many private automaker announcements and investments in PEVs that have been outlined in the preceding paragraphs. In developing these standards, EPA also considered many of the key issues associated with growth in penetration of PEVs, including charging infrastructure, consumer acceptance, critical minerals and mineral security, and others, as well as the emissions from the wide range of ICE-based vehicle technologies (*e.g.,* non-hybrid ICE, mild HEVs, strong HEVs) that will continue to be produced during the timeframe of these standards. We discuss each of these issues in more detail in respective sections of the preamble and RIA.

3. The Bipartisan Infrastructure Law and Inflation Reduction Act

A particular consideration with regard to the increased penetration of zero-emission vehicle technology is Congress' passage of the Bipartisan Infrastructure Law (BIL)[115 116] in 2021 and the Inflation Reduction Act (IRA)[117] in 2022. These measures represent significant Congressional support for investment in expanding the manufacture, sale, and use of zero-emission vehicles by addressing elements critical to the advancement of clean transportation and clean electricity generation in ways that will facilitate and accelerate the development, production and adoption of zero-emission technology during the time frame of this rule. Congressional passage of the BIL and IRA represent pivotal milestones in the creation of a broad-based infrastructure instrumental to the expansion of clean transportation, including light- and medium-duty zero-emission vehicles, and we have taken these developments into account in assessing the feasibility of the standards.

The BIL became law in November 2021 and includes a wide range of programs and significant funding for infrastructure investments, many of which are oriented toward reducing GHG emissions across the U.S. transportation network, upgrading power generation infrastructure, and making the transportation infrastructure resilient to climate impacts such as extreme weather. Notably, in support of light-duty zero-emissions transportation, the BIL included $7.5 billion in funding for installation of public charging and other alternative fueling infrastructure. This will have a major impact on feasibility of PEVs across the U.S. by improving access to charging and other infrastructure, and it will further support the Administration's goal of deploying 500,000 PEV chargers by 2030. It also includes $5 billion for electrification of school buses through the Clean School Bus Program, providing for further reductions in emissions from the heavy-duty sector.[118 119] To help ensure that clean vehicles are powered by clean energy, it also includes $65 billion to upgrade the power infrastructure to facilitate increased use of renewables and clean energy. Further, the BIL allocated an additional $10.5 billion to DOE's Grid Deployment Office (GDO) and the Grid Resilience and Innovation Partnerships program (GRIP) for investments to increase the flexibility, efficiency and reliability of the electric power system, which will further support PEV adoption.

The IRA became law in August 2022, bringing significant new momentum to clean vehicles (PEVs and fuel cell electric vehicles (FCEVs)) through measures that reduce the cost to purchase and manufacture them, incentivize the growth of manufacturing capacity and onshore sourcing of critical minerals and battery components needed for their manufacture, incentivize buildout of public charging infrastructure for PEVs, and promote modernization of the electrical grid that will power them. It includes significant consumer incentives of up to $7,500 for new clean vehicles (Clean Vehicle Credit or Internal Revenue Code (IRC) 30D, and Commercial Clean Vehicle Credit or IRC 45W) and up to $4,000 for used vehicles (Used Clean Vehicle Credit or IRC 25E). These credits will have a strong and immediate impact on the upfront affordability of these vehicles for a wide range of customers, including buyers at over 10,000 dealers that have registered to offer the 30D or

[109] Zayer, E. et al., ''EV Charging Shifts into High Gear,'' Bain & Company, June 20, 2022. Accessed March 4, 2023, at *https://www.bain.com/insights/electric-vehicle-charging-shifts-into-high-gear/*.

[110] The White House, ''FACT SHEET: Biden-Harris Administration Announces New Actions to Cut Electric Vehicle Costs for Americans and Continue Building Out a Convenient, Reliable, Made-in-America EV Charging Network'', January 19, 2024. Accessed at *https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/19/fact-sheet-biden-harris-administration-announces-new-actions-to-cut-electric-vehicle-costs-for-americans-and-continue-building-out-a-convenient-reliable-made-in-america-ev-charging-network/*.

[111] Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles—Regulatory Impact Analysis; EPA–420–R–24–004.

[112] Wards Auto, ''GM Investing Billions in ICE Truck, SUV Production,'' June 13, 2023. Accessed on January 5, 2024 at *https://www.wardsauto.com/industry-news/gm-investing-billions-ice-truck-suv-production*.

[113] Forbes, ''GM To Put Nearly $1 Billion More Into Production of Internal Combustion Engines,'' January 20, 2023. Accessed on January 5, 2024 at *https://www.forbes.com/sites/edgarsten/2023/01/20/internal-combustion-engine-production-wins-nearly-all-1-billion-of-new-gm-plant-investments/?sh=ec7346969383*.

[114] Wards Auto, ''BMW 'Not Ready' to Give Up on ICE,'' August 3, 2023. Accessed on January 5, 2024 at *https://www.wardsauto.com/industry-news/bmw-not-ready-give-ice*.

[115] *https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf*.

[116] Also known as the Infrastructure Investment and Jobs Act (IIJA).

[117] *https://www.congress.gov/117/plaws/publ169/PLAW-117publ169.pdf*.

[118] *https://www.epa.gov/cleanschoolbus*. Accessed February 14, 2023.

[119] U.S. EPA, ''EPA Clean School Bus Program Second Report to Congress,'' EPA 420–R–23–002, February 2023.

25E credits at the point of sale,[120] buyers of vehicles for commercial and fleet use under 45W, and indirectly to lessees of vehicles purchased for lease to consumers. Manufacturer production tax incentives of $35 per kWh for U.S. production of battery cells, $10 per kWh for U.S. production of modules, and 10 percent of production cost for U.S.-made critical minerals and electrode active materials (Production Tax Credit, IRC 45X), will significantly reduce the manufacturing cost of these battery components, further reducing PEV and FCEV cost for consumers. In addition, the IRA includes significant tax credits for certain charging and hydrogen infrastructure equipment (Alternative Fuel Vehicle Refueling Infrastructure Property Tax Credit, IRC 30C), and sizeable incentives for investment in and production of clean electricity.

With respect to sourcing of critical minerals and battery components, and building a secure supply chain for clean vehicles and refueling infrastructure, the IRA also includes provisions that will greatly reduce reliance on imports by strongly supporting the continued development of a domestic and North American supply chain, as well as securing sources among Free Trade Agreement (FTA) countries and other trade partners and allies. Manufacturers who want their customers to take advantage of the Clean Vehicle Credit (30D) must assemble the vehicles in North America, must meet a gradually increasing value requirement for sourcing of critical minerals from U.S. or free-trade countries, and battery components from within North America, and cannot utilize content acquired from foreign entities of concern (FEOCs).[121] Manufacturer eligibility for the Production Tax Credit (45X) for cells and modules is conditioned on their manufacture in the U.S., as is eligibility for the 10 percent credit on the cost of producing critical minerals and electrode active materials. Manufacturers are already taking advantage of these opportunities to improve their sales and reduce their production costs by securing eligible sources of critical mineral content and siting new production facilities in the U.S.[122] [123] [124] [125] [126] [127] [128] [129] [130] Although 45W is not subject to the sourcing requirements of 30D, the latter remains highly influential in manufacturer siting decisions; for example, Hyundai has increased the leasing of vehicles to consumers while also continuing plans to site battery and vehicle manufacturing in the U.S.,[131] and the Korean battery industry is renegotiating ventures to comply with FEOC restrictions that impact 30D.[132] [133] According to ANL's most recent analysis of public announcements of cell manufacturing plants in North America through January 2024, cell manufacturers in the United States could supply about 10 million new light-duty electric vehicles each year by 2030, assuming an average pack size of 80 to 100 kWh.[134] There is a coordinated effort by Executive Branch agencies, including the Department of Energy and the National Laboratories, to provide guidance and resources and to administer funding to support this collective effort to further develop a robust supply chain for clean vehicles and the infrastructure that will support them.[135] [136] [137] [138] [139] [140] Section IV.C.7 of this preamble and Chapters 3.1.3 and 3.1.4 of the RIA discuss these provisions and measures in more detail.

Incentives provided by the IRA, along with manufacturers' strategies to meet consumer demand, are expected to result in even greater adoption of electrification technologies. Our No Action case (*i.e.,* without this rule) includes effects of the IRA. The third-party estimates to which we compare our No Action case are all very recent and include the IRA. Importantly, they do not include these standards, but do differ in other assumptions such as state level policies and consideration of manufacturer announced plans. We project PEV penetration of 42 percent in 2030 in the No Action case, while mid-range third-party projections we have reviewed range from 48 to 58 percent in 2030.[141] [142] [143] [144] [145] [146] [147] We consider

[120] U.S. Department of the Treasury, ''Remarks by Assistant Secretary for Tax Policy Lily Batchelder on Phase Three of Implementation of the Inflation Reduction Act's Clean Energy Provisions,'' January 31, 2024. Accessed February 4, 2024 at *https://home.treasury.gov/news/press-releases/jy2070*.

[121] Foreign entities of concern include entities (individuals and businesses) ''owned by, controlled by, or subject to jurisdiction or direction of'' a ''covered nation'' (defined in 10 U.S. Code 2533(c)(d)(2) as the Democratic People's Republic of North Korea, the People's Republic of China, the Russian Federation, and the Islamic Republic of Iran).

[122] Green Car Congress, ''Ford sources battery capacity and raw materials for 600K EV annual run rate by late 2023, 2M by end of 2026; adding LFP,'' July 22, 2022.

[123] Ford Motor Company, ''Ford Releases New Battery Capacity Plan, Raw Materials Details to Scale EVs; On Track to Ramp to 600K Run Rate by '23 and 2M+ by '26, Leveraging Global Relationships,'' Press Release, July 21, 2022.

[124] Green Car Congress, ''GM signs major Li-ion supply chain agreements: CAM with LG Chem and lithium hydroxide with Livent,'' July 26, 2022.

[125] Grzelewski, J., ''GM says it has enough EV battery raw materials to hit 2025 production target,'' The Detroit News, July 26, 2022.

[126] Hall, K., ''GM announces new partnership for EV battery supply,'' The Detroit News, April 12, 2022.

[127] Hawkins, A., ''General Motors makes moves to source rare earth metals for EV motors in North America,'' The Verge, December 9, 2021.

[128] Piedmont Lithium, ''Piedmont Lithium Signs Sales Agreement With Tesla,'' Press Release, September 28, 2020.

[129] Subramanian, P., ''Why Honda's EV battery plant likely wouldn't happen without new climate credits,'' Yahoo Finance, August 29, 2022.

[130] LG Chem, ''LG Chem to Establish Largest Cathode Plant in US for EV Batteries,'' Press Release, November 22, 2022.

[131] Korea Economic Daily, ''Hyundai Motor to boost EV leasing in US for tax credits from 2023,'' December 30, 2022. Accessed on February 14, 2024 at *https://www.kedglobal.com/electric-vehicles/newsView/ked202212300014*.

[132] Nikkei Asia, ''U.S. rules force South Korea's EV battery makers to rethink China deals,'' December 8, 2023. Accessed on February 14, 2024 at *https://asia.nikkei.com/Business/Business-Spotlight/U.S.-rules-force-South-Korea-s-EV-battery-makers-to-rethink-China-deals*.

[133] Korea Economic Daily, ''US regulations push Korean battery industry to cut reliance on China,'' December 12, 2023. Accessed on February 14, 2024 at *https://www.kedglobal.com/batteries/newsView/ked202312120008*.

[134] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates'', January 2024. Accessed February 2, 2024 at *https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates*.

[135] Executive Order 14017, Securing America's Supply Chains, February 24, 2021. *https://www.whitehouse.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/*.

[136] The White House, ''FACT SHEET: Biden-Harris Administration Driving U.S. Battery Manufacturing and Good-Paying Jobs,'' October 19, 2022. Available at: *https://www.whitehouse.gov/briefing-room/statements-releases/2022/10/19/fact-sheet-biden-harris-administration-driving-u-s-battery-manufacturing-and-good-paying-jobs/*.

[137] Department of Energy, ''Biden Administration, DOE to Invest $3 Billion to Strengthen U.S. Supply Chain for Advanced Batteries for Vehicles and Energy Storage,'' February 11, 2022. Available at: *https://www.energy.gov/articles/biden-administration-doe-invest-3-billion-strengthen-us-supply-chain-advanced-batteries*.

[138] Department of Energy, ''Supply Chains Progress Report,'' August 2023. *https://www.energy.gov/sites/default/files/2023-08/Supply%20Chain%20Progress%20Report%20-%20August%202023.pdf*.

[139] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024. *https://publications.anl.gov/anlpubs/2024/03/187735.pdf*.

[140] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024. *https://publications.anl.gov/anlpubs/2024/03/187907.pdf*.

[141] Cole, Cassandra, Michael Droste, Christopher Knittel, Shanjun Li, and James H. Stock. 2023. ''Policies for Electrifying the Light-Duty Fleet in the United States.'' AEA Papers and Proceedings 113: 316–322. doi:*https://doi.org/10.1257/pandp.20231063*.

[142] IEA. 2023. ''Global EV Outlook 2023: Catching up with climate ambitions.'' International Energy Agency.

[143] Forsythe, Connor R., Kenneth T. Gillingham, Jeremy J. Michalek, and Kate S. Whitefoot. 2023. ''Technology advancement is driving electric vehicle adoption.'' PNAS 120 (23). doi:*https://doi.org/10.1073/pnas.2219396120*.

our No Action case projections to be somewhat more conservative than these third-party estimates, although generally consistent given the differences in treatment of state-level policies and manufacturer announced plans. Nevertheless, the very substantial rates of PEV penetration under the No Action scenario underscore that a shift to widespread use of electrification technologies is already well underway, which contributes to the feasibility of further emissions controls under these standards.

B. Summary of Light- and Medium-Duty Vehicle Emissions Programs

EPA is establishing new emissions standards for both light-duty and medium-duty vehicles. The light-duty vehicle category includes passenger cars and light trucks consistent with previous EPA criteria pollutant and GHG rules. In this rule, heavy-duty Class 2b and 3 vehicles are referred to as ''medium-duty vehicles'' (MDVs) to distinguish them from Class 4 and higher vehicles, which remain under the heavy-duty program. EPA has not previously used the MDV nomenclature, referring to these larger vehicles in prior rules as light-heavy-duty vehicles,[148] heavy-duty Class 2b and 3 vehicles,[149] or heavy-duty pickups and vans.[150] In the context of this rule, the MDV category includes primarily large pickups and vans with a gross vehicle weight rating (GVWR) of 8,501 to 14,000 pounds and excludes vehicles used primarily as passenger vehicles (which are called medium-duty passenger vehicles, or MDPVs, and which are covered under the light-duty program).

The program consists of several key elements: more stringent emissions standards for GHGs, more stringent emissions standards for criteria pollutants, changes to certain optional credit programs, durability provisions for light-duty and medium-duty electrified vehicle batteries, warranty provisions for both electrified vehicles and diesel engine-equipped vehicles, and various improvements to several elements of the existing light-duty and medium-duty programs.

For both light- and medium-duty vehicles, the levels of stringency established by this rule continue the trend over the past 50 years (for criteria pollutants) and over the past 14 years (for GHGs) of EPA establishing numerically lower performance-based emissions standards in recognition of both the continued threat to human health and welfare from pollution and continued advancements in emissions control technology that make it possible to achieve important emissions reductions at a reasonable cost. EPA has also continued its longstanding approach of allowing manufacturers flexibilities, such as averaging, banking and trading, to reduce their cost of reducing emissions while producing a diverse fleet meeting consumers' varied preferences. In addition to advanced ICE technologies, including hybrid electric vehicles, the feasibility assessment for this rule recognizes the increasing availability of zero and near-zero tailpipe emissions technologies, including PEVs, as cost-effective compliance technologies. The technological feasibility of PEVs is further supported by the economic incentives provided in the IRA and the auto manufacturers' stated plans for significantly increasing the production of zero and near-zero emission vehicles, including PEVs, independent of this rule. This increased feasibility of PEVs, in addition to ICE and advanced ICE technologies, is one of the factors EPA considered in setting the stringency of the standards.

Through the public comment process, EPA heard from a wide range of stakeholders and individuals who provided a diversity of views on a broad range of issues, including stringency and pace of the standards; availability and readiness of the industry to support the needs of electrified vehicles (such as battery critical minerals, charging infrastructure, electric grid, and consumer acceptance); and specific elements of EPA's analysis (such as potential PEV adoption rates, battery costs, BIL and IRA impacts, and other areas). As part of their comments, many stakeholders, including NGOs, industry groups, and others, provided detailed technical analyses for EPA to consider.

Many commenters strongly supported the proposal overall. Comments from organizations representing environmental, public health, and consumer groups, as well as numerous state and local governments and associations, emphasized the importance of air pollution emissions reductions to protect public health and welfare and combat climate change, and noted that emissions reductions are especially critical in communities overburdened by air pollution. Many of these commenters recommended adopting the strongest standards possible for both GHGs and criteria pollutants. Some of these commenters supported light-duty GHG standards even more stringent than the proposal's most stringent alternative. Similarly, automakers that produce only electric vehicles (including Tesla, Rivian, and Lucid) and commenters representing the electric vehicle industry also expressed strong support for the proposal, with some of these stakeholders also advocating standards more stringent than the proposal's most stringent alternative. Automotive suppliers largely expressed strong support for performance-based standards for GHG and criteria pollutants. Some suggested that the GHG standards should phase-in more gradually, relying on increased ICE technology in the near term. Suppliers also strongly supported the proposed particulate matter (PM) emissions standard, attested to the feasibility and readiness of gasoline particulate filter technology expected to be used to meet the standard, and urged that the standard be phased in even sooner than proposed. Several commenters provided supportive data on development of the battery supply chain, critical minerals, grid readiness, and charging infrastructure.

Comments from automakers that historically have produced primarily ICE vehicles, such as comments by the Alliance for Automotive Innovation (hereafter referred to as ''the Alliance'') as well as comments by several individual automakers, generally expressed the auto industry's strong commitment to the goals of the proposed rule and to the transition to zero emission vehicles, as well as their support for continued efforts to reduce emissions from ICE vehicles that will continue to be produced during the transition to electrification. Many auto companies described their significant R&D investments in clean transportation and their corporate commitments to carbon neutrality and transitioning their vehicle offerings to electrified vehicles. The Alliance and many auto companies expressed their concern that the proposed standards would be very challenging to meet. A common theme was that the proposed GHG standards

[144] Bloomberg NEF. 2023. ''Electric Vehicle Outlook 2023.''

[145] U.S. Department of Energy, Office of Policy. 2023. ''Investing in American Energy: Significant Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Energy Economy and Emissions Reductions.''

[146] Slowik, Peter, Stephanie Searle, Hussein Basma, Josh Miller, Yuanrong Zhou, Felipe Rodriguez, Claire Buysse, et al. 2023. ''Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States.'' International Council on Clean Transportation and Energy Innovation Policy & Technology LLC.

[147] Mid-range third-party estimates exclude more extreme scenarios, which did not include all IRA incentives or were described as ''High'' or ''Advanced'' by respective study authors. See RIA Chapter 4.1.2.

[148] 66 FR 5002.

[149] 79 FR 23414.

[150] 76 FR 57106.

''moved the goalposts'' with respect to the Administration's goal of 50 percent zero emission vehicle sales by 2030, which the automakers had supported. These commenters noted that automakers' support for the Administration's goal was premised on various developments important to electrification, as well as governmental support for such developments, that they believe are unlikely to be ready in time to meet the proposed standards (for example, development of charging infrastructure, critical minerals, consumer acceptance, and readiness of the electric grid). Several auto manufacturers, including Ford, supported the MY 2032 end point for the proposed standards, but indicated that a more gradual ramp rate in early years (such as the proposal's Alternative 3) is needed to align with their anticipated scaling of the electric vehicle (EV) supply chain and manufacturing base. Another common theme from many auto manufacturers was that meeting the proposed criteria pollutant standards in addition to GHG standards could divert the auto manufacturers' investments away from electrification and toward ICE technology.

The United Auto Workers (UAW) expressed support for the transition to a cleaner auto industry and believes that regulations that push the industry to adopt cleaner technologies are important to create a strong domestic manufacturing base. Both UAW and the United Steelworkers expressed concern regarding the pace of the proposed standards and its possible effects on employment. These organizations believed that the pace of technology transition under the proposed standards could lead to job disruptions and lower-quality jobs, and generally suggested that EPA pursue GHG standards that phase in more gradually over a longer time period. The United Steelworkers expressed strong support for the proposed PM standard.

In contrast to the strong support expressed by many state and local governments described above, several other state and local governments and a group of state Attorneys General expressed strong concerns with the proposal. These comments included that they question EPA's authority to set standards that would promote production of electric vehicles, believe there are significant hurdles to widespread EV adoption, and otherwise raise concerns with various aspects of EPA's analysis.

Commenters representing the fuels industry (petroleum and/or biofuels) expressed many concerns with the proposal, in particular the levels of increased BEV penetrations projected. Other themes included questions regarding EPA's Clean Air Act authority related to electric vehicles and fleet averaging, concerns about dependence on imports of critical minerals, concerns about grid reliability, infrastructure needs, and safety. Many of the fuel industry commenters recommended that EPA adopt a life cycle analysis approach to setting standards and give greater consideration to the role of low carbon fuels.

Utility organizations generally indicated that the proposal sends appropriate signals to support continued infrastructure buildout. Investor-owned utilities believe they can accommodate localized power needs at the pace of customer demand, provided customer engagement and enabling policies are in place. Not-for-profit electric cooperatives serving rural areas and underserved communities highlighted the substantial grid upgrade investments needed to support increased transportation electrification and urged EPA to account for these costs.

EPA has thoroughly considered the public comments, including the data and information submitted by commenters, as well as our updated analysis based on this public record and the best available information. This preamble, together with the accompanying Response to Comments (RTC) document, responds to the comments we received on the proposed rule. This final rule reflects the input we received through the public comment process and is also supported by updated analyses for which EPA considered the most recent and best available technical and scientific data.

The following sections summarize at a high level each of the standards and program provisions finalized in this rule. Section III of this preamble includes a more detailed discussion of each of these elements and how we considered public comments and updated information in determining the final standards and program provisions.

1. GHG Emissions Standards

EPA is establishing GHG standards for both light-duty vehicles and medium-duty vehicles for MYs 2027 through 2032 that are more stringent than the prior standards applicable under the 2021 rule. For light-duty vehicles, EPA is finalizing standards that increase in stringency each year over a six-year period, from MYs 2027–2032. The standards are projected to result in an industry-wide average target for the light-duty fleet of 85 grams/mile (g/mile) of CO_2 in MY 2032, representing a nearly 50 percent reduction in projected fleet average GHG emissions target levels from the existing MY 2026 standards. Table 1 presents a summary of the projected industry average targets for the light-duty GHG standards for MY 2027–2032 for cars, trucks, and the overall light-duty fleet.

TABLE 1—PROJECTED TARGETS FOR FINAL LIGHT-DUTY VEHICLE GHG STANDARDS, BY REGULATORY CLASS

[CO_2 grams/mile] [a]

	2026 (reference)	2027	2028	2029	2030	2031	2032
Cars	131	139	125	112	99	86	73
Trucks	184	184	165	146	128	109	90
Total Fleet	168	170	153	136	119	102	85

[a] This table does not reflect changes in credit flexibilities such as the phase-out of available off-cycle and A/C credits. Adjusted targets are shown in section III.C.2.iv.b of the preamble.

In the NPRM, EPA requested comment on the proposed light-duty GHG standards as well as three alternatives: a more stringent alternative (Alternative 1), a less stringent alternative (Alternative 2), and an alternative that landed at the same stringency as the proposal in MY 2032 but provided a linear ramp rate from MY 2027 to 2032 (Alternative 3). Alternative 3's linear ramp rate had less stringent light-duty GHG standards than the proposed standards for MYs 2027–2031.

As discussed in this section above, in public comments, various stakeholders had opposing views on the light-duty GHG standards stringency alternatives.

Many environmental and public health NGOs, states, consumer groups, BEV-only manufacturers, and PEV industry groups supported the strongest possible standards, with many supporting standards even more stringent than Alternative 1. The major automakers, in contrast, expressed concern that the proposed standards were too ambitious, that EPA's technical analysis was overly optimistic, and that the levels of battery electric vehicles (BEVs) projected under the proposed standards would be challenging to reach, especially given uncertainties in the battery supply chain, market demand, and infrastructure buildout. Labor groups urged a slower transition to PEVs to mitigate potential adverse impacts on jobs. A few automakers, including Ford, supported the 2032 end point of the proposal, but believed that a slower ramp rate, like Alternative 3, was necessary in the early years to allow for the scale up of PEV supply chains and manufacturing. These companies recommended that in addition to Alternative 3, EPA should slow the phase-down of several credit provisions, such as the off-cycle credits and air conditioning leakage credits, which would be additional ways to address lead time in the early years.

Based on our consideration of the public comments and our updated technical analysis, EPA is finalizing light-duty GHG standards that land at the same stringency level as proposed in MY 2032 but have a relatively more linear ramp rate of standards stringency, one that is more gradual in the early years from MYs 2027–2031. Specifically, the final standards are the proposal's Alternative 3 footprint CO_2 standards curves. In addition, in response to auto industry and labor group concerns about lead time, particularly for MYs 2027–2029, EPA is finalizing an extended phase-down for two optional credit flexibilities: off-cycle credits and air conditioning leakage credits. The extension of these two flexibility provisions will help to address lead time issues in the early years of the program, by providing additional paths for automakers to earn GHG credits that contribute to compliance with the footprint-based CO_2 standards. EPA also is delaying the phase-in of the revised PHEV utility factor from MY 2027 until MY 2031, to provide additional stability for the program, and to give manufacturers ample time to transition to the new compliance calculation for PHEVs. EPA discusses the light-duty GHG final standards in detail in section III.C.1 of this preamble. The off-cycle credits, air conditioning credits, and PHEV utility factor provisions are described in more detail in sections III.C.4 through III.C.6 of this preamble.

For medium-duty vehicles, EPA is revising the existing standard for MY 2027 given the increased feasibility of GHG emissions reducing technologies in this sector in this time frame. EPA's standards for MDVs increase in stringency year over year from MY 2027 through MY 2032. EPA is finalizing MDV GHG standards that land at the same stringency as the proposal in MY 2032, but which have a more gradual rate of stringency in the early years compared to the proposed standards. These changes are responsive to comments from manufacturers that recommended additional lead time in early years of the program. When phased in, the MDV standards are projected to result in an average fleet target of 274 grams/mile of CO_2 by MY 2032, which represents a reduction of 44 percent compared to the current MY 2026 standards. Table 2 presents a summary of the industry average targets projected for the medium-duty GHG standards for MYs 2027–2032, for vans, MDV pickups, and the MDV fleet overall.

TABLE 2—PROJECTED TARGETS FOR FINAL MEDIUM-DUTY VEHICLE GHG STANDARDS, BY BODY STYLE

[CO_2 grams/mile]

	2026 (reference)	2027	2028	2029	2030	2031	2032
Vans	423	392	391	355	317	281	245
Pickups	522	497	486	437	371	331	290
Total Fleet	488	461	453	408	353	314	274

EPA emphasizes that its standards are performance-based, and manufacturers are not required to use particular technologies to meet the standards. There are many potential pathways to compliance with the final standards manufacturers may choose that involve different mixtures of vehicle technologies. The technology pathway in our central case [151] supporting the feasibility of the final rule standards includes a projected mix of improvements to internal combustion engine performance, as well as increases in use of powertrain electrification technologies (across the range from mild hybrid to BEV). In addition, to further assess the feasibility of the standards under different potential scenarios and to illustrate that there are many potential pathways to compliance with the final standards that include a wide range of potential technology mixes, we evaluated examples of other potential compliance pathways. Table 3 presents three such pathways as examples, including: Pathway A, which reflects a higher level of BEVs and a lower level of HEVs and PHEVs (and is also our central case analysis); Pathway B, which achieves compliance at a lower level of BEV production and a moderate level of HEVs and PHEVs; and Pathway C, which achieves compliance with no additional BEVs beyond those projected in the No Action case, and with a higher level of HEVs and PHEVs.[152] EPA also

[151] EPA recognizes that the pathway labeled as the central case, shown as Pathway A in Table 3, features greater BEV penetration than Pathways B and C, which feature greater use of various ICE technologies. This does not mean that EPA requires or prefers any manufacturer to adopt the pathway in this case over the other cases. EPA has conducted significant analysis for each of the cases. However, we had to identify a single case to subject to the full scope of our analysis given practical limitations on agency resources, the complexity and wide-ranging nature of the analysis, and the importance of promulgating this rule in a reasonable timeframe so as to address the significant public health and welfare impacts associated with motor vehicle emissions. Moreover, the reason Pathway A is the central case is not due to any a priori agency inclination to any specific technology, but rather because our evaluation of updated real-world information, described in this section and throughout the record, shows that the market is most likely to comply with increasing GHG emission standards through increased BEV production and that BEV technologies are the most cost-effective way to do so.

[152] Specifically, Pathway B reflects a scenario in which manufacturers limit production of BEVs and consumer adoption of PHEVs is more prevalent than for BEVs, and Pathway C reflects a scenario in which manufacturers sell approximately the number of BEVs that we project to be sold under the No Action scenario for our central case projection and thus produce a greater share of PHEVs and HEVs under the standards. In our discussion of sensitivities in section IV.F.5, Pathways B and C are titled ''Lower BEV Production'' and ''No Additional BEVs Beyond the No Action Case,'' respectively. See sections IV.F

Continued

evaluated additional technology pathways as sensitivities which are presented fully in sections IV.F and G of this preamble and Chapter 12 of the RIA. In addition, we evaluated an illustrative scenario that does not rely on any new BEV introductions beyond those in the existing fleet (see section IV.H.1 of the preamble).

TABLE 3—PROJECTED NEW VEHICLE TECHNOLOGY PENETRATIONS FOR FINAL LIGHT-DUTY VEHICLE GHG STANDARDS FOR VARYING SCENARIOS [153]

Pathway	Technology	2027 (percent)	2028 (percent)	2029 (percent)	2030 (percent)	2031 (percent)	2032 (percent)
Pathway A—Higher BEV Pathway (central analysis case)	ICE	64	58	49	43	35	29
	HEV	4	5	5	4	3	3
	PHEV	6	6	8	9	11	13
	BEV	26	31	39	44	51	56
Pathway B—Moderate HEV and PHEV Pathway	ICE	62	56	49	39	28	21
	HEV	4	4	3	6	7	6
	PHEV	10	12	15	18	24	29
	BEV	24	29	33	37	41	43
Pathway C—Higher HEV and PHEV Pathway	ICE	61	41	35	27	19	17
	HEV	4	15	13	16	15	13
	PHEV	10	17	22	27	32	36
	BEV	24	26	30	31	34	35

EPA also sought comment on whether the standards should continue to increase in stringency for future years, such as through MY 2035. While a few commenters supported extending standards to MY 2035, many commenters raised concerns with setting standards beyond 2032, pointing to considerable uncertainty in projecting out ten or more years the state of the BEV market and supporting conditions, such as charging infrastructure buildout, given that the proposal had projected high penetrations of BEVs. Other commenters suggested that if standards were extended beyond MY 2032, that some form of mid-course review could be necessary given the increased uncertainty. In consideration of these comments and recognizing the increased uncertainty around emissions technology developments and costs in the MYs 2033–2035 timeframe, EPA is establishing standards in this action for MYs 2027 through 2032.

The light-duty CO_2 standards continue to be footprint-based, with separate standards curves for cars and light trucks. EPA has updated its assessment of the footprint standards curves to reflect anticipated changes in the vehicle technologies that we project will be used to meet the standards. EPA also has assessed ways to ensure future fleet mix changes do not inadvertently provide an incentive for manufacturers to change the size or regulatory class of vehicles as a compliance strategy. EPA is finalizing the proposed approach to flatten the slope of each footprint standards curve and to narrow the numerical stringency difference between the car and truck curves. The medium-duty vehicle standards continue to be based on a work-factor metric designed for commercially-oriented vehicles, which reflects a combination of payload, towing and 4-wheel drive equipment.

EPA has reassessed certain credit programs available under the existing GHG programs considering the agency's experience with the program implementation to date, trends in technology development, recent related statutory provisions, and other factors. EPA is revising the air conditioning (A/C) credits program in two ways. First, for A/C system efficiency credits under the light-duty GHG program, EPA is limiting the eligibility for these voluntary credits for tailpipe CO_2 emissions control to ICE vehicles starting in MY 2027 (*i.e.,* BEVs do not earn A/C efficiency credits because A/C efficiency improvements do not result in any reduction in direct vehicle emissions). Second, EPA is significantly reducing the magnitude of available refrigerant-based A/C credits for light-duty vehicles because, under a separate rulemaking, EPA has disallowed the use of high Global Warming Potential (GWP) refrigerants under the Technology Transitions Rule of October 2023, implemented under the American Innovation and Manufacturing (AIM) Act of 2020. EPA is finalizing provisions that phase-down the A/C refrigerant credits beginning in MY 2027. For MY 2031 and later, EPA is retaining small A/C refrigerant credits designed to incentivize the continued application of A/C refrigerant leakage mitigation countermeasures and the use of refrigerants with GWP lower than that required under the Technology Transitions Rule.

EPA is also sunsetting the off-cycle credits program for light-duty vehicles as follows. First, EPA is phasing out menu-based credits by reducing the menu credit cap year-over-year until it is fully phased out in MY 2033. Specifically, EPA is setting a declining menu cap of 10/8/6/0 grams per mile (g/mile) for non-BEVs over MYs 2030–2033 such that MY 2032 would be the last year manufacturers could generate optional off-cycle credits. Second, EPA is eliminating the 5-cycle and public process pathways for generating off-cycle credits starting in MY 2027. Third, EPA is limiting eligibility for off-cycle credits only to vehicles with tailpipe emissions greater than zero (*i.e.,* vehicles equipped with IC engines) starting in MY 2027.

EPA is not reopening its averaging, banking, and trading provisions, which continue to be a central part of its fleet average standards compliance program, and which help manufacturers to employ a wide range of compliance paths. EPA is also not reopening its existing regulations which sunset in MY 2024 light-duty multiplier incentives for BEVs, PHEVs and fuel cell vehicles. EPA is revising multiplier incentives previously in place for MDVs for MY 2027 (established in the heavy-duty Phase 2 rule) to end the multipliers one model year earlier, such that MY 2026 is the last year that MDV multipliers will be in effect. EPA is also finalizing regulatory text to ensure that compliance with vehicle GHG emissions standards continues to be assessed based on vehicle emissions. Under this final rule, BEVs and the electric operation of PHEVs will continue to be counted as zero g/mile in a

and G of this preamble for additional description of these and other sensitivity scenarios.

[153] In this table, the ICE category includes ICE vehicles (base ICE and advanced ICE) and mild HEVs. The Hybrids (HEVs) category represent strong hybrids only. See section III.A of this preamble for further clarification of definitions.

manufacturer's compliance calculation as has been the case since the beginning of the light-duty GHG program in MY 2012.

Finally, EPA is establishing provisions for small volume manufacturers (*i.e.,* production of less than 5,000 vehicles per year) to transition them from the prior approach of unique case-by-case alternative standards to the primary program standards by MY 2032, recognizing that this extended lead time is appropriate given the level of the existing case-by-case alternative standards.

2. Criteria Pollutant Standards

EPA is finalizing more stringent emissions standards for criteria pollutants [154] for both light-duty and medium-duty vehicles that begin in MY 2027. For light-duty vehicles, EPA is finalizing non-methane organic gases (NMOG) plus nitrogen oxides (NO_X) standards [155] that would phase-down to a fleet average level of 15 milligrams per mile (mg/mile) by MY 2032, representing a 50 percent reduction from the existing 30 mg/mile standards for MY 2025 established in the Tier 3 rule in 2014. For medium-duty vehicles, EPA is finalizing NMOG+NO_X standards that require a fleet average level of 75 mg/mile by MY 2031 representing a 58 percent to 70 percent reduction from the Tier 3 standards of 178 mg/mile for Class 2b vehicles and 247 mg/mile for Class 3 vehicles. EPA is also finalizing cold temperature (−7°C) NMOG+NO_X standards for all light-duty vehicles and gasoline medium-duty vehicles to ensure robust emissions control over a broad range of operating conditions.

For all light-duty vehicles and gasoline medium-duty vehicles, EPA is finalizing a particulate matter (PM) standard of 0.5 mg/mile and a requirement that the standard be met across three test cycles, including a cold temperature (−7°C) test. This standard revises the existing PM standards established in the 2014 Tier 3 rule. Through the application of readily available emissions control technology and requiring compliance across the broad range of driving conditions represented by the three test cycles, EPA projects the standards will reduce tailpipe PM emissions from ICE vehicles by over 95 percent. In addition to reducing PM emissions, the standards will reduce emissions of mobile source air toxics.

[154] In this notice, EPA is using ''criteria pollutants'' to refer generally to criteria pollutants and their precursors, including tailpipe NMOG, NO_X, PM, and CO, as well as evaporative and refueling HC.

[155] Together referred to as NMOG+NO_X.

EPA is finalizing in-use standards for medium-duty vehicles with high gross combination weight rating (GCWR), changes to medium-duty vehicle refueling emissions requirements for incomplete vehicles, and several NMOG+NO_X provisions aligned with the California Air Resources Board (CARB) Advanced Clean Cars II program for light-duty vehicles. EPA is finalizing changes to the carbon monoxide and formaldehyde standards for light- and medium-duty vehicles, including at −7°C. EPA is not finalizing new limitations on the application of commanded enrichment, but will revisit the issue as a follow-on to this final rule. As with the GHG program, EPA is not reopening its averaging, banking, and trading provisions for the criteria pollutant program, excepting discrete provisions regarding how credits may be transferred from the Tier 3 program.

3. Electrified Vehicle Battery Durability and Warranty Provisions

EPA is establishing new requirements related to battery durability for PEVs, substantially as proposed. As described in more detail in section III.G.2 of this preamble, the importance of battery durability in the context of PEVs is well documented and has been cited by several authorities in recent years. Because electrified vehicles are playing an increasing role in automakers' compliance strategies, their durability and reliability are important to achieving the full useful life for which emissions reductions are projected under this program. To this end we are establishing battery durability monitoring and performance requirements for light-duty PEVs and battery durability monitoring requirements for medium-duty PEVs. In addition, the agency is including PEV batteries and associated electric powertrain components under existing emission warranty provisions. Relatedly, EPA is also finalizing the addition of two new grouping definitions for PEVs (monitor family and battery durability family), new reporting requirements, and a new calculation for the PHEV charge depletion test to support the battery durability requirements. The background and content of the battery durability and warranty provisions are outlined in section III.G.2 of this preamble.

4. Light-Duty Vehicle Certification and Testing Program Improvements

EPA is finalizing various improvements to the current light-duty program to clarify, simplify, streamline and update the certification and testing provisions for manufacturers. These improvements include: Clarification of the certification compliance and enforcement requirements for CO_2 exhaust emission standards to more accurately reflect the intention of the 2010 light-duty vehicle GHG rule; a revision to the In Use Confirmatory Program (IUCP) threshold criteria; changes to the Part 2 application; updating the On Board Diagnostics (OBD) program to the latest version of the CARB OBD regulation and the removal of any conflicting or redundant text from EPA's OBD requirements; streamlining the test procedures for Fuel Economy Data Vehicles (FEDVs); streamlining the manufacturer conducted confirmatory testing requirements; updating the emissions warranty for diesel powered vehicles (including Class 2b and 3 vehicles) by designating major emissions components subject to the 8year/80,000 mile warranty period; making the definition of light-duty truck consistent between the GHG and criteria pollutant programs; and miscellaneous other amendments. EPA is also establishing, as proposed, that gasoline particulate filters (GPFs) qualify as specified major emission control components for purposes of applying warranty requirements. These changes are described in more detail in sections III.G and III.H of this preamble.

C. Summary of Emission Reductions, Costs, and Benefits

This section summarizes our analyses of the rule's estimated emission impacts, costs, and monetized benefits, which are described in more detail in sections V through VIII of this preamble. EPA notes that, consistent with CAA section 202, in evaluating potential standards we carefully weighed the statutory factors, including the emissions impacts of the standards, and the feasibility of the standards (including cost of compliance in light of available lead time). We monetize benefits of the standards and evaluate costs in part to enable a comparison of costs and benefits pursuant to E.O. 12866, but we recognize there are benefits that we are currently unable to fully quantify and monetize. EPA's practice has been to set standards to achieve improved air quality consistent with CAA section 202, and not to rely on cost-benefit calculations, with their uncertainties and limitations, as identifying the appropriate standards. Nonetheless, our conclusion that the monetized estimated benefits exceed the estimated costs of the final program reinforces our view that the standards are appropriate under section 202(a).

The standards will result in substantial net reductions of emissions of GHGs and criteria air pollutants in 2055, considering the impacts from light- and medium-duty vehicles, power plants (*i.e.,* electric generating units (EGUs)), and refineries. Table 4 shows the GHG emission impacts in 2055 while Table 5 shows the cumulative impacts for the years 2027 through 2055. CO_2 equivalent (CO_2e) values use 100-year global warming potential values of 28 and 265 for CH_4 and N_2O, respectively.[156] We show cumulative impacts for GHGs because elevated concentrations of GHGs in the atmosphere are resulting in warming and other changes in the Earth's climate. Table 6 shows the criteria pollutant emissions impacts in 2055, which include the substantial reduction in criteria pollutants from vehicle and refinery emissions, and the significant reduction in net criteria pollutant impacts as a result of this final rule. As shown in Table 7, we also predict reductions in air toxic emissions from light- and medium-duty vehicles. We project that GHG and criteria pollutant emissions from EGUs will increase as a result of the increased demand for electricity associated with the final rule, although those projected impacts decrease over time because of projected increases in clean electricity in the future power generation mix. We also project that GHG and criteria pollutant emissions from refineries will decrease as a result of the lower demand for liquid fuel associated with the GHG standards. Notably, even at their highest levels, the EGU emissions increases are more than offset by the large reductions in vehicle emissions as well as reductions from the refinery sector. Sections VI and VII of this preamble and Chapter 8 of the RIA provide more information on the projected emission reductions for the standards.

TABLE 4—PROJECTED GHG EMISSION IMPACTS FROM THE FINAL RULE IN 2055

[Million metric tons] [a]

Pollutant	Vehicle	EGU	Refinery	Net impact	Net impact (%)
CO_2	−410	21	−16	−410	−37
CH_4	−0.0079	0.00083	−0.00088	−0.0079	−34
N_2O	−0.0071	0.0001	−0.00013	−0.0072	−38
CO_2e	−410	21	−16	−410	−37

[a] Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

TABLE 5—PROJECTED CUMULATIVE GHG EMISSION IMPACTS FROM THE FINAL RULE IN 2027–2055

[Million metric tons] [a]

Pollutant	Vehicle	EGU	Refinery	Net impact	Net impact (%)
CO_2	−7,500	550	−280	−7,200	−21
CH_4	−0.13	0.027	−0.016	−0.12	−15
N_2O	−0.13	0.0034	−0.0023	−0.13	−23
CO_2e	−7,500	550	−280	−7,200	−21

[a] Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

TABLE 6—PROJECTED CRITERIA AIR POLLUTANT IMPACTS FROM THE FINAL RULE IN 2055

[U.S. tons] [a]

Pollutant	Vehicle	EGU	Refinery	Net impact	Net impact (%)
$PM_{2.5}$	−8,500	1,500	−1,800	−8,700	−22
NO_X	−35,000	5,500	−7,400	−36,000	−25
VOC	−140,000	930	−5,100	−150,000	−46
SO_X	−1,900	1,300	−2,200	−2,800	−16
CO	−1,700,000	0	−4,900	−1,700,000	−52

[a] EPA did not have data available to calculate CO impacts from EGUs. Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

TABLE 7—PROJECTED VEHICLE AIR TOXIC IMPACTS FROM THE FINAL RULE IN 2055

[U.S. tons] [a]

Pollutant	Vehicle	Vehicle (%)
Acetaldehyde	−740	−47
Benzene	−2,300	−51
Formaldehyde	−440	−47
Naphthalene	−90	−51
1,3-Butadiene	−290	−51

[156] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], pp 87. Available online: *https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf.*

TABLE 7—PROJECTED VEHICLE AIR TOXIC IMPACTS FROM THE FINAL RULE IN 2055—Continued

[U.S. tons] [a]

Pollutant	Vehicle	Vehicle (%)
15 Polyaromatic Hydrocarbons	−4	−78

[a] Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

These GHG emission reductions will make an important contribution to efforts to limit climate change and subsequently reduce the probability of severe climate change related impacts including heat waves, drought, sea level rise, extreme climate and weather events, coastal flooding, and wildfires. People of color, low-income populations and/or indigenous peoples may be especially vulnerable to the impacts of climate change (see section VIII.J.2 of this preamble).

The decreases in vehicle emissions will reduce traffic-related pollution in close proximity to roadways. As discussed in section II.C.8 of this preamble, concentrations of many air pollutants are elevated near high-traffic roadways, and populations who live, work, or go to school near high-traffic roadways experience higher rates of numerous adverse health effects, compared to populations far away from major roads. An EPA study estimated that 72 million people live near truck freight routes, which includes many large highways and other routes where light- and medium-duty vehicles operate.[157] Our consideration of scientific literature indicates that people of color and people with low income are disproportionately exposed to elevated concentrations of many pollutants in close proximity to major roadways (see section VIII.J.3.i of this preamble).

The changes in emissions of criteria and toxic pollutants from vehicles, EGUs, and refineries will also impact ambient levels of ozone, $PM_{2.5}$, NO_2, SO_2, CO, and air toxics over a larger geographic scale. As discussed in section VII.B of this preamble, we expect that in 2055 the final rule will result in widespread decreases in ozone, $PM_{2.5}$, NO_2, CO, and some air toxics, even when accounting for the impacts of increased electricity generation. We expect that in some localized areas, increased electricity generation will increase ambient SO_2, $PM_{2.5}$, ozone, or some air toxics. However, as the power sector becomes cleaner over time, these impacts will decrease as a result of the IRA as well as future policies that are not accounted for in this analysis.

Climate benefits are monetized using estimates of the social cost of greenhouse gases (SC–GHG), which in principle includes the value of all climate change impacts (both negative and positive), however in practice, data and modeling limitations naturally restrain the ability of SC–GHG estimates to include all the important physical, ecological, and economic impacts of climate change, such that the estimates are a partial accounting of climate change impacts and will therefore, tend to be underestimates of the marginal benefits of abatement. In our proposal, EPA used interim Social Cost of GHGs (SC–GHG) values developed for use in benefit-cost analyses until updated estimates of the impacts of climate change could be developed based on the best available science and economics. In response to recent advances in the scientific literature on climate change and its economic impacts, incorporating recommendations made by the National Academies of Science, Engineering, and Medicine (National Academies, 2017), and to address public comments on this topic, for this final rule we are using updated SC–GHG values. EPA presented these updated values in a sensitivity analysis in the December 2022 Oil and Gas Rule RIA which underwent public comment on the methodology and use of these estimates as well as external peer review. After consideration of public comment and peer review, EPA issued a technical report in December 2023 updating the estimates of SC–GHG in light of recent information and advances. This is discussed further in section VIII.E.1 of this preamble and RIA Chapter 9.

EPA estimates that the total benefits of this action far exceed the total costs with the annualized value of monetized net benefits to society estimated at $99 billion through the year 2055, assuming a 2 percent discount rate, as shown in Table 8.[158] The annualized value of monetized emission benefits is $85 billion, with $72 billion of that attributed to climate-related economic benefits from reducing emissions of GHGs that contribute to climate change and the remainder attributed to reduced emissions of criteria pollutants that contribute to ambient concentrations of smaller particulate matter ($PM_{2.5}$). $PM_{2.5}$ is associated with premature death and serious health effects such as hospital admissions due to respiratory and cardiovascular illnesses, nonfatal heart attacks, aggravated asthma, and decreased lung function.

The annualized value of vehicle technology costs is estimated at $40 billion. Notably, this rule will result in significant savings in vehicle maintenance and repair for consumers, which we estimate at an annualized value of $16 billion (note that these values are presented as negative costs, or savings, in the table). EPA projects generally lower maintenance and repair costs for electric vehicles and those societal maintenance and repair savings grow significantly over time. We also estimate various impacts associated with our assumption that consumers choose to drive more due to the lower cost of driving under the standards, called the rebound effect (as discussed further in section VIII of this preamble and in Chapters 4, 8 and 9 of the RIA). Increased traffic noise and congestion costs are two such effects due to the rebound effect, which we estimate at an annualized value of $1.2 billion.

EPA also estimates impacts associated with fueling the vehicles under our standards. The rule will provide significant savings to society through reduced fuel expenditures with annualized pre-tax fuel savings of $46 billion. Somewhat offsetting those fuel savings is the expected cost of EV chargers, or electric vehicle supply equipment (EVSE), of $9 billion.

This rule includes other benefits not associated with emission reductions. Energy security benefits are estimated at an annualized value of $2.1 billion. The drive value benefit, which is the value of consumers' choice to drive more under the rebound effect, has an estimated annualized value of $2.1 billion. The refueling time impact includes two effects: time saved refueling for ICE vehicles with lower

[157] U.S. EPA (2021). Estimation of Population Size and Demographic Characteristics among People Living Near Truck Routes in the Conterminous United States. Memorandum to the Docket.

[158] All subsequent annualized costs and annualized benefits cited in this executive summary refer to the values generated at a 2 percent discount rate.

fuel consumption under our standards, and mid-trip recharging events for electric vehicles. Our past GHG rules have estimated that refueling time would be reduced due to the lower fuel consumption of new vehicles; hence, a benefit. However, in this analysis, we are estimating that refueling time will increase somewhat overall for the fleet due to our additional assumption for mid-trip recharging events for electric vehicles. Therefore, the refueling time impact represents a disbenefit (a negative benefit) as shown, with an annualized value at negative $0.8 billion. As noted in section VIII of this preamble and in RIA Chapter 4, we have updated our refueling time estimates but still consider that they may be conservatively high for electric vehicles considering the rapid changes taking place in electric vehicle charging infrastructure, including those driven by the Bipartisan Infrastructure Law and the Inflation Reduction Act.

Note that some costs are shown as negative values in Table 8. Those entries represent savings but are included under the ''costs'' category because, in past rules, categories such as repair and maintenance have been viewed as costs of vehicle operation; as discussed above, under this rule we project significant savings in repair and maintenance costs for consumers. Where negative values are shown, we are estimating that those costs are lower under the final standards than in the No Action case.

TABLE 8—MONETIZED COSTS, BENEFITS, AND NET BENEFITS OF THE FINAL PROGRAM FOR CALENDAR YEARS (CYS) 2027 THROUGH 2055

[Billions of 2022 dollars] [a, b, c, d]

	CY 2055	PV, 2%	PV, 3%	PV, 7%	AV, 2%	AV, 3%	AV, 7%
Vehicle Technology Costs	$38	$870	$760	$450	$40	$39	$37
Insurance Costs	1.9	33	28	15	1.5	1.4	1.2
Repair Costs	−7.1	−40	−32	−12	−1.8	−1.6	−0.99
Maintenance Costs	−35	−300	−250	−110	−14	−13	−9.3
Congestion Costs	2.4	25	21	10	1.2	1.1	0.83
Noise Costs	0.04	0.41	0.34	0.17	0.019	0.018	0.014
Sum of Costs	0.59	590	530	350	27	28	29
Pre-tax Fuel Savings	94	1,000	840	420	46	44	34
EVSE Port Costs	8.6	190	160	96	9	8.8	7.9
Sum of Fuel Savings less EVSE Port Costs	86	820	680	330	37	35	26
Drive Value Benefits	4.7	46	38	18	2.1	2	1.5
Refueling Time Benefits	−1.7	−17	−15	−7.5	−0.8	−0.76	−0.61
Energy Security Benefits	4.1	47	39	20	2.1	2	1.6
Sum of Non-Emission Benefits	7	75	62	30	3.4	3.2	2.5
Climate Benefits, 2% Near-term Ramsey	150	1,600	1,600	1,600	72	72	72
$PM_{2.5}$ Health Benefits	25	240	200	88	13	10	7.2
Sum of Emission Benefits	170	1,800	1,800	1,700	85	83	80
Net Benefits	270	2,100	2,000	1,700	99	94	80

[a] Net benefits are emission benefits, non-emission benefits, and fuel savings (less EVSE port costs) minus the costs of the program. Values rounded to two significant figures; totals may not sum due to rounding. Present and annualized values are based on the stream of annual calendar year costs and benefits included in the analysis (2027—2055) and discounted back to year 2027. Climate benefits are based on reductions in GHG emissions and are calculated using three different SC–GHG estimates that assume either a 1.5 percent, 2.0 percent, or 2.5 percent near-term Ramsey discount rate. See EPA's Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (EPA, 2023). For presentational purposes in this table, we use the climate benefits associated with the SC–GHG under the 2-percent near-term Ramsey discount rate. All other costs and benefits are discounted using either a 2-percent, 3-percent, or 7-percent constant discount rate. For further discussion of the SC–GHGs and how EPA accounted for these estimates, please refer to section VIII.E of this preamble and Chapter 6.2 of the RIA.

[b] To calculate net benefits, we use the monetized suite of total avoided $PM_{2.5}$-related health effects that includes avoided deaths based on the Pope III et al., 2019 study, which is the larger of the two $PM_{2.5}$ health benefits estimates presented in section VIII.F of this preamble.

[c] The annual $PM_{2.5}$ health benefits estimate presented in the CY 2055 column reflects the value of certain avoided health outcomes, such as avoided deaths, that are expected to accrue over more than a single year discounted using a 3-percent discount rate.

[d] We do not currently have year-over-year estimates of $PM_{2.5}$ benefits that discount such annual health outcomes using a 2-percent discount rate. We have therefore discounted the annual stream of health benefits that reflect a 3-percent discount rate lag adjustment using a 2-percent discount rate to populate the PV, 2 percent and AV, 2 percent columns. The annual stream of $PM_{2.5}$-related health benefits that reflect a 3-percent and 7-percent discount rate lag adjustment were used to populate the PV/AV 3 percent and PV/AV 7 percent columns, respectively. See section VIII.F of this preamble for more details on the annual stream of $PM_{2.5}$-related benefits associated with this rule.

As described in section VII of this preamble and RIA Chapter 7, EPA conducted an air quality modeling analysis of a light- and medium-duty vehicle policy scenario in 2055. The results of that analysis found that in 2055, consistent with the emission inventory results presented in section VII of the preamble,[159] the standards will result in widespread decreases in criteria pollutant emissions that will lead to substantial improvements in public health and welfare. We estimate that in 2055, 1,000 to 2,000 $PM_{2.5}$-related premature deaths will be avoided as a result of the modeled policy scenario, depending on the assumed long-term exposure study of $PM_{2.5}$-related premature mortality risk. We also estimate that the modeled policy scenario will avoid 25 to 550 ozone-related premature deaths, depending on the assumed study of ozone-related mortality risk. The monetized benefits of the improvements in public health in 2055 related to the modeled policy scenario (including reductions in both mortality and non-fatal illnesses) are $16 billion to $36 billion assuming a 2 percent discount rate (2022 dollars).

[159] Section VII of the preamble presents emission inventory results from OMEGA, EPA's light- and medium-duty GHG compliance and effects model. We discuss OMEGA in detail in the RIA, specifically Chapters 2, 4, 8 and 12.

EPA estimates the average upfront per-vehicle cost for manufacturers to meet the light-duty standards to be approximately $1,200 on average over the six-year rulemaking period between MYs 2027–2032, and range from about $200 in MY 2027 to about $2,100 in MY 2032, as shown in Table 9.[160] We discuss per-vehicle cost in more detail in section IV.C of this preamble and RIA Chapter 12. These costs are attributable to our projection that the MY 2032 fleet will be made up of a larger share of BEVs relative to ICE vehicles. However, after considering purchase incentives and their lower operating costs relative to ICE vehicles, BEVs are estimated to save vehicle owners money over time. We estimate that the standards will save an average consumer approximately $6,000 over the lifetime of a light-duty vehicle, as compared to a vehicle meeting the MY 2026 standards.[161] As another example, over an eight-year period (the average period of first ownership), we estimate a MY 2032 PEV owner will, on average, save $8,000 on purchase and operating costs compared to a gasoline vehicle that meets these standards.[162] We discuss ownership savings and expenses in more detail in RIA Chapter 4.2.2.

TABLE 9—AVERAGE INCREMENTAL VEHICLE COST BY REG CLASS, RELATIVE TO THE NO ACTION SCENARIO, LIGHT-DUTY VEHICLES

(2022 dollars)

	2027	2028	2029	2030	2031	2032	6-year avg
Cars	$135	$348	$552	$968	$849	$934	$631
Trucks	276	642	1,199	1,703	2,318	2,561	1,450
Total	232	552	1,002	1,481	1,875	2,074	1,203

For medium-duty vehicles, EPA estimates the average upfront per-vehicle cost for manufacturers to be approximately $1,400 over the six-year rulemaking period between MYs 2027–2032 and range from an average cost of about $100 in MY 2027 to about $3,300 in MY 2032, as shown in Table 10.

TABLE 10—AVERAGE INCREMENTAL VEHICLE COST BY BODY STYLE, RELATIVE TO THE NO ACTION SCENARIO, MEDIUM-DUTY VEHICLES

(2022 dollars) [163]

	2027	2028	2029	2030	2031	2032	6-year avg
Vans	$178	$185	$1,443	$2,732	$4,128	$4,915	$2,264
Pickups	97	88	531	1,432	1,516	2,416	1,013
Total	125	122	847	1,881	2,416	3,275	1,444

In addition, the standards will result in significant savings for consumers from fuel savings for all vehicles and, for PEVs, reduced vehicle repair and maintenance. These lower operating costs will offset the upfront vehicle costs. The annualized retail fuel savings, which include fuel taxes and therefore represents the amount consumers will save through 2055, are estimated at $57 billion at a 2 percent discount rate, see section VIII.C of this preamble. These savings are in addition to the already mentioned savings associated with reduced maintenance and repair costs (See section VIII.B of this preamble and Chapter 4 of the RIA).

II. Public Health and Welfare Need for Emission Reductions

A. Climate Change From GHG Emissions

Elevated concentrations of greenhouse gases (GHGs) have been warming the planet, leading to changes in the Earth's climate that are occurring at a pace and in a way that threatens human health, society, and the natural environment. While EPA is not making any new scientific or factual findings with regard to the well-documented impact of GHG emissions on public health and welfare in support of this rule, EPA is providing in this section a brief scientific background on climate change to offer additional context for this rulemaking and to help the public understand the public health and environmental impacts of GHGs.

Extensive information on climate change is available in the scientific assessments and the EPA documents that are briefly described in this section, as well as in the technical and scientific information supporting them. One of those documents is EPA's 2009 Endangerment and Cause or Contribute Findings for Greenhouse Gases Under section 202(a) of the Clean Air Act (CAA) (74 FR 66496, December 15, 2009). In the 2009 Endangerment Finding, the Administrator found under section 202(a) of the CAA that elevated atmospheric concentrations of six key well-mixed GHGs—CO_2, methane (CH_4), nitrous oxide (N_2O), HFCs, perfluorocarbons (PFCs), and sulfur hexafluoride (SF6)—''may reasonably be anticipated to endanger the public health and welfare of current and future generations'' (74 FR 66523, December 15, 2009). The 2009 Endangerment Finding, together with the extensive scientific and technical evidence in the supporting record, documented that climate change caused by human emissions of GHGs threatens the public health of the U.S. population. It explained that by raising average temperatures, climate change increases the likelihood of heat waves, which are associated with increased deaths and illnesses (74 FR 66497, December 15, 2009). While climate change also increases the likelihood of reductions in cold-related mortality, evidence indicates that the increases in heat mortality will be larger than the decreases in cold mortality in the United States (74 FR 66525, December 15, 2009). The 2009 Endangerment

[160] Unless otherwise specified, all monetized values are expressed in 2022 dollars.

[161] This vehicle lifetime savings estimate takes into account the fleet-wide average Federal purchase incentive under the final standards and under the MY 2026 standards. See RIA Chapter 4.2.2 for additional discussion.

[162] This 8-year savings estimate includes the average Federal purchase incentive of $6,000 for BEVs and PHEVs. See RIA Chapter 4.2.2.

[163] For more details on the medium-duty GHG standards, refer to Section III.C.3 of the preamble.

Finding further explained that compared with a future without climate change, climate change is expected to increase tropospheric ozone pollution over broad areas of the United States, including in the largest metropolitan areas with the worst tropospheric ozone problems, and thereby increase the risk of adverse effects on public health (74 FR 66525, December 15, 2009). Climate change is also expected to cause more intense hurricanes and more frequent and intense storms of other types and heavy precipitation, with impacts on other areas of public health, such as the potential for increased deaths, injuries, infectious and waterborne diseases, and stress-related disorders (74 FR 66525, December 15, 2009). Children, the elderly, and the poor are among the most vulnerable to these climate-related health effects (74 FR 66498, December 15, 2009).

The 2009 Endangerment Finding also documented, together with the extensive scientific and technical evidence in the supporting record, that climate change touches nearly every aspect of public welfare [164] in the U.S., including: Changes in water supply and quality due to changes in drought and extreme rainfall events; increased risk of storm surge and flooding in coastal areas and land loss due to inundation; increases in peak electricity demand and risks to electricity infrastructure; and the potential for significant agricultural disruptions and crop failures (though offset to some extent by carbon fertilization). These impacts are also global and may exacerbate problems outside the U.S. that raise humanitarian, trade, and national security issues for the U.S. (74 FR 66530).

In 2016, the Administrator issued a similar finding for GHG emissions from aircraft under section 231(a)(2)(A) of the CAA.[165] In the 2016 Endangerment Finding, the Administrator found that the body of scientific evidence amassed in the record for the 2009 Endangerment Finding compellingly supported a similar endangerment finding under CAA section 231(a)(2)(A), and also found that the science assessments released between the 2009 and the 2016 Findings ''strengthen and further support the judgment that GHGs in the atmosphere may reasonably be anticipated to endanger the public health and welfare of current and future generations'' (81 FR 54424).

Since the 2016 Endangerment Finding, the climate has continued to change, with new observational records being set for several climate indicators such as global average surface temperatures, GHG concentrations, and sea level rise. Additionally, major scientific assessments continue to be released that further advance our understanding of the climate system and the impacts that GHGs have on public health and welfare both for current and future generations. These updated observations and projections document the rapid rate of current and future climate change both globally and in the United States.[166 167 168 169 170 171 172 173 174 175 176 177 178]

The most recent information demonstrates that the climate is continuing to change in response to the human-induced buildup of GHGs in the atmosphere. These recent assessments show that atmospheric concentrations of GHGs have risen to a level that has no precedent in human history and that they continue to climb, primarily because of both historical and current anthropogenic emissions, and that these elevated concentrations endanger our health by affecting our food and water sources, the air we breathe, the weather we experience, and our interactions with the natural and built environments. For example, atmospheric concentrations of one of these GHGs, CO_2, measured at Mauna Loa in Hawaii and at other sites around the world reached an annual mean of 419 parts per million (ppm) in 2022 (nearly 50 percent higher than preindustrial levels) [179] and have continued to rise at a rapid rate. Global average temperature has increased by about 1.1 °C (2.0 °F) in the 2011–2020

[164] The CAA states in section 302(h) that ''[a]ll language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.'' 42 U.S.C. 7602(h).

[165] ''Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare.'' 81 FR 54422, August 15, 2016. (''2016 Endangerment Finding'').

[166] USGCRP, 2017: *Climate Science Special Report: Fourth National Climate Assessment,* Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 470 pp, doi: 10.7930/J0J964J6.

[167] USGCRP, 2016: *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.* Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C.

[168] USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi:10.7930/NCA4.2018.

[169] IPCC, 2018: *Global Warming of 1.5 °C.* An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)].

[170] IPCC, 2019: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D. C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)].

[171] IPCC, 2019: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [H.-O. Pörtner, DC Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)].

1 IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1–34, doi:10.59327/IPCC/AR6–9789291691647.001.

[172] National Academies of Sciences, Engineering, and Medicine. 2016. *Attribution of Extreme Weather Events in the Context of Climate Change.* Washington, DC: The National Academies Press. *https://doi.org/10.17226/21852.*

[173] National Academies of Sciences, Engineering, and Medicine. 2017. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.* Washington, DC: The National Academies Press. *https://doi.org/10.17226/24651.*

[174] National Academies of Sciences, Engineering, and Medicine. 2019. *Climate Change and Ecosystems.* Washington, DC: The National Academies Press. *https://doi.org/10.17226/25504.*

[175] Blunden, J., T. Boyer, and E. Bartow-Gillies, Eds., 2023: ''State of the Climate in 2022''. Bull. Amer. Meteor. Soc., 104 (9), Si–S501 *https://doi.org/10.1175/2023BAMSStateoftheClimate.1.*

[176] EPA. 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430–R–21–003.

[177] Jay, A.K., A.R. Crimmins, C.W. Avery, T.A. Dahl, R.S. Dodder, B.D. Hamlington, A. Lustig, K. Marvel, P.A. Méndez-Lazaro, M.S. Osler, A. Terando, E.S. Weeks, and A. Zycherman, 2023: Ch. 1. Overview: Understanding risks, impacts, and responses. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA.*https://doi.org/10.7930/NCA5.2023.CH1.*

[178] Jay, A.K., A.R. Crimmins, C.W. Avery, T.A. Dahl, R.S. Dodder, B.D. Hamlington, A. Lustig, K. Marvel, P.A. Méndez-Lazaro, M.S. Osler, A. Terando, E.S. Weeks, and A. Zycherman, 2023: Ch. 1. Overview: Understanding risks, impacts, and responses. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA.*https://doi.org/10.7930/NCA5.2023.CH1.*

[179] *https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt.*

decade relative to 1850–1900.[180] The years 2015–2022 were the warmest 8 years in the 1880–2022 record.[181] The Intergovernmental Panel on Climate Change (IPCC) determined (with medium confidence) that this past decade was warmer than any multi-century period in at least the past 100,000 years.[182] Global average sea level has risen by about 8 inches (about 21 centimeters (cm)) from 1901 to 2018, with the rate from 2006 to 2018 (0.15 inches/year or 3.7 millimeters (mm)/year) almost twice the rate over the 1971 to 2006 period, and three times the rate of the 1901 to 2018 period.[183] The rate of sea level rise over the 20th century was higher than in any other century in at least the last 2,800 years.[184] Higher CO_2 concentrations have led to acidification of the surface ocean in recent decades to an extent unusual in the past 2 million years, with negative impacts on marine organisms that use calcium carbonate to build shells or skeletons.[185] Arctic sea ice extent continues to decline in all months of the year; the most rapid reductions occur in September (very likely almost a 13 percent decrease per decade between 1979 and 2018) and are unprecedented in at least 1,000 years.[186] Human-induced climate change has led to heatwaves and heavy precipitation becoming more frequent and more intense, along with increases in agricultural and ecological droughts[187] in many regions.[188]

The assessment literature demonstrates that modest additional amounts of warming may lead to a climate different from anything humans have ever experienced. The 2022 CO_2 concentration of 419 ppm is already higher than at any time in the last 2 million years.[189] If concentrations exceed 450 ppm, they would likely be higher than any time in the past 23 million years:[190] at the current rate of increase of more than 2 ppm per year, this would occur in about 15 years. While GHGs are not the only factor that controls climate, it is illustrative that 3 million years ago (the last time CO_2 concentrations were above 400 ppm) Greenland was not yet completely covered by ice and still supported forests, while 23 million years ago (the last time concentrations were above 450 ppm) the West Antarctic ice sheet was not yet developed, indicating the possibility that high GHG concentrations could lead to a world that looks very different from today and from the conditions in which human civilization has developed. If the Greenland and Antarctic ice sheets were to melt substantially, sea levels would rise dramatically—the IPCC estimated that over the next 2,000 years, sea level will rise by 7 to 10 feet even if warming is limited to 1.5 °C (2.7 °F), from 7 to 20 feet if limited to 2 °C (3.6 °F), and by 60 to 70 feet if warming is allowed to reach 5 °C (9 °F) above preindustrial levels.[191] For context, almost all of the city of Miami is less than 25 feet above sea level, and the 4th National Climate Assessment NCA4 stated that 13 million Americans would be at risk of migration due to 6 feet of sea level rise. Moreover, the CO_2 being absorbed by the ocean has resulted in changes in ocean chemistry due to acidification of a magnitude not seen in 65 million years,[192] putting many marine species—particularly calcifying species—at risk.

The NCA4 found that it is very likely (greater than 90 percent likelihood) that by mid-century, the Arctic Ocean will be almost entirely free of sea ice by late summer for the first time in about 2 million years.[193] Coral reefs will be at risk for almost complete (99 percent) losses with 1 °C (1.8 °F) of additional warming from today (2 °C or 3.6 °F since preindustrial). At this temperature, between 8 and 18 percent of animal, plant, and insect species could lose over half of the geographic area with suitable climate for their survival, and 7 to 10 percent of rangeland livestock would be projected to be lost.[194] The IPCC similarly found that climate change has caused substantial damages and increasingly irreversible losses in terrestrial, freshwater, and coastal and open ocean marine ecosystems.

Every additional increment of temperature comes with consequences. For example, the half degree of warming from 1.5 to 2 °C (0.9 °F of warming from 2.7 °F to 3.6 °F) above preindustrial temperatures is projected on a global scale to expose 420 million more people to extreme heatwaves at least every five years, and 62 million more people to exceptional heatwaves at least every five years (where heatwaves are defined based on a heat wave magnitude index which takes into account duration and intensity—using this index, the 2003 French heat wave that led to almost 15,000 deaths would be classified as an ''extreme heatwave'' and the 2010 Russian heatwave which led to thousands of deaths and extensive wildfires would be classified as ''exceptional''). It would increase the frequency of sea-ice-free Arctic summers from once in 100 years to once in a decade. It could lead to 4 inches of additional sea level rise by the end of the century, exposing an additional 10 million people to risks of inundation as well as increasing the probability of triggering instabilities in either the Greenland or Antarctic ice sheets. Between half a million and a million additional square miles of permafrost would thaw over several centuries. Risks to food security would increase from medium to high for several lower-income regions in the Sahel, southern Africa, the Mediterranean, central Europe, and the Amazon. In addition to food security issues, this temperature increase would have implications for human health in terms of increasing ozone concentrations, heatwaves, and vector-borne diseases (for example, expanding the range of the mosquitoes which carry dengue fever, chikungunya, yellow fever, and the Zika virus, or the ticks which carry Lyme, babesiosis, or Rocky Mountain Spotted Fever).[195] Moreover, every additional increment in warming leads to larger changes in extremes, including the potential for events unprecedented in the observational record. Every additional degree will intensify extreme precipitation events by about 7 percent. The peak winds of the most intense tropical cyclones (hurricanes) are projected to increase with warming. In addition to a higher intensity, the IPCC found that precipitation and frequency of rapid intensification of these storms has already increased, the movement speed has decreased, and elevated sea levels have increased coastal flooding,

[180] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3−32, doi:10.1017/9781009157896.001.

[181] Blunden, et al. 2023.

[182] IPCC, 2021.

[183] IPCC, 2021.

[184] USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi:10.7930/NCA4.2018.

[185] IPCC, 2021.

[186] IPCC, 2021.

[187] These are drought measures based on soil moisture.

[188] IPCC, 2021.

[189] Annual Mauna Loa CO_2 concentration data from *https://gml.noaa.gov/webdata/ccgg/trends/co2/co2_annmean_mlo.txt*, accessed September 9, 2023.

[190] IPCC, 2013.

[191] IPCC, 2021.

[192] IPCC, 2018.

[193] USGCRP, 2018.

[194] IPCC, 2018.

[195] IPCC, 2018.

all of which make these tropical cyclones more damaging.[196]

The NCA4 also evaluated a number of impacts specific to the United States. Severe drought and outbreaks of insects like the mountain pine beetle have killed hundreds of millions of trees in the western United States. Wildfires have burned more than 3.7 million acres in 14 of the 17 years between 2000 and 2016, and Federal wildfire suppression costs were about a billion dollars annually.[197] The National Interagency Fire Center has documented U.S. wildfires since 1983, and the 10 years with the largest acreage burned have all occurred since 2004.[198] Wildfire smoke degrades air quality, increasing health risks, and more frequent and severe wildfires due to climate change would further diminish air quality, increase incidences of respiratory illness, impair visibility, and disrupt outdoor activities, sometimes thousands of miles from the location of the fire. Meanwhile, sea level rise has amplified coastal flooding and erosion impacts, requiring the installation of costly pump stations, flooding streets, and increasing storm surge damages. Tens of billions of dollars of U.S. real estate could be below sea level by 2050 under some scenarios. Increased frequency and duration of drought will reduce agricultural productivity in some regions, accelerate depletion of water supplies for irrigation, and expand the distribution and incidence of pests and diseases for crops and livestock. The NCA4 also recognized that climate change can increase risks to national security, both through direct impacts on military infrastructure and by affecting factors such as food and water availability that can exacerbate conflict outside U.S. borders. Droughts, floods, storm surges, wildfires, and other extreme events stress nations and people through loss of life, displacement of populations, and impacts on livelihoods.[199]

EPA modeling efforts can further illustrate how these impacts from climate change may be experienced across the United States. EPA's Framework for Evaluating Damages and Impacts (FrEDI)[200] uses information from over 30 peer-reviewed climate change impact studies to project the physical and economic impacts of climate change to the United States. resulting from future temperature changes. These impacts are projected for specific regions within the United States. and for more than 20 impact categories, which span a large number of sectors of the U.S. economy.[201] Using this framework, EPA estimates that global emission projections, with no additional mitigation, will result in significant climate-related damages to the United States.[202] These damages to the United States. would mainly be from increases in lives lost due to increases in temperatures, as well as impacts to human health from increases in climate-driven changes in air quality, dust and wildfire smoke exposure, and incidence of suicide. Additional major climate-related damages would occur to U.S. infrastructure such as roads and rail, as well as transportation impacts and coastal flooding from sea level rise, increases in property damage from tropical cyclones, and reductions in labor hours worked in outdoor settings and buildings without air conditioning. These impacts are also projected to vary from region to region with the Southeast, for example, projected to see some of the largest damages from sea level rise, the West Coast projected to experience damages from wildfire smoke more than other parts of the country, and the Northern Plains states projected to see a higher proportion of damages to rail and road infrastructure. While information on the distribution of climate impacts helps to better understand the ways in which climate change may impact the United States, recent analyses are still only a partial assessment of climate impacts relevant to U.S. interests and do not reflect increased damages that occur due to interactions between different sectors impacted by climate change or all the ways in which physical impacts of climate change occurring abroad have spillover effects in different regions of the United States.

Some GHGs also have impacts beyond those mediated through climate change. For example, elevated concentrations of CO_2 stimulate plant growth (which can be positive in the case of beneficial species, but negative in terms of weeds and invasive species, and can also lead to a reduction in plant micronutrients[203]) and cause ocean acidification. Nitrous oxide depletes the levels of protective stratospheric ozone.[204]

These scientific assessments, the EPA analyses, and documented observed changes in the climate of the planet and of the United States present clear support regarding the current and future dangers of climate change and the importance of GHG emissions mitigation.

B. Background on Criteria and Air Toxics Pollutants Impacted by This Rule

1. Particulate Matter

Particulate matter (PM) is a complex mixture of solid particles and liquid droplets distributed among numerous atmospheric gases which interact with solid and liquid phases. Particles in the atmosphere range in size from less than 0.01 to more than 10 micrometers (μm) in diameter.[205] Atmospheric particles can be grouped into several classes according to their aerodynamic diameter and physical sizes. Generally, the three broad classes of particles include ultrafine particles (UFPs, generally considered as particles with a diameter less than or equal to 0.1 μm [typically based on physical size, thermal diffusivity or electrical mobility]), ''fine'' particles ($PM_{2.5}$; particles with a nominal mean aerodynamic diameter less than or equal to 2.5 μm), and ''thoracic'' particles (PM_{10}; particles with a nominal mean aerodynamic diameter less than or equal to 10 μm).

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[196] IPCC, 2021.

[197] USGCRP, 2018.

[198] NIFC (National Interagency Fire Center). 2021. Total wildland fires and acres (1983–2020). Accessed August 2021. *www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html*.

[199] USGCRP, 2018.

[200] (1) Hartin, C., *et al.* (2023). Advancing the estimation of future climate impacts within the United States. Earth Syst. Dynam., 14, 1015–1037, *https://doi.org/10.5194/esd-14-1015-2023*. (2) *Supplementary Material for the Regulatory Impact Analysis for the Supplemental Proposed Rulemaking, ''Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review,''* Docket ID No. EPA–HQ–OAR–2021–0317, September 2022, (3) *The Long-Term Strategy of the United States: Pathways to Net-Zero* Greenhouse *Gas Emissions by 2050.* Published by the U.S. Department of State and the U.S. Executive Office of the President, Washington, DC. November 2021, (4) *Climate Risk Exposure: An Assessment of the Federal Government's Financial Risks to Climate Change,* White Paper, Office of Management and Budget, April 2022.

[201] EPA (2021). Technical Documentation on the Framework for Evaluating Damages and Impacts (FrEDI). U.S. Environmental Protection Agency, EPA 430–R–21–004, available at *https://www.epa.gov/cira/fredi*. Documentation has been subject to both a public review comment period and an independent expert peer review, following EPA peer-review guidelines.

[202] Compared to a world with no additional warming after the model baseline (1986–2005).

[203] Ziska, L., A. Crimmins, A. Auclair, S. DeGrasse, J.F. Garofalo, A.S. Khan, I. Loladze, A.A. Pérez de León, A. Showler, J. Thurston, and I. Walls, 2016: Ch. 7: Food Safety, Nutrition, and Distribution. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC, 189–216. *https://health2016.globalchange.gov/low/ClimateHealth2016_07_Food_small.pdf*.

[204] WMO (World Meteorological Organization), *Scientific Assessment of Ozone Depletion: 2018, Global Ozone Research and Monitoring Project*—Report No. 58, 588 pp., Geneva, Switzerland, 2018.

[205] U.S. EPA. Policy Assessment (PA) for the Reconsideration of the PM NAAQS. U.S. Environmental Protection Agency, Washington, DC, EPA/452/R–22–004, 2022.

Particles that fall within the size range between $PM_{2.5}$ and PM_{10}, are referred to as ''thoracic coarse particles'' ($PM_{10-2.5}$, particles with a nominal mean aerodynamic diameter greater than 2.5 µm and less than or equal to 10 µm). EPA currently has NAAQS for $PM_{2.5}$ and PM_{10}.[206]

Most particles are found in the lower troposphere, where they can have residence times ranging from a few hours to weeks. Particles are removed from the atmosphere by wet deposition, such as when they are carried by rain or snow, or by dry deposition, when particles settle out of suspension due to gravity. Atmospheric lifetimes are generally longest for $PM_{2.5}$, which often remains in the atmosphere for days to weeks before being removed by wet or dry deposition.[207] In contrast, atmospheric lifetimes for UFP and $PM_{10-2.5}$ are shorter. Within hours, UFP can undergo coagulation and condensation that lead to formation of larger particles in the accumulation mode, or can be removed from the atmosphere by evaporation, deposition, or reactions with other atmospheric components. $PM_{10-2.5}$ are also generally removed from the atmosphere within hours, through wet or dry deposition.[208]

Particulate matter consists of both primary and secondary particles. Primary particles are emitted directly from sources, such as combustion-related activities (*e.g.,* industrial activities, motor vehicle operation, biomass burning), while secondary particles are formed through atmospheric chemical reactions of gaseous precursors (*e.g.,* sulfur oxides (SO_X), nitrogen oxides (NO_X) and volatile organic compounds (VOCs)). From 2000 to 2021, national annual average ambient $PM_{2.5}$ concentrations have declined by over 35 percent,[209] largely reflecting reductions in emissions of precursor gases.

There are two primary NAAQS for $PM_{2.5}$: An annual standard (9.0 micrograms per cubic meter (µg/m^3)) and a 24-hour standard (35 µg/m^3), and there are two secondary NAAQS for $PM_{2.5}$: An annual standard (15.0 µg/m^3) and a 24-hour standard (35 µg/m^3). The initial $PM_{2.5}$ standards were set in 1997 and revisions to the standards were finalized in 2006, in 2012, and in 2024.

We received comments on the proposal that referenced EPA modeling of ambient concentrations in 2032 that indicates that the primary annual $PM_{2.5}$ NAAQS will be met in most areas of the country outside of California.[210] [211] On February 5, 2024, EPA finalized a rule to revise the primary annual $PM_{2.5}$ standard to 9.0 µg/m^3.[212] The revised primary annual $PM_{2.5}$ NAAQS could lead to additional designations of nonattainment areas in the future. In addition, there are many areas of the country that are currently in nonattainment for the annual and 24-hour primary $PM_{2.5}$ NAAQS. As of November 30, 2023, more than 19 million people lived in the 3 areas that are designated as nonattainment for the 1997 $PM_{2.5}$ NAAQS. Also, as of November 30, 2023, more than 31 million people lived in the 11 areas that are designated as nonattainment for the 2006 $PM_{2.5}$ NAAQS and more than 20 million people lived in the 5 areas designated as nonattainment for the 2012 $PM_{2.5}$ NAAQS. In total, there are currently 12 $PM_{2.5}$ nonattainment areas with a population of more than 32 million people.[213] The light- and medium-duty vehicle standards established in this rule will take effect beginning in MY 2027 and will assist some areas with attaining the NAAQS and may relieve areas with already stringent local regulations from some of the burden associated with adopting additional local controls. The rule will also assist some counties with ambient concentrations near the level of the NAAQS who are working to ensure long-term attainment or maintenance of the $PM_{2.5}$ NAAQS.

2. Ozone

Ground-level ozone pollution forms in areas with high concentrations of ambient NO_X and VOCs when solar radiation is strong. Major U.S. sources of NO_X are highway and nonroad motor vehicles, engines, power plants and other industrial sources, with natural sources, such as soil, vegetation, and lightning, serving as smaller sources. Vegetation is the dominant source of VOCs in the United States. Volatile consumer and commercial products, such as propellants and solvents, highway and nonroad vehicles, engines, fires, and industrial sources also contribute to the atmospheric burden of VOCs at ground-level.

The processes underlying ozone formation, transport, and accumulation are complex. Ground-level ozone is produced and destroyed by an interwoven network of free radical reactions involving the hydroxyl radical (OH), NO, NO_2, and complex reaction intermediates derived from VOCs. Many of these reactions are sensitive to temperature and available sunlight. High ozone events most often occur when ambient temperatures and sunlight intensities remain high for several days under stagnant conditions. Ozone and its precursors can also be transported hundreds of miles downwind, which can lead to elevated ozone levels in areas with otherwise low VOC or NO_X emissions. As an air mass moves and is exposed to changing ambient concentrations of NO_X and VOCs, the ozone photochemical regime (relative sensitivity of ozone formation to NO_X and VOC emissions) can change.

When ambient VOC concentrations are high, comparatively small amounts of NO_X catalyze rapid ozone formation. Without available NO_X, ground-level ozone production is severely limited, and VOC reductions would have little impact on ozone concentrations. Photochemistry under these conditions is said to be ''NO_X-limited.'' When NO_X levels are sufficiently high, faster NO_2 oxidation consumes more radicals, dampening ozone production. Under these ''VOC-limited'' conditions (also referred to as ''NO_X-saturated'' conditions), VOC reductions are effective in reducing ozone, and NO_X can react directly with ozone, resulting in suppressed ozone concentrations near NO_X emission sources. Under these NO_X-saturated conditions, NO_X reductions can actually increase local ozone under certain circumstances, but overall ozone production (considering downwind formation) decreases and even in VOC-limited areas, NO_X reductions are not expected to increase ozone levels if the NO_X reductions are sufficiently large—large enough to become NO_X-limited.

[206] 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. With regard to NAAQS which provide protection against health and welfare effects, the 24-hour PM_{10} standard provides protection against effects associated with short-term exposure to thoracic coarse particles (*i.e.,* $PM_{10-2.5}$).

[207] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019. Table 2–1.

[208] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019. Table 2–1.

[209] See *https://www.epa.gov/air-trends/particulate-matter-pm25-trends* for more information.

[210] *https://www.epa.gov/pm-pollution/proposed-decision-reconsideration-national-ambient-air-quality-standards-particulate.*

[211] Detailed discussion of the comments we received on the $PM_{2.5}$ emissions and air quality impact of the standards can be found in Sections 4 and 11 of the RTC.

[212] *https://www.epa.gov/pm-pollution/national-ambient-air-quality-standards-naaqs-pm.*

[213] The population total is calculated by summing, without double counting, the 1997, 2006 and 2012 $PM_{2.5}$ nonattainment populations contained in the Criteria Pollutant Nonattainment Summary report (*https://www.epa.gov/green-book/green-book-data-download*).

The primary NAAQS for ozone, established in 2015 and retained in 2020, is an 8-hour standard with a level of 0.07 ppm.[214] EPA is also implementing the previous 8-hour ozone primary standard, set in 2008, at a level of 0.075 ppm. As of November 30, 2023, there were 34 ozone nonattainment areas for the 2008 ozone NAAQS, composed of 141 full or partial counties, with a population of more than 90 million, and 46 ozone nonattainment areas for the 2015 ozone NAAQS, composed of 191 full or partial counties, with a population of more than 115 million. In total, there are currently, as of November 30, 2023, 54 ozone nonattainment areas with a population of more than 119 million people.[215]

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. The attainment dates for areas designated nonattainment for the 2008 8-hour ozone NAAQS are in the 2015 to 2032 timeframe, depending on the severity of the problem in each area. Attainment dates for areas designated nonattainment for the 2015 ozone NAAQS are in the 2021 to 2038 timeframe, again depending on the severity of the problem in each area.[216] The standards will take effect starting in MY 2027 and will assist areas with attaining the NAAQS and may relieve areas with already stringent local regulations from some of the burden associated with adopting additional local controls. The rule will also provide assistance to counties with ambient concentrations near the level of the NAAQS who are working to ensure long-term attainment or maintenance of the NAAQS.

3. Nitrogen Oxides

Oxides of nitrogen (NO_X) refers to nitric oxide (NO) and nitrogen dioxide (NO_2). Most NO_2 is formed in the air through the oxidation of nitric oxide (NO) emitted when fuel is burned at a high temperature. NO_X is a criteria pollutant, regulated for its adverse effects on public health and the environment, and highway vehicles are an important contributor to NO_X emissions. NO_X, along with VOCs, are the two major precursors of ozone and NO_X is also a major contributor to secondary $PM_{2.5}$ formation. There are two primary NAAQS for NO_2: An annual standard (53 ppb) and a 1-hour standard (100 ppb).[217] In 2010, EPA established requirements for monitoring NO_2 near roadways expected to have the highest concentrations within large cities. Monitoring within this near-roadway network began in 2014, with additional sites deployed in the following years. At present, there are no nonattainment areas for NO_2.

4. Sulfur Oxides

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), extracting gasoline from oil, or extracting metals from ore. SO_2 and its gas phase oxidation products can dissolve in water droplets and further oxidize to form sulfuric acid which reacts with ammonia to form sulfates, which are important components of ambient PM.

EPA most recently completed a review of the primary SO_2 NAAQS in February 2019 and decided to retain the existing 2010 SO_2 NAAQS.[218] The current primary NAAQS for SO_2 is a 1-hour standard of 75 ppb. As of November 30, 2023, more than two million people lived in the 30 areas that are designated as nonattainment for the 2010 SO_2 NAAQS.[219]

5. Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas formed by incomplete combustion of carbon-containing fuels and by photochemical reactions in the atmosphere. Nationally, particularly in urban areas, the majority of CO emissions to ambient air come from mobile sources.[220]

6. Diesel Exhaust

Diesel exhaust is a complex mixture composed of particulate matter, carbon dioxide, oxygen, nitrogen, water vapor, carbon monoxide, nitrogen compounds, sulfur compounds and numerous low-molecular-weight hydrocarbons. A number of these gaseous hydrocarbon components are individually known to be toxic, including aldehydes, benzene and 1,3-butadiene. The diesel particulate matter present in diesel exhaust consists mostly of fine particles (<2.5 µm), of which a significant fraction is ultrafine particles (<0.1 µm). These particles have a large surface area which makes them an excellent medium for adsorbing organics and their small size makes them highly respirable. Many of the organic compounds present in the gases and on the particles, such as polycyclic organic matter, are individually known to have mutagenic and carcinogenic properties.

Diesel exhaust varies significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, acceleration, deceleration), and fuel formulations (high/low sulfur fuel). Also, there are emissions differences between onroad and nonroad engines because the nonroad engines are generally of older technology. After being emitted in the engine exhaust, diesel exhaust undergoes dilution as well as chemical and physical changes in the atmosphere. The lifetimes of the components present in diesel exhaust range from seconds to months.

7. Air Toxics

The most recent available data indicate that millions of Americans live in areas where air toxics pose potential health concerns.[221] [222] 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 EPA's 2007 Mobile Source Air Toxics Rule.[223] According to EPA's 2017 National Emissions Inventory (NEI), mobile sources were responsible for 39 percent of outdoor anthropogenic toxic emissions. Further, mobile sources were the largest contributor to national average risk of cancer and immunological and respiratory health effects from directly emitted pollutants, according to EPA's Air Toxics Screening

[214] *https://www.epa.gov/ground-level-ozone-pollution/ozone-national-ambient-air-quality-standards-naaqs.*

[215] The population total is calculated by summing, without double counting, the 2008 and 2015 ozone nonattainment populations contained in the Criteria Pollutant Nonattainment Summary report (*https://www.epa.gov/green-book/green-book-data-download*).

[216] *https://www.epa.gov/ground-level-ozone-pollution/ozone-naaqs-timelines.*

[217] The statistical form of the 1-hour NAAQS for NO_2 is the 3-year average of the yearly distribution of 1-hour daily maximum concentrations.

[218] *https://www.epa.gov/so2-pollution/primary-national-ambient-air-quality-standard-naaqs-sulfur-dioxide.*

[219] *https://www3.epa.gov/airquality/greenbook/tnsum.html.*

[220] U.S. EPA, (2010). Integrated Science Assessment for Carbon Monoxide (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–09/019F, 2010. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=218686.* See Section 2.1.

[221] Air toxics are pollutants known to cause or suspected of causing cancer or other serious health effects. Air toxics are also known as toxic air pollutants or hazardous air pollutants. *https://www.epa.gov/AirToxScreen/airtoxscreen-glossary-terms#air-toxics.*

[222] U.S. EPA (2022) Technical Support Document EPA Air Toxics Screening Assessment. 2018 AirToxScreen TSD. *https://www.epa.gov/system/files/documents/2023-02/AirToxScreen_2018%20TSD.pdf.*

[223] U.S. Environmental Protection Agency (2007). Control of Hazardous Air Pollutants from Mobile Sources; Final Rule. 72 FR 8434, February 26, 2007.

Assessment (AirToxScreen) for 2019.[224 225] Mobile sources are also significant contributors to precursor emissions which react to form air toxics.[226] Formaldehyde is the largest contributor to cancer risk of all 72 pollutants quantitatively assessed in the 2019 AirToxScreen. Mobile sources were responsible for 26 percent of primary anthropogenic emissions of this pollutant in the 2017 NEI and are significant contributors to formaldehyde precursor emissions. Benzene is also a large contributor to cancer risk, and mobile sources account for about 60 percent of average exposure to ambient concentrations.

C. Health Effects Associated With Exposure to Criteria and Air Toxics Pollutants

Emissions sources impacted by this rulemaking, including vehicles and power plants, emit pollutants that contribute to ambient concentrations of PM, ozone, NO_2, SO_2, CO, and air toxics. This section of the preamble discusses the health effects associated with exposure to these pollutants.

Additionally, because children have increased vulnerability and susceptibility for adverse health effects related to air pollution exposures, EPA's findings regarding adverse effects for children related to exposure to pollutants that are impacted by this rule are noted in this section. The increased vulnerability and susceptibility of children to air pollution exposures may arise because infants and children generally breathe more relative to their size than adults do, and consequently may be exposed to relatively higher amounts of air pollution.[227] Children also tend to breathe through their mouths more than adults and their nasal passages are less effective at removing pollutants, which leads to greater lung deposition of some pollutants, such as PM.[228 229] Furthermore, air pollutants may pose health risks specific to children because children's bodies are still developing.[230] For example, during periods of rapid growth such as fetal development, infancy and puberty, their developing systems and organs may be more easily harmed.[231 232] EPA produces the report titled ''America's Children and the Environment,'' which presents national trends on air pollution and other contaminants and environmental health of children.[233]

Information on environmental effects associated with exposure to these pollutants is included in section II.D of the preamble, information on environmental justice is included in section VIII.I of the preamble and information on emission reductions and air quality impacts from this rule are included in sections VI and VII of this preamble.

1. Particulate Matter

Scientific evidence spanning animal toxicological, controlled human exposure, and epidemiologic studies shows that exposure to ambient PM is associated with a broad range of health effects. These health effects are discussed in detail in the Integrated Science Assessment for Particulate Matter, which was finalized in December 2019 (2019 p.m. ISA), with a more targeted evaluation of studies published since the literature cutoff date of the 2019 p.m. ISA in the Supplement to the Integrated Science Assessment for PM (Supplement).[234 235] The PM ISA characterizes the causal nature of relationships between PM exposure and broad health categories (*e.g.,* cardiovascular effects, respiratory effects, etc.) using a weight-of-evidence approach.[236] Within this characterization, the PM ISA summarizes the health effects evidence for short-term (*i.e.,* hours up to one month) and long-term (*i.e.,* one month to years) exposures to $PM_{2.5}$, $PM_{10-2.5}$, and ultrafine particles, and concludes that exposures to ambient $PM_{2.5}$ are associated with a number of adverse health effects. The following discussion highlights the PM ISA's conclusions, and summarizes additional information from the Supplement where appropriate, pertaining to the health effects evidence for both short- and long-term PM exposures. Further discussion of PM-related health effects can also be found in the 2022 Policy Assessment for the review of the PM NAAQS.[237]

EPA has concluded that recent evidence in combination with evidence evaluated in the 2009 p.m. ISA supports a ''causal relationship'' between both long- and short-term exposures to $PM_{2.5}$ and premature mortality and cardiovascular effects and a ''likely to be causal relationship'' between long- and short-term $PM_{2.5}$ exposures and respiratory effects.[238] Additionally, recent experimental and epidemiologic studies provide evidence supporting a ''likely to be causal relationship''

[224] U.S. EPA. (2022) 2019 AirToxScreen: Assessment Results. *https://www.epa.gov/AirToxScreen/2019-airtoxscreen-assessment-results*.

[225] AirToxScreen also includes estimates of risk attributable to background concentrations, which includes contributions from long-range transport, persistent air toxics, and natural sources; as well as secondary concentrations, where toxics are formed via secondary formation. Mobile sources substantially contribute to long-range transport and secondarily formed air toxics.

[226] Rich Cook, Sharon Phillips, Madeleine Strum, Alison Eyth & James Thurman (2020): Contribution of mobile sources to secondary formation of carbonyl compounds, Journal of the Air & Waste Management Association, DOI: 10.1080/10962247.2020.1813839.

[227] EPA (2009) Metabolically-derived ventilation rates: A revised approach based upon oxygen consumption rates. Washington, DC: Office of Research and Development. EPA/600/R–06/129F. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=202543*.

[228] U.S. EPA Integrated Science Assessment for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019. Chapter 4 ''Overall Conclusions'' p. 4–1.

[229] Foos, B.; Marty, M.; Schwartz, J.; Bennet, W.; Moya, J.; Jarabek, A.M.; Salmon, A.G. (2008) Focusing on children's inhalation dosimetry and health effects for risk assessment: An introduction. J Toxicol Environ Health 71A: 149–165.

[230] Children's environmental health includes conception, infancy, early childhood and through adolescence until 21 years of age as described in the EPA Memorandum: Issuance of EPA's 2021 Policy on Children's Health. October 5, 2021. Available at *https://www.epa.gov/system/files/documents/2021-10/2021-policy-on-childrens-health.pdf*.

[231] EPA (2006) A Framework for Assessing Health Risks of Environmental Exposures to Children. EPA, Washington, DC, EPA/600/R–05/093F, 2006.

[232] U.S. Environmental Protection Agency. (2005). Supplemental guidance for assessing susceptibility from early-life exposure to carcinogens. Washington, DC: Risk Assessment Forum. EPA/630/R–03/003F. *https://www3.epa.gov/airtoxics/childrens_supplement_final.pdf*.

[233] U.S. EPA. America's Children and the Environment. Available at: *https://www.epa.gov/americaschildrenenvironment*.

[234] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[235] U.S. EPA. Supplement to the 2019 Integrated Science Assessment for Particulate Matter (Final Report, 2022). U.S. Environmental Protection Agency, Washington, DC, EPA/635/R–22/028, 2022.

[236] The causal framework draws upon the assessment and integration of evidence from across scientific disciplines, spanning atmospheric chemistry, exposure, dosimetry and health effects studies (*i.e.,* epidemiologic, controlled human exposure, and animal toxicological studies), and assess the related uncertainties and limitations that ultimately influence our understanding of the evidence. This framework employs a five-level hierarchy that classifies the overall weight-of-evidence with respect to the causal nature of relationships between criteria pollutant exposures and health and welfare effects using the following categorizations: causal relationship; likely to be causal relationship; suggestive of, but not sufficient to infer, a causal relationship; inadequate to infer the presence or absence of a causal relationship; and not likely to be a causal relationship (U.S. EPA. (2019). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, Section P. 3.2.3).

[237] U.S. EPA. Policy Assessment (PA) for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter (Final Report, 2022). U.S. Environmental Protection Agency, Washington, DC, EPA–452/R–22–004, 2022.

[238] U.S. EPA. (2009). Integrated Science Assessment for Particulate Matter (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–08/139F.

between long-term $PM_{2.5}$ exposure and nervous system effects, and long-term $PM_{2.5}$ exposure and cancer. Because of remaining uncertainties and limitations in the evidence base, EPA determined a ''suggestive of, but not sufficient to infer, a causal relationship'' for long-term $PM_{2.5}$ exposure and reproductive and developmental effects (*i.e.,* male/female reproduction and fertility; pregnancy and birth outcomes), long- and short-term exposures and metabolic effects, and short-term exposure and nervous system effects.

As discussed extensively in the 2019 p.m. ISA and the Supplement, recent studies continue to support a ''causal relationship'' between short- and long-term $PM_{2.5}$ exposures and mortality.[239 240] For short-term $PM_{2.5}$ exposure, multi-city studies, in combination with single- and multi-city studies evaluated in the 2009 p.m. ISA, provide evidence of consistent, positive associations across studies conducted in different geographic locations, populations with different demographic characteristics, and studies using different exposure assignment techniques. Additionally, the consistent and coherent evidence across scientific disciplines for cardiovascular morbidity, including exacerbations of chronic obstructive pulmonary disease (COPD) and asthma, provide biological plausibility for cause-specific mortality and ultimately total mortality. Recent epidemiologic studies evaluated in the Supplement, including studies that employed alternative methods for confounder control, provide additional support to the evidence base that contributed to the 2019 p.m. ISA conclusion for short-term $PM_{2.5}$ exposure and mortality.

The 2019 p.m. ISA concluded a ''causal relationship'' between long-term $PM_{2.5}$ exposure and mortality. In addition to reanalyses and extensions of the American Cancer Society (ACS) and Harvard Six Cities (HSC) cohorts, multiple new cohort studies conducted in the United States and Canada consisting of people employed in a specific job (*e.g.,* teacher, nurse), and that apply different exposure assignment techniques, provide evidence of positive associations between long-term $PM_{2.5}$ exposure and mortality. Biological plausibility for mortality due to long-term $PM_{2.5}$ exposure is provided by the coherence of effects across scientific disciplines for cardiovascular morbidity, particularly for coronary heart disease, stroke, and atherosclerosis, and for respiratory morbidity, particularly for the development of COPD. Additionally, recent studies provide evidence indicating that as long-term $PM_{2.5}$ concentrations decrease there is an increase in life expectancy. Recent cohort studies evaluated in the Supplement, as well as epidemiologic studies that conducted accountability analyses or employed alternative methods for confounder controls, support and extend the evidence base that contributed to the 2019 p.m. ISA conclusion for long-term $PM_{2.5}$ exposure and mortality.

A large body of studies examining both short- and long-term $PM_{2.5}$ exposure and cardiovascular effects supports and extends the evidence base evaluated in the 2009 p.m. ISA. The strongest evidence for cardiovascular effects in response to short-term $PM_{2.5}$ exposures is for ischemic heart disease and heart failure. The evidence for short-term $PM_{2.5}$ exposure and cardiovascular effects is coherent across scientific disciplines and supports a continuum of effects ranging from subtle changes in indicators of cardiovascular health to serious clinical events, such as increased emergency department visits and hospital admissions due to cardiovascular disease and cardiovascular mortality. For long-term $PM_{2.5}$ exposure, there is strong and consistent epidemiologic evidence of a relationship with cardiovascular mortality. This evidence is supported by epidemiologic and animal toxicological studies demonstrating a range of cardiovascular effects including coronary heart disease, stroke, impaired heart function, and subclinical markers (*e.g.,* coronary artery calcification, atherosclerotic plaque progression), which collectively provide coherence and biological plausibility. Recent epidemiologic studies evaluated in the Supplement, as well as studies that conducted accountability analyses or employed alternative methods for confounder control, support and extend the evidence base that contributed to the 2019 p.m. ISA conclusion for both short- and long-term $PM_{2.5}$ exposure and cardiovascular effects.

Studies evaluated in the 2019 p.m. ISA continue to provide evidence of a ''likely to be causal relationship'' between both short- and long-term $PM_{2.5}$ exposure and respiratory effects. Epidemiologic studies provide consistent evidence of a relationship between short-term $PM_{2.5}$ exposure and asthma exacerbation in children and COPD exacerbation in adults as indicated by increases in emergency department visits and hospital admissions, which is supported by animal toxicological studies indicating worsening allergic airways disease and subclinical effects related to COPD. Epidemiologic studies also provide evidence of a relationship between short-term $PM_{2.5}$ exposure and respiratory mortality. However, there is inconsistent evidence of respiratory effects, specifically lung function declines and pulmonary inflammation, in controlled human exposure studies. With respect to long term $PM_{2.5}$ exposure, epidemiologic studies conducted in the United States and abroad provide evidence of a relationship with respiratory effects, including consistent changes in lung function and lung function growth rate, increased asthma incidence, asthma prevalence, and wheeze in children; acceleration of lung function decline in adults; and respiratory mortality. The epidemiologic evidence is supported by animal toxicological studies, which provide coherence and biological plausibility for a range of effects including impaired lung development, decrements in lung function growth, and asthma development.

Since the 2009 p.m. ISA, a growing body of scientific evidence examined the relationship between long-term $PM_{2.5}$ exposure and nervous system effects, resulting for the first time in a causality determination for this health effects category of a ''likely to be causal relationship.'' The strongest evidence for effects on the nervous system come from epidemiologic studies that consistently report cognitive decrements and reductions in brain volume in adults. The effects observed in epidemiologic studies in adults are supported by animal toxicological studies demonstrating effects on the brain of adult animals including inflammation, morphologic changes, and neurodegeneration of specific regions of the brain. There is more limited evidence for neurodevelopmental effects in children, with some studies reporting positive associations with autism spectrum disorder and others providing limited evidence of an association with cognitive function. While there is some evidence from animal toxicological studies indicating effects on the brain (*i.e.,* inflammatory and morphological changes) to support a biologically plausible pathway for neurodevelopmental effects, epidemiologic studies are limited due to

[239] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[240] U.S. EPA. Supplement to the 2019 Integrated Science Assessment for Particulate Matter (Final Report, 2022). U.S. Environmental Protection Agency, Washington, DC, EPA/635/R–22/028, 2022.

their lack of control for potential confounding by copollutants, the small number of studies conducted, and uncertainty regarding critical exposure windows.

Building off the decades of research demonstrating mutagenicity, DNA damage, and other endpoints related to genotoxicity due to whole PM exposures, recent experimental and epidemiologic studies focusing specifically on $PM_{2.5}$ provide evidence of a relationship between long-term $PM_{2.5}$ exposure and cancer. Epidemiologic studies examining long-term $PM_{2.5}$ exposure and lung cancer incidence and mortality provide evidence of generally positive associations in cohort studies spanning different populations, locations, and exposure assignment techniques. Additionally, there is evidence of positive associations with lung cancer incidence and mortality in analyses limited to never smokers. The epidemiologic evidence is supported by both experimental and epidemiologic evidence of genotoxicity, epigenetic effects, carcinogenic potential, and that $PM_{2.5}$ exhibits several characteristics of carcinogens, which collectively provides biological plausibility for cancer development and resulted in the conclusion of a ''likely to be causal relationship.''

For the additional health effects categories evaluated for $PM_{2.5}$ in the 2019 PM ISA, experimental and epidemiologic studies provide limited and/or inconsistent evidence of a relationship with $PM_{2.5}$ exposure. As a result, the 2019 PM ISA concluded that the evidence is ''suggestive of, but not sufficient to infer a causal relationship'' for short-term $PM_{2.5}$ exposure and metabolic effects and nervous system effects, and for long-term $PM_{2.5}$ exposures and metabolic effects as well as reproductive and developmental effects.

In addition to evaluating the health effects attributed to short- and long-term exposure to $PM_{2.5}$, the 2019 PM ISA also conducted an extensive evaluation as to whether specific components or sources of $PM_{2.5}$ are more strongly related with health effects than $PM_{2.5}$ mass. An evaluation of those studies resulted in the 2019 PM ISA concluding that ''many $PM_{2.5}$ components and sources are associated with many health effects, and the evidence does not indicate that any one source or component is consistently more strongly related to health effects than $PM_{2.5}$ mass.'' [241]

For both $PM_{10-2.5}$ and ultrafine particles (UFPs), for all health effects categories evaluated, the 2019 PM ISA concluded that the evidence was ''suggestive of, but not sufficient to infer, a causal relationship'' or ''inadequate to determine the presence or absence of a causal relationship.'' For $PM_{10-2.5}$, although a Federal Reference Method was instituted in 2011 to measure $PM_{10-2.5}$ concentrations nationally, the causality determinations reflect that the same uncertainty identified in the 2009 PM ISA with respect to the method used to estimate $PM_{10-2.5}$ concentrations in epidemiologic studies persists. Specifically, across epidemiologic studies, different approaches are used to estimate $PM_{10-2.5}$ concentrations (*e.g.,* direct measurement of $PM_{10-2.5}$, difference between PM_{10} and $PM_{2.5}$ concentrations), and it remains unclear how well correlated $PM_{10-2.5}$ concentrations are both spatially and temporally across the different methods used.

For UFPs, which have often been defined as particles less than 0.1 µm, the uncertainty in the evidence for the health effect categories evaluated across experimental and epidemiologic studies reflects the inconsistency in the exposure metric used (*i.e.,* particle number concentration, surface area concentration, mass concentration) as well as the size fractions examined. In epidemiologic studies the size fraction examined can vary depending on the monitor used and exposure metric, with some studies examining number count over the entire particle size range, while experimental studies that use a particle concentrator often examine particles up to 0.3 µm. Additionally, due to the lack of a monitoring network, there is limited information on the spatial and temporal variability of UFPs within the United States, as well as population exposures to UFPs, which adds uncertainty to epidemiologic study results.

The 2019 PM ISA cites extensive evidence indicating that ''both the general population as well as specific populations and life stages are at risk for $PM_{2.5}$-related health effects.'' [242] For example, in support of its ''causal'' and ''likely to be causal'' determinations, the ISA cites substantial evidence for: (1) PM-related mortality and cardiovascular effects in older adults; (2) PM-related cardiovascular effects in people with pre-existing cardiovascular disease; (3) PM-related respiratory effects in people with pre-existing respiratory disease, particularly asthma exacerbations in children; and (4) PM-related impairments in lung function growth and asthma development in children. The ISA additionally notes that stratified analyses (*i.e.,* analyses that directly compare PM-related health effects across groups) provide strong evidence for racial and ethnic differences in $PM_{2.5}$ exposures and in the risk of $PM_{2.5}$-related health effects, specifically within Hispanic and non-Hispanic Black populations, with some evidence of increased risk for populations of low socioeconomic status. Recent studies evaluated in the Supplement support the conclusion of the 2019 PM ISA with respect to disparities in both $PM_{2.5}$ exposure and health risk by race and ethnicity and provide additional support for disparities for populations of lower socioeconomic status.[243] Additionally, evidence spanning epidemiologic studies that conducted stratified analyses, experimental studies focusing on animal models of disease or individuals with pre-existing disease, dosimetry studies, as well as studies focusing on differential exposure suggest that populations with pre-existing cardiovascular or respiratory disease, populations that are overweight or obese, populations that have particular genetic variants, and current/former smokers could be at increased risk for adverse $PM_{2.5}$-related health effects. The 2022 Policy Assessment for the review of the PM NAAQS also highlights that factors that may contribute to increased risk of $PM_{2.5}$-related health effects include lifestage (children and older adults), pre-existing diseases (cardiovascular disease and respiratory disease), race/ethnicity, and socioeconomic status.[244]

2. Ozone

This section provides a summary of the health effects associated with exposure to ambient concentrations of ozone.[245] The information in this

[241] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[242] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[243] U.S. EPA. Supplement to the 2019 Integrated Science Assessment for Particulate Matter (Final Report, 2022). U.S. Environmental Protection Agency, Washington, DC, EPA/635/R–22/028, 2022.

[244] U.S. EPA. Policy Assessment (PA) for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter (Final Report, 2022). U.S. Environmental Protection Agency, Washington, DC, EPA–452/R–22–004, 2022, p. 3–53.

[245] Human exposure to ozone varies over time due to changes in ambient ozone concentration and because people move between locations which have notably different ozone concentrations. Also, the amount of ozone delivered to the lung is influenced

Continued

section is based on the information and conclusions in the April 2020 Integrated Science Assessment for Ozone (Ozone ISA).[246] The Ozone ISA concludes that human exposures to ambient concentrations of ozone are associated with a number of adverse health effects and characterizes the weight of evidence for these health effects.[247] The following discussion highlights the Ozone ISA's conclusions pertaining to health effects associated with both short-term and long-term periods of exposure to ozone.

For short-term exposure to ozone, the Ozone ISA concludes that respiratory effects, including lung function decrements, pulmonary inflammation, exacerbation of asthma, respiratory-related hospital admissions, and mortality, are causally associated with ozone exposure. It also concludes that metabolic effects, including metabolic syndrome (*i.e.,* changes in insulin or glucose levels, cholesterol levels, obesity, and blood pressure) and complications due to diabetes are likely to be causally associated with short-term exposure to ozone and that evidence is suggestive of a causal relationship between cardiovascular effects, central nervous system effects and total mortality and short-term exposure to ozone.

For long-term exposure to ozone, the Ozone ISA concludes that respiratory effects, including new onset asthma, pulmonary inflammation and injury, are likely to be causally related with ozone exposure. The Ozone ISA characterizes the evidence as suggestive of a causal relationship for associations between long-term ozone exposure and cardiovascular effects, metabolic effects, reproductive and developmental effects, central nervous system effects and total mortality. The evidence is inadequate to infer a causal relationship between chronic ozone exposure and increased risk of cancer.

Finally, interindividual variation in human responses to ozone exposure can result in some groups being at increased risk for detrimental effects in response to exposure. In addition, some groups are at increased risk of exposure due to their activities, such as outdoor workers and children. The Ozone ISA identified several groups that are at increased risk for ozone-related health effects. These groups are people with asthma, children and older adults, individuals with reduced intake of certain nutrients (*i.e.,* Vitamins C and E), outdoor workers, and individuals having certain genetic variants related to oxidative metabolism or inflammation. Ozone exposure during childhood can have lasting effects through adulthood. Such effects include altered function of the respiratory and immune systems. Children absorb higher doses (normalized to lung surface area) of ambient ozone, compared to adults, due to their increased time spent outdoors, higher ventilation rates relative to body size, and a tendency to breathe a greater fraction of air through the mouth. Children also have a higher asthma prevalence compared to adults. Recent epidemiologic studies provide generally consistent evidence that long-term ozone exposure is associated with the development of asthma in children. Studies comparing age groups reported higher magnitude associations for short-term ozone exposure and respiratory hospital admissions and emergency room visits among children than among adults. Panel studies also provide support for experimental studies with consistent associations between short-term ozone exposure and lung function and pulmonary inflammation in healthy children. Additional children's vulnerability and susceptibility factors are listed in section IX.G of the preamble.

3. Nitrogen Oxides

The most recent review of the health effects of oxides of nitrogen completed by EPA can be found in the 2016 Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (Oxides of Nitrogen ISA).[248] The largest source of NO_2 is motor vehicle emissions, and ambient NO_2 concentrations tend to be highly correlated with other traffic-related pollutants. Thus, a key issue in characterizing the causality of NO_2-health effect relationships was evaluating the extent to which studies supported an effect of NO_2 that is independent of other traffic-related pollutants. EPA concluded that the findings for asthma exacerbation integrated from epidemiologic and controlled human exposure studies provided evidence that is sufficient to infer a causal relationship between respiratory effects and short-term NO_2 exposure. The strongest evidence supporting an independent effect of NO_2 exposure comes from controlled human exposure studies demonstrating increased airway responsiveness in individuals with asthma following ambient-relevant NO_2 exposures. The coherence of this evidence with epidemiologic findings for asthma hospital admissions and ED visits as well as lung function decrements and increased pulmonary inflammation in children with asthma describe a plausible pathway by which NO_2 exposure can cause an asthma exacerbation. The 2016 ISA for Oxides of Nitrogen also concluded that there is likely to be a causal relationship between long-term NO_2 exposure and respiratory effects. This conclusion is based on new epidemiologic evidence for associations of NO_2 with asthma development in children combined with biological plausibility from experimental studies.

In evaluating a broader range of health effects, the 2016 ISA for Oxides of Nitrogen concluded that evidence is ''suggestive of, but not sufficient to infer, a causal relationship'' between short-term NO_2 exposure and cardiovascular effects and mortality and between long-term NO_2 exposure and cardiovascular effects and diabetes, birth outcomes, and cancer. In addition, the scientific evidence is inadequate (insufficient consistency of epidemiologic and toxicological evidence) to infer a causal relationship for long-term NO_2 exposure with fertility, reproduction, and pregnancy, as well as with postnatal development. A key uncertainty in understanding the relationship between these non-respiratory health effects and short- or long-term exposure to NO_2 is co-pollutant confounding, particularly by other roadway pollutants. The available evidence for non-respiratory health effects does not adequately address whether NO_2 has an independent effect or whether it primarily represents effects related to other or a mixture of traffic-related pollutants.

The 2016 ISA for Oxides of Nitrogen concluded that people with asthma, children, and older adults are at increased risk for NO_2-related health effects. In these groups and lifestages, NO_2 is consistently related to larger effects on outcomes related to asthma exacerbation, for which there is confidence in the relationship with NO_2 exposure.

not only by the ambient concentrations but also by the breathing route and rate.

[246] U.S. EPA. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[247] The ISA evaluates evidence and draws conclusions on the causal relationship between relevant pollutant exposures and 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 more information on these levels of evidence, please refer to Table II in the Preamble of the ISA.

[248] U.S. EPA. Integrated Science Assessment for Oxides of Nitrogen—Health Criteria (2016 Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–15/068, 2016.

4. Sulfur Oxides

This section provides an overview of the health effects associated with SO_2. Additional information on the health effects of SO_2 can be found in the 2017 Integrated Science Assessment for Sulfur Oxides—Health Criteria (SO_X ISA).[249] Following an extensive evaluation of health evidence from animal toxicological, controlled human exposure, and epidemiologic studies, EPA has concluded that there is a causal relationship between respiratory health effects and short-term exposure to SO_2. The immediate effect of SO_2 on the respiratory system in humans is bronchoconstriction. People with asthma are more sensitive to the effects of SO_2, likely resulting from preexisting inflammation associated with this disease. In addition to those with asthma (both children and adults), there is suggestive evidence that all children and older adults may be at increased risk of SO_2-related health effects. In free-breathing laboratory studies involving controlled human exposures to SO_2, respiratory effects have consistently been observed following 5–10 min exposures at SO_2 concentrations ≥ 400 ppb in people with asthma engaged in moderate to heavy levels of exercise, with respiratory effects occurring at concentrations as low as 200 ppb in some individuals with asthma. A clear concentration-response relationship has been demonstrated in these studies following exposures to SO_2 at concentrations between 200 and 1000 ppb, both in terms of increasing severity of respiratory symptoms and decrements in lung function, as well as the percentage of individuals with asthma adversely affected. Epidemiologic studies have reported positive associations between short-term ambient SO_2 concentrations and hospital admissions and emergency department visits for asthma and for all respiratory causes, particularly among children and older adults (≥ 65 years). The studies provide supportive evidence for the causal relationship.

For long-term SO_2 exposure and respiratory effects, EPA has concluded that the evidence is suggestive of a causal relationship. This conclusion is based on new epidemiologic evidence for positive associations between long-term SO_2 exposure and increases in asthma incidence among children, together with animal toxicological evidence that provides a pathophysiologic basis for the development of asthma. However, uncertainty remains regarding the influence of other pollutants on the observed associations with SO_2 because these epidemiologic studies have not examined the potential for co-pollutant confounding.

Consistent associations between short-term exposure to SO_2 and mortality have been observed in epidemiologic studies with larger effect estimates reported for respiratory mortality than for cardiovascular mortality. While this finding is consistent with the demonstrated effects of SO_2 on respiratory morbidity, uncertainty remains with respect to the interpretation of these observed mortality associations due to potential confounding by various copollutants. Therefore, EPA has concluded that the overall evidence is suggestive of a causal relationship between short-term exposure to SO_2 and mortality.

5. Carbon Monoxide

Information on the health effects of carbon monoxide (CO) can be found in the January 2010 Integrated Science Assessment for Carbon Monoxide (CO ISA).[250] The CO ISA presents conclusions regarding the presence of causal relationships between CO exposure and categories of adverse health effects.[251] This section provides a summary of the health effects associated with exposure to ambient concentrations of CO, along with the CO ISA conclusions.[252]

Controlled human exposure 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 presented in the CO ISA observed 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 CO 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 central nervous system and behavioral effects following low-level CO exposures, although the findings have not been consistent across all studies. The CO ISA concludes that 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 studies cited in the CO ISA have evaluated the role of CO exposure in birth outcomes such as preterm birth or cardiac birth defects. There is limited epidemiologic 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 perinatal CO exposure to affect birth weight, as well as other developmental outcomes. The CO ISA concludes that the evidence is suggestive of a causal relationship between long-term exposures to CO and developmental effects and birth outcomes.

Epidemiologic studies provide evidence of associations between short-term CO concentrations and respiratory morbidity such as changes in pulmonary function, respiratory symptoms, and hospital admissions. 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 CO ISA concludes that the evidence is suggestive of a causal relationship between short-term CO exposure and respiratory morbidity, and inadequate to

[249] U.S. EPA. Integrated Science Assessment (ISA) for Sulfur Oxides—Health Criteria (Final Report, Dec 2017). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–17/451, 2017.

[250] U.S. EPA, (2010). Integrated Science Assessment for Carbon Monoxide (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–09/019F, 2010. *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=218686.*

[251] 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.

[252] Personal exposure includes contributions from many sources, and in many different environments. Total personal exposure to CO includes both ambient and non-ambient components; and both components may contribute to adverse health effects.

conclude that a causal relationship exists between long-term exposure and respiratory morbidity.

Finally, the CO ISA concludes that the epidemiologic evidence is suggestive of a causal relationship between short-term concentrations of CO and mortality. Epidemiologic evidence suggests an association exists 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 co-pollutant models contributes to the uncertainty as to whether CO is acting alone or as an indicator for other combustion-related pollutants. The CO ISA also concludes that there is not likely to be a causal relationship between relevant long-term exposures to CO and mortality.

6. Diesel Exhaust

In EPA's 2002 Diesel Health Assessment Document (Diesel HAD), exposure to diesel exhaust was classified as likely to be carcinogenic to humans by inhalation from environmental exposures, in accordance with the revised draft 1996/1999 EPA cancer guidelines.[253] [254] A number of other agencies (National Institute for Occupational Safety and Health, the International Agency for Research on Cancer, the World Health Organization, California EPA, and the U.S. Department of Health and Human Services) made similar hazard classifications prior to 2002. EPA also concluded in the 2002 Diesel HAD that it was not possible to calculate a cancer unit risk for diesel exhaust due to limitations in the exposure data for the occupational groups or the absence of a dose-response relationship.

In the absence of a cancer unit risk, the Diesel HAD sought to provide additional insight into the significance of the diesel exhaust cancer hazard by estimating possible ranges of risk that might be present in the population. An exploratory analysis was used to characterize a range of possible lung cancer risk. The outcome was that environmental risks of cancer from long-term diesel exhaust exposures could plausibly range from as low as 10^{-5} to as high as 10^{-3}. Because of uncertainties, the analysis acknowledged that the risks could be lower than 10^{-5}, and a zero risk from diesel exhaust exposure could not be ruled out.

Noncancer health effects of acute and chronic exposure to diesel exhaust emissions are also of concern to EPA. EPA derived a diesel exhaust reference concentration (RfC) from consideration of four well-conducted chronic rat inhalation studies showing adverse pulmonary effects. The RfC is 5 $\mu g/m^3$ for diesel exhaust measured as diesel particulate matter. This RfC does not consider allergenic effects such as those associated with asthma or immunologic or the potential for cardiac effects. There was emerging evidence in 2002, discussed in the Diesel HAD, that exposure to diesel exhaust can exacerbate these effects, but the exposure-response data were lacking at that time to derive an RfC based on these then-emerging considerations. The Diesel HAD states, ''With [diesel particulate matter] being a ubiquitous component of ambient PM, there is an uncertainty about the adequacy of the existing [diesel exhaust] noncancer database to identify all of the pertinent [diesel exhaust]-caused noncancer health hazards.'' The Diesel HAD also noted ''that acute exposure to [diesel exhaust] has been associated with irritation of the eye, nose, and throat, respiratory symptoms (cough and phlegm), and neurophysiological symptoms such as headache, lightheadedness, nausea, vomiting, and numbness or tingling of the extremities.'' The Diesel HAD notes that the cancer and noncancer hazard conclusions applied to the general use of diesel engines then on the market and as cleaner engines replace a substantial number of existing ones, the applicability of the conclusions would need to be reevaluated.

It is important to note that the Diesel HAD also briefly summarizes health effects associated with ambient PM and discusses EPA's then-annual $PM_{2.5}$ NAAQS of 15 $\mu g/m^3$.[255] In 2012, EPA revised the level of the annual $PM_{2.5}$ NAAQS to 12 $\mu g/m^3$ and in 2024 EPA revised the level of the annual $PM_{2.5}$ NAAQS to 9.0 $\mu g/m^3$.[256] There is a large and extensive body of human data showing a wide spectrum of adverse health effects associated with exposure to ambient PM, of which diesel exhaust is an important component. The $PM_{2.5}$ NAAQS provides protection from the health effects attributed to exposure to $PM_{2.5}$. The contribution of diesel PM to total ambient PM varies in different regions of the country and also within a region from one area to another. The contribution can be high in near-roadway environments, for example, or in other locations where diesel engine use is concentrated.

Since 2002, several new studies have been published which continue to report increased lung cancer risk associated with occupational exposure to diesel exhaust from older engines. Of particular note since 2011 are three new epidemiology studies that have examined lung cancer in occupational populations, including, truck drivers, underground nonmetal miners, and other diesel motor-related occupations. These studies reported increased risk of lung cancer related to exposure to diesel exhaust, with evidence of positive exposure-response relationships to varying degrees.[257] [258] [259] These newer studies (along with others that have appeared in the scientific literature) add to the evidence EPA evaluated in the 2002 Diesel HAD and further reinforce the concern that diesel exhaust exposure likely poses a lung cancer hazard. The findings from these newer studies do not necessarily apply to newer technology diesel engines (*i.e.,* heavy-duty highway engines from 2007 and later model years) since the newer engines have large reductions in the emission constituents compared to older technology diesel engines.

In light of the growing body of scientific literature evaluating the health effects of exposure to diesel exhaust, in June 2012 the World Health Organization's International Agency for Research on Cancer (IARC), a recognized international authority on the carcinogenic potential of chemicals and other agents, evaluated the full range of cancer-related health effects data for diesel engine exhaust. IARC concluded that diesel exhaust should be regarded as ''carcinogenic to

[253] U.S. EPA. (1999). Guidelines for Carcinogen Risk Assessment. Review Draft. NCEA–F–0644, July. Washington, DC: U.S. EPA. Retrieved on March 19, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=54932*.

[254] U.S. EPA (2002). Health Assessment Document for Diesel Engine Exhaust. EPA/600/8–90/057F Office of research and Development, Washington DC. Retrieved on March 17, 2009 from *http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=29060. pp. 1–1 1–2.*

[255] See Section II.B.1 of the preamble for discussion of the current $PM_{2.5}$ NAAQS standard, and *https://www.epa.gov/pm-pollution/national-ambient-air-quality-standards-naaqs-pm.*

[256] *https://www.epa.gov/pm-pollution/national-ambient-air-quality-standards-naaqs-pm.*

[257] Garshick, Eric, Francine Laden, Jaime E. Hart, Mary E. Davis, Ellen A. Eisen, and Thomas J. Smith. 2012. Lung cancer and elemental carbon exposure in trucking industry workers. Environmental Health Perspectives 120(9): 1301–1306.

[258] Silverman, D. T., Samanic, C. M., Lubin, J. H., Blair, A. E., Stewart, P. A., Vermeulen, R., & Attfield, M. D. (2012). The diesel exhaust in miners study: a nested case–control study of lung cancer and diesel exhaust. Journal of the National Cancer Institute.

[259] Olsson, Ann C., et al. ''Exposure to diesel motor exhaust and lung cancer risk in a pooled analysis from case-control studies in Europe and Canada.'' American journal of respiratory and critical care medicine 183.7 (2011): 941–948.

humans.'' [260] This designation was an update from its 1988 evaluation that considered the evidence to be indicative of a ''probable human carcinogen.''

7. Air Toxics

Light- and medium-duty engine emissions contribute to ambient levels of air toxics that are known or suspected human or animal carcinogens or that have noncancer health effects. These compounds include, but are not limited to, acetaldehyde, benzene, 1, 3-butadiene, formaldehyde, naphthalene, and polycyclic organic matter. These compounds were all identified as national or regional cancer risk drivers or contributors in the 2019 AirToxScreen Assessment.[261] [262]

i. 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.[263] The inhalation unit risk estimate (URE) in IRIS for acetaldehyde is 2.2×10^{-6} per µg/m^3.[264] Acetaldehyde is reasonably anticipated to be a human carcinogen by the NTP in the 14th Report on Carcinogens and is classified as possibly carcinogenic to humans (Group 2B) by the IARC.[265] [266]

The primary noncancer effects of exposure to acetaldehyde vapors include irritation of the eyes, skin, and respiratory tract.[267] In short-term (4 week) rat studies, degeneration of olfactory epithelium was observed at various concentration levels of acetaldehyde exposure.[268] Data from these studies were used by EPA to develop an inhalation reference concentration of 9 µg/m3. Some asthmatics have been shown to be a sensitive subpopulation to decrements in functional expiratory volume (FEV1 test) and bronchoconstriction upon acetaldehyde inhalation.[269] Children, especially those with diagnosed asthma, may be more likely to show impaired pulmonary function and symptoms of asthma than are adults following exposure to acetaldehyde.[270]

ii. Benzene

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.[271] [272] [273] 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. EPA's IRIS documentation for benzene also lists a range of 2.2×10^{-6} to 7.8×10^{-6} per µg/m^3 as the unit risk estimate (URE) for benzene.[274] [275] The International Agency for Research on Cancer (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.[276] [277]

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.[278] [279] The most sensitive noncancer effect observed in humans, based on current data, is the depression of the absolute lymphocyte count in blood.[280] [281] EPA's inhalation reference concentration (RfC) for benzene is 30 µg/m^3. The RfC is based on suppressed absolute lymphocyte counts seen in humans under occupational exposure conditions. In addition, studies sponsored by the Health Effects Institute (HEI) provide evidence that biochemical responses occur at lower levels of benzene exposure than previously known.[282] [283] [284] [285] EPA's IRIS program

[260] IARC [International Agency for Research on Cancer]. (2013). Diesel and gasoline engine exhausts and some nitroarenes. IARC Monographs Volume 105. Online at *http://monographs.iarc.fr/ENG/Monographs/vol105/index.php*.

[261] U.S. EPA (2022) Technical Support Document EPA's Air Toxics Screening Assessment. 2018 AirToxScreen TSD. *https://www.epa.gov/system/files/documents/2023-02/AirToxScreen_2018%20TSD.pdf*.

[262] U.S. EPA (2023) 2019 AirToxScreen Risk Drivers. *https://www.epa.gov/AirToxScreen/airtoxscreen-risk-drivers*.

[263] U.S. EPA (1991). Integrated Risk Information System File of Acetaldehyde. Research and Development, National Center for Environmental Assessment, Washington, DC. This material is available electronically at *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=290*.

[264] U.S. EPA (1991). Integrated Risk Information System File of Acetaldehyde. This material is available electronically at *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=290*.

[265] NTP (National Toxicology Program). 2016. Report on Carcinogens, Fourteenth Edition.; Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. *https://ntp.niehs.nih.gov/go/roc14*.

[266] International Agency for Research on Cancer (IARC). (1999). Re-evaluation of some organic chemicals, hydrazine, and hydrogen peroxide. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemical to Humans, Vol 71. Lyon, France.

[267] U.S. EPA (1991). Integrated Risk Information System File of Acetaldehyde. This material is available electronically at *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=290*.

[268] 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.

[269] 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): 940–943.

[270] California OEHHA, 2014. TSD for Noncancer RELs: Appendix D. Individual, Acute, 8-Hour, and Chronic Reference Exposure Level Summaries. December 2008 (updated July 2014). *https://oehha.ca.gov/media/downloads/crnr/appendixd1final.pdf*.

[271] U.S. EPA. (2000). Integrated Risk Information System File for Benzene. This material is available electronically at: *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=276*.

[272] International Agency for Research on Cancer. (1982). IARC monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 29, Some industrial chemicals and dyestuffs, International Agency for Research on Cancer, World Health Organization, Lyon, France 1982.

[273] 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.

[274] A unit risk estimate is defined as the increase in the lifetime risk of cancer of an individual who is exposed for a lifetime to 1 µg/m3 benzene in air.

[275] U.S. EPA. (2000). Integrated Risk Information System File for Benzene. This material is available electronically at: *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=276*.

[276] International Agency for Research on Cancer (IARC, 2018. Monographs on the evaluation of carcinogenic risks to humans, volume 120. World Health Organization—Lyon, France. *http://publications.iarc.fr/Book-And-Report-Series/Iarc-Monographs-On-The-Identification-Of-Carcinogenic-Hazards-To-Humans/Benzene-2018*.

[277] NTP (National Toxicology Program). 2016. Report on Carcinogens, Fourteenth Edition.; Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. *https://ntp.niehs.nih.gov/go/roc14*.

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[279] Goldstein, B.D. (1988). Benzene toxicity. Occupational medicine. State of the Art Reviews. 3: 541–554.

[280] 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.

[281] U.S. EPA (2002). Toxicological Review of Benzene (Noncancer Effects). Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington DC. This material is available electronically at *https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0276tr.pdf*.

[282] Qu, O.; Shore, R.; Li, G.; Jin, X.; Chen, C.L.; Cohen, B.; Melikian, A.; Eastmond, D.; Rappaport, S.; Li, H.; Rupa, D.; Suramaya, R.; Songnian, W.; Huifant, Y.; Meng, M.; Winnik, M.; Kwok, E.; Li, Y.; Mu, R.; Xu, B.; Zhang, X.; Li, K. (2003). HEI Report 115, Validation & Evaluation of Biomarkers in Workers Exposed to Benzene in China.

[283] Qu, Q., R. Shore, G. Li, X. Jin, L.C. Chen, B. Cohen, et al. (2002). Hematological changes among

Continued

has not yet evaluated these new data. EPA does not currently have an acute reference concentration for benzene. The Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Level (MRL) for acute exposure to benzene is 29 μg/m³ for 1–14 days exposure.[286 287]

There is limited information from two studies regarding an increased risk of adverse effects to children whose parents have been occupationally exposed to benzene.[288 289] Data from animal studies have shown benzene exposures result in damage to the hematopoietic (blood cell formation) system during development.[290 291 292] Also, key changes related to the development of childhood leukemia occur in the developing fetus.[293] Several studies have reported that genetic changes related to eventual leukemia development occur before birth. For example, there is one study of genetic changes in twins who developed T cell leukemia at nine years of age.[294]

Chinese workers with a broad range of benzene exposures. Am. J. Industr. Med. 42: 275–285.

[284] Lan, Qing, Zhang, L., Li, G., Vermeulen, R., et al. (2004). Hematotoxically in Workers Exposed to Low Levels of Benzene. Science 306: 1774–1776.

[285] 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.

[286] U.S. Agency for Toxic Substances and Disease Registry (ATSDR). (2007). Toxicological profile for benzene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. *http://www.atsdr.cdc.gov/ToxProfiles/tp3.pdf*.

[287] A minimal risk level (MRL) is defined as an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure.

[288] Corti, M; Snyder, CA. (1996) Influences of gender, development, pregnancy and ethanol consumption on the hematotoxicity of inhaled 10 ppm benzene. Arch Toxicol 70:209–217.

[289] McKinney P.A.; Alexander, F.E.; Cartwright, R.A.; et al. (1991) Parental occupations of children with leukemia in west Cumbria, north Humberside, and Gateshead, Br Med J 302:681–686.

[290] Keller, KA; Snyder, CA. (1986) Mice exposed in utero to low concentrations of benzene exhibit enduring changes in their colony forming hematopoietic cells. Toxicology 42:171–181.

[291] Keller, KA; Snyder, CA. (1988) Mice exposed in utero to 20 ppm benzene exhibit altered numbers of recognizable hematopoietic cells up to seven weeks after exposure. Fundam Appl Toxicol 10:224–232.

[292] Corti, M; Snyder, CA. (1996) Influences of gender, development, pregnancy and ethanol consumption on the hematotoxicity of inhaled 10 ppm benzene. Arch Toxicol 70:209–217.

[293] U. S. EPA. (2002). Toxicological Review of Benzene (Noncancer Effects). National Center for Environmental Assessment, Washington, DC. Report No. EPA/635/R–02/001F. *https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0276tr.pdf*.

[294] Ford, AM; Pombo-de-Oliveira, MS; McCarthy, KP; MacLean, JM; Carrico, KC; Vincent, RF; Greaves, M. (1997) Monoclonal origin of concordant T-cell malignancy in identical twins. Blood 89:281–285.

iii. 1,3-Butadiene

EPA has characterized 1,3-butadiene as carcinogenic to humans by inhalation.[295 296] 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.[297 298 299 300] There are numerous studies consistently demonstrating that 1,3-butadiene is metabolized into genotoxic metabolites by experimental animals and humans. The specific mechanisms of 1,3-butadiene-induced carcinogenesis are unknown; however, the scientific evidence strongly suggests that the carcinogenic effects are mediated by genotoxic metabolites. Animal data suggest that females may be more sensitive than males for cancer effects associated with 1,3-butadiene exposure; there are insufficient data in humans from which to draw conclusions about sensitive subpopulations. The URE for 1,3-butadiene is 3 × 10–5 per μg/m³.[301] 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.[302] Based on this critical effect and the benchmark concentration methodology, an RfC for chronic health effects was calculated at 0.9 ppb (approximately 2 μg/m³).

[295] 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 *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=54499*.

[296] 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 *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=139*.

[297] International Agency for Research on Cancer (IARC). (1999). Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 71, Re-evaluation of some organic chemicals, hydrazine and hydrogen peroxide, World Health Organization, Lyon, France.

[298] International Agency for Research on Cancer (IARC). (2008). Monographs on the evaluation of carcinogenic risk of chemicals to humans, 1,3-Butadiene, Ethylene Oxide and Vinyl Halides (Vinyl Fluoride, Vinyl Chloride and Vinyl Bromide) Volume 97, World Health Organization, Lyon, France.

[299] NTP (National Toxicology Program). 2016. Report on Carcinogens, Fourteenth Edition.; Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. *https://ntp.niehs.nih.gov/go/roc14*.

[300] International Agency for Research on Cancer (IARC). (2012). Monographs on the evaluation of carcinogenic risk of chemicals to humans, Volume 100F chemical agents and related occupations, World Health Organization, Lyon, France.

[301] 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 *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=139*.

iv. Formaldehyde

In 1991, EPA concluded that formaldehyde is a Class B1 probable human carcinogen based on limited evidence in humans and sufficient evidence in animals.[303] An Inhalation URE for cancer and a reference dose for oral noncancer effects were developed by EPA and posted on the IRIS database. Since that time, the NTP and IARC have concluded that formaldehyde is a known human carcinogen.[304 305 306]

The conclusions by IARC and NTP reflect the results of epidemiologic research published since 1991 in combination with previous and more recent 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.[307 308 309] 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.[310] Extended follow-up of

[302] 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.

[303] EPA. Integrated Risk Information System. Formaldehyde (CASRN 50–00–0) *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=419*.

[304] NTP (National Toxicology Program). 2016. Report on Carcinogens, Fourteenth Edition.; Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. *https://ntp.niehs.nih.gov/go/roc14*.

[305] IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 88 (2006): Formaldehyde, 2-Butoxyethanol and 1-tert-Butoxypropan-2-ol.

[306] IARC Monographs on the Evaluation of Carcinogenic Risks to Humans Volume 100F (2012): Formaldehyde.

[307] 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.

[308] 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.

[309] 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.

[310] Pinkerton, L. E. 2004. Mortality among a cohort of garment workers exposed to formaldehyde: an update. Occup. Environ. Med. 61: 193–200.

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.[311] Finally, a study of embalmers reported formaldehyde exposures to be associated with an increased risk of myeloid leukemia but not brain cancer.[312]

Health effects of formaldehyde in addition to cancer were reviewed by the Agency for Toxic Substances and Disease Registry in 1999, supplemented in 2010, and by the World Health Organization.[313] [314] [315] These organizations reviewed the scientific literature concerning health effects linked to formaldehyde exposure to evaluate hazards and dose response relationships and defined exposure concentrations for minimal risk levels (MRLs). The health endpoints reviewed included sensory irritation of eyes and respiratory tract, reduced pulmonary function, nasal histopathology, and immune system effects. In addition, research on reproductive and developmental effects and neurological effects were discussed along with several studies that suggest that formaldehyde may increase the risk of asthma—particularly in the young.

In June 2010, 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.[316] That 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.[317] EPA addressed the NRC (2011) recommendations and applied systematic review methods to the evaluation of the available noncancer and cancer health effects evidence and released a new draft IRIS Toxicological Review of Formaldehyde—Inhalation in April 2022.[318] In this draft, updates to the 1991 IRIS finding include a stronger determination of the carcinogenicity of formaldehyde inhalation to humans, as well as characterization of its noncancer effects to propose an overall reference concentration for inhalation exposure. The National Academies of Sciences, Engineering, and Medicine released their review of EPA's 2022 Draft Formaldehyde Assessment in August 2023, concluding that EPA's ''findings on formaldehyde hazard and quantitative risk are supported by the evidence identified.'' [319] EPA is currently revising the draft IRIS assessment in response to comments received.[320]

v. 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.[321] Chronic (long term) exposure of workers and rodents to naphthalene has been reported to cause cataracts and retinal damage.[322] Children, especially neonates, appear to be more susceptible to acute naphthalene poisoning based on the number of reports of lethal cases in children and infants (hypothesized to be due to immature naphthalene detoxification pathways).[323] EPA released an external review draft of a reassessment of the inhalation carcinogenicity of naphthalene based on a number of recent animal carcinogenicity studies.[324] The draft reassessment completed external peer review.[325] Based on external peer review comments received, EPA is developing a revised draft assessment that considers inhalation and oral routes of exposure, as well as cancer and noncancer effects.[326] 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 NTP 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.[327] California EPA has released a risk assessment for naphthalene,[328] and the IARC has reevaluated naphthalene and re-classified it as Group 2B: possibly carcinogenic to humans.[329]

Naphthalene also causes a number of non-cancer effects in animals following

[311] 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.

[312] 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.

[313] ATSDR. 1999. Toxicological Profile for Formaldehyde, U.S. Department of Health and Human Services (HHS), July 1999.

[314] ATSDR. 2010. Addendum to the Toxicological Profile for Formaldehyde. U.S. Department of Health and Human Services (HHS), October 2010.

[315] IPCS. 2002. Concise International Chemical Assessment Document 40. Formaldehyde. World Health Organization.

[316] 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/iris_drafts/recordisplay.cfm?deid=223614*.

[317] NRC (National Research Council). 2011. Review of the Environmental Protection Agency's Draft IRIS Assessment of Formaldehyde. Washington DC: National Academies Press. *http://books.nap.edu/openbook.php?record_id=13142*.

[318] U.S. EPA. 2022. IRIS Toxicological Review of Formaldehyde-Inhalation (External Review Draft, 2022). U.S. Environmental Protection Agency, Washington, DC, EPA/635/R–22/039.

[319] National Academies of Sciences, Engineering, and Medicine. 2023. Review of EPA's 2022 Draft Formaldehyde Assessment. Washington, DC: The National Academies Press. *https://doi.org/10.17226/27153*.

[320] For more information, see *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=248150#*.

[321] 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 *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=56434*.

[322] 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 *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=56434*.

[323] 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 *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=56434*.

[324] 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 *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=56434*.

[325] 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*.

[326] U.S. EPA. (2018) See: *https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=436*.

[327] NTP (National Toxicology Program). 2016. Report on Carcinogens, Fourteenth Edition.; Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service. *https://ntp.niehs.nih.gov/go/roc14*.

[328] California Environmental Protection Agency Office of Environmental Health Hazard. (2002). *https://oehha.ca.gov/media/downloads/proposition-65/chemicals/41902not.pdf*.

[329] International Agency for Research on Cancer (IARC). (2002). Monographs on the Evaluation of the Carcinogenic Risk of Chemicals for Humans. Vol. 82. Lyon, France.

chronic and less-than-chronic exposure, including abnormal cell changes and growth in respiratory and nasal tissues.[330] The current EPA IRIS assessment includes noncancer data on hyperplasia and metaplasia in nasal tissue that form the basis of the inhalation RfC of 3 μg/m³.[331] The ATSDR MRL for acute and intermediate duration oral exposure to naphthalene is 0.6 mg/kg-day based on maternal toxicity in a developmental toxicology study in rats.[332] ATSDR also derived an ad hoc reference value of 6×10^{-2} mg/m³ for acute (≤24-hour) inhalation exposure to naphthalene in a Letter Health Consultation dated March 24, 2014 to address a potential exposure concern in Illinois.[333] The ATSDR acute inhalation reference value was based on a qualitative identification of an exposure level interpreted not to cause pulmonary lesions in mice. More recently, EPA developed acute RfCs for 1-, 8-, and 24-hour exposure scenarios; the ≤24-hour reference value is 2×10^{-2} mg/m³.[334] EPA's acute RfCs are based on a systematic review of the literature, benchmark dose modeling of naphthalene-induced nasal lesions in rats, and application of a PBPK (physiologically based pharmacokinetic) model.

vi. POM/PAHs

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 in section II.C.7.vii of the preamble. POM compounds are formed primarily from combustion and are present in the atmosphere in gas and particulate form as well as in some fried and grilled foods. 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.[335] [336] In 1991 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 based on the 1986 EPA Guidelines for Carcinogen Risk Assessment.[337] Studies in multiple animal species demonstrate that benzo[a]pyrene is carcinogenic at multiple tumor sites (alimentary tract, liver, kidney, respiratory tract, pharynx, and skin) by all routes of exposure. An increasing number of occupational studies demonstrate a positive exposure-response relationship with cumulative benzo[a]pyrene exposure and lung cancer. The inhalation URE in IRIS for benzo[a]pyrene is 6×10^{-4} per μg/m³ and the oral slope factor for cancer is 1 per mg/kg-day.[338]

Animal studies demonstrate that exposure to benzo[a]pyrene is also associated with developmental (including developmental neurotoxicity), reproductive, and immunological effects. In addition, epidemiology studies involving exposure to PAH mixtures have reported associations between internal biomarkers of exposure to benzo[a]pyrene (benzo[a]pyrene diol epoxide-DNA adducts) and adverse birth outcomes (including reduced birth weight, postnatal body weight, and head circumference), neurobehavioral effects, and decreased fertility. The inhalation RfC for benzo[a]pyrene is 2×10^{-6} mg/m³ and the RfD for oral exposure is 3×10^{-4} mg/kg-day.[339]

8. Exposure and Health Effects Associated With Traffic

Locations near major roadways generally have elevated concentrations of many air pollutants emitted from motor vehicles. Hundreds of studies have been published in peer-reviewed journals, concluding that concentrations of CO, CO_2, NO, NO_2, benzene, aldehydes, particulate matter, black carbon, and many other compounds are elevated in ambient air within approximately 300–600 meters (about 1,000–2,000 feet) of major roadways. The highest concentrations of most pollutants emitted directly by motor vehicles are found within 50 meters (about 165 feet) of the edge of a roadway's traffic lanes.

A large-scale review of air quality measurements in the vicinity of major roadways between 1978 and 2008 concluded that the pollutants with the steepest concentration gradients in vicinities of roadways were CO, ultrafine particles, metals, elemental carbon (EC), NO, NO_X, and several VOCs.[340] These pollutants showed a large reduction in concentrations within 100 meters downwind of the roadway. Pollutants that showed more gradual reductions with distance from roadways included benzene, NO_2, $PM_{2.5}$, and PM_{10}. In reviewing the literature, Karner et al. (2010) reported that results varied based on the method of statistical analysis used to determine the gradient in pollutant concentration. More recent studies of traffic-related air pollutants continue to report sharp gradients around roadways, particularly within several hundred meters.[341] [342] [343] [344] [345] [346] [347] [348] There is

[330] 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 *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=56434*.

[331] U.S. EPA. (1998). Toxicological Review of Naphthalene. Environmental Protection Agency, Integrated Risk Information System (IRIS), Research and Development, National Center for Environmental Assessment, Washington, DC *https://cfpub.epa.gov/ncea/iris_drafts/recordisplay.cfm?deid=56434*.

[332] ATSDR. Toxicological Profile for Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene (2005). *https://www.atsdr.cdc.gov/ToxProfiles/tp67-p.pdf*.

[333] ATSDR. Letter Health Consultation, Radiac Abrasives, Inc., Chicago, Illinois (2014). *https://www.atsdr.cdc.gov/HAC/pha/RadiacAbrasives/Radiac%20Abrasives,%20Inc.%20_%20LHC%20(Final)%20_%2003-24-2014%20(2)_508.pdf*.

[334] U. S. EPA. Derivation of an acute reference concentration for inhalation exposure to naphthalene. Report No. EPA/600/R–21/292. *https://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=355035*.

[335] 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*.

[336] 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*.

[337] U.S. EPA (1991). Drinking Water Criteria Document for Polycyclic Aromatic Hydrocarbons (PAHS). ECAO–CIN–0010. EPA Research and Development.

[338] U.S. EPA (2017). Toxicological Review of Benzo[a]pyrene. This material is available electronically at: *https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0136tr.pdf*.

[339] U.S. EPA (2017). Toxicological Review of Benzo[a]pyrene. This material is available electronically at: *https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/0136tr.pdf*.

[340] Karner, A.A.; Eisinger, D.S.; Niemeier, D.A. (2010). Near-roadway air quality: synthesizing the findings from real-world data. Environ Sci Technol 44: 5334–5344.

[341] McDonald, B.C.; McBride, Z.C.; Martin, E.W.; Harley, R.A. (2014) High-resolution mapping of motor vehicle carbon dioxide emissions. J. Geophys. Res. Atmos.,119, 5283–5298, doi:10.1002/2013JD021219.

[342] Kimbrough, S.; Baldauf, R.W.; Hagler, G.S.W.; Shores, R.C.; Mitchell, W.; Whitaker, D.A.; Croghan, C.W.; Vallero, D.A. (2013) Long-term continuous measurement of near-road air pollution in Las Vegas: seasonal variability in traffic emissions impact on air quality. Air Qual Atmos Health 6: 295–305. DOI 10.1007/s11869–012–0171–x.

[343] Kimbrough, S.; Palma, T.; Baldauf, R.W. (2014) Analysis of mobile source air toxics (MSATs)—Near-road VOC and carbonyl concentrations. Journal of the Air &Waste Management Association, 64:3, 349–359, DOI: 10.1080/10962247.2013.863814.

[344] Kimbrough, S.; Owen, R.C.; Snyder, M.; Richmond-Bryant, J. (2017) NO to NO_2 Conversion Rate Analysis and Implications for Dispersion Model Chemistry Methods using Las Vegas, Nevada Near-Road Field Measurements. Atmos Environ 165: 23–24.

evidence that EPA's regulations for vehicles have lowered the near-road concentrations and gradients.[349] Starting in 2010, EPA required through the NAAQS process that air quality monitors be placed near high-traffic roadways for determining concentrations of CO, NO_2, and $PM_{2.5}$. The monitoring data for NO_2 and CO indicate that in urban areas, monitors near roadways often report the highest concentrations.[350] [351]

For pollutants with relatively high background concentrations relative to near-road concentrations, detecting concentration gradients can be difficult. For example, many carbonyls have high background concentrations because of photochemical breakdown of precursors from many different organic compounds. However, several studies have measured carbonyls in multiple weather conditions and found higher concentrations of many carbonyls downwind of roadways.[352] [353] These findings suggest a substantial roadway source of these carbonyls.

In the past 30 years, many studies have been published with results reporting that populations who live, work, or go to school near high-traffic roadways experience higher rates of numerous adverse health effects, compared to populations far away from major roads.[354] In addition, numerous studies have found adverse health effects associated with spending time in traffic, such as commuting or walking along high-traffic roadways, including studies among children.[355] [356] [357] [358]

Numerous reviews of this body of health literature have been published. In a 2022 final report, an expert panel of the Health Effects Institute (HEI) employed a systematic review focusing on selected health endpoints related to exposure to traffic-related air pollution.[359] The HEI panel concluded that there was a high level of confidence in evidence between long-term exposure to traffic-related air pollution and health effects in adults, including all-cause, circulatory, and ischemic heart disease mortality.[360] The panel also found that there is a moderate-to-high level of confidence in evidence of associations with asthma onset and acute respiratory infections in children and lung cancer and asthma onset in adults. The panel concluded that there was a moderate level of evidence of associations with small for gestational age births, but low-to-moderate confidence for other birth outcomes (term birth weight and preterm birth). This report follows on an earlier expert review published by HEI in 2010, where it found strongest evidence for asthma-related traffic impacts. Other literature reviews have been published with conclusions generally similar to the HEI panels'.[361] [362] [363] [364] Additionally, in 2014, researchers from the U.S. Centers for Disease Control and Prevention (CDC) published a systematic review and meta-analysis of studies evaluating the risk of childhood leukemia associated with traffic exposure and reported positive associations between postnatal proximity to traffic and leukemia risks, but no such association for prenatal exposures.[365] The U.S. Department of Health and Human Services' National Toxicology Program published a monograph including a systematic review of traffic-related air pollution and its impacts on hypertensive disorders of pregnancy. The National Toxicology Program concluded that exposure to traffic-related air pollution is ''presumed to be a hazard to pregnant women'' for developing hypertensive disorders of pregnancy.[366]

For several other health outcomes there are publications to suggest the

345 Apte, J.S.; Messier, K.P.; Gani, S.; Brauer, M.; Kirchstetter, T.W.; Lunden, M.M.; Marshall, J.D.; Portier, C.J.; Vermeulen, R.C.H.; Hamburg, S.P. (2017) High-Resolution Air Pollution Mapping with Google Street View Cars: Exploiting Big Data. Environ Sci Technol 51: 6999–7008. *https://doi.org/10.1021/acs.est.7b00891*.

346 Gu, P.; Li, H.Z.; Ye, Q.; et al. (2018) Intercity variability of particulate matter is driven by carbonaceous sources and correlated with land-use variables. Environ Sci Technol 52: 52: 11545–11554. [Online at *http://dx.doi.org/10.1021/acs.est.8b03833]*.

347 Hilker, N.; Wang, J.W.; Jong, C–H.; Healy, R.M.; Sofowote, U.; Debosz, J.; Su, Y.; Noble, M.; Munoz, A.; Doerkson, G.; White, L.; Audette, C.; Herod, D.; Brook, J.R.; Evans, G.J. (2019) Traffic-related air pollution near roadways: discerning local impacts from background. Atmos. Meas. Tech., 12, 5247–5261. *https://doi.org/10.5194/amt-12-5247-2019*.

348 Dabek-Zlotorzynska, E., V. Celo, L. Ding, D. Herod, C–H. Jeong, G. Evans, and N. Hilker. 2019. ''Characteristics and sources of $PM_{2.5}$ and reactive gases near roadways in two metropolitan areas in Canada.'' Atmos Environ 218: 116980.

349 Sarnat, J.A.; Russell, A.; Liang, D.; Moutinho, J.L; Golan, R.; Weber, R.; Gao, D.; Sarnat, S.; Chang, H.H.; Greenwald, R.; Yu, T. (2018) Developing Multipollutant Exposure Indicators of Traffic Pollution: The Dorm Room Inhalation to Vehicle Emissions (DRIVE) Study. Health Effects Institute Research Report Number 196. [Online at: *https://www.healtheffects.org/publication/developing-multipollutant-exposure-indicators-traffic-pollution-dorm-room-inhalation*].

350 Gantt, B; Owen, R.C.; Watkins, N. (2021) Characterizing nitrogen oxides and fine particulate matter near major highways in the United States using the National Near-road Monitoring Network. Environ Sci Technol 55: 2831–2838. [Online at *https://doi.org/10.1021/acs.est.0c05851*].

351 Lal, R.M.; Ramaswani, A.; Russell, A.G. (2020) Assessment of the near-road (monitoring) network including comparison with nearby monitors within U.S. cities. Environ Res Letters 15: 114026. [Online at *https://doi.org/10.1088/1748-9326/ab8156*].

352 Liu, W.; Zhang, J.; Kwon, J.l; et l. (2006). Concentrations and source characteristics of airborne carbonyl compounds measured outside urban residences. J Air Waste Manage Assoc 56: 1196–1204.

353 Cahill, T.M.; Charles, M.J.; Seaman, V.Y. (2010). Development and application of a sensitive method to determine concentrations of acrolein and other carbonyls in ambient air. Health Effects Institute Research Report 149. Available at *https://www.healtheffects.org/system/files/Cahill149.pdf*.

354 In the widely used PubMed database of health publications, between January 1, 1990 and December 31, 2021, 1,979 publications contained the keywords ''traffic, pollution, epidemiology,'' with approximately half the studies published after 2015.

355 Laden, F.; Hart, J.E.; Smith, T.J.; Davis, M.E.; Garshick, E. (2007) Cause-specific mortality in the unionized U.S. trucking industry. Environmental Health Perspect 115:1192–1196.

356 Peters, A.; von Klot, S.; Heier, M.; Trentinaglia, I.; Hörmann, A.; Wichmann, H.E.; Löwel, H. (2004) Exposure to traffic and the onset of myocardial infarction. New England J Med 351: 1721–1730.

357 Zanobetti, A.; Stone, P.H.; Spelzer, F.E.; Schwartz, J.D.; Coull, B.A.; Suh, H.H.; Nearling, B.D.; Mittleman, M.A.; Verrier, R.L.; Gold, D.R. (2009) T-wave alternans, air pollution and traffic in high-risk subjects. Am J Cardiol 104: 665–670.

358 Adar, S.; Adamkiewicz, G.; Gold, D.R.; Schwartz, J.; Coull, B.A.; Suh, H. (2007) Ambient and microenvironmental particles and exhaled nitric oxide before and after a group bus trip. Environ Health Perspect 115: 507–512.

359 HEI Panel on the Health Effects of Long-Term Exposure to Traffic-Related Air Pollution (2022) Systematic review and meta-analysis of selected health effects of long-term exposure to traffic-related air pollution. Health Effects Institute Special Report 23. [Online at *https://www.healtheffects.org/publication/systematic-review-and-meta-analysis-selected-health-effects-long-term-exposure-traffic*] This more recent review focused on health outcomes related to birth effects, respiratory effects, cardiometabolic effects, and mortality.

360 Boogaard, H.; Patton, A.P.; Atkinson, R.W.; Brook, J.R.; Chang, H.H.; Crouse, D.L.; Fussell, J.C.; Hoek, G.; Hoffmann, B.; Kappeler, R.; Kutlar Joss, M.; Ondras, M.; Sagiv, S.K.; Samoli, E.; Shaikh, R.; Smargiassi, A.; Szpiro, A.A.; Van Vliet, E.D.S.; Vienneau, D.; Weuve, J.; Lurmann, F.W.; Forastiere, F. (2022) Long-term exposure to traffic-related air pollution and selected health outcomes: A systematic review and meta-analysis. Environ Internatl 164: 107262. [Online at *https://doi.org/10.1016/j.envint.2022.107262*].

361 Boothe, V.L.; Shendell, D.G. (2008). Potential health effects associated with residential proximity to freeways and primary roads: review of scientific literature, 1999–2006. J Environ Health 70: 33–41.

362 Salam, M.T.; Islam, T.; Gilliland, F.D. (2008). Recent evidence for adverse effects of residential proximity to traffic sources on asthma. Curr Opin Pulm Med 14: 3–8.

363 Sun, X.; Zhang, S.; Ma, X. (2014) No association between traffic density and risk of childhood leukemia: a meta-analysis. Asia Pac J Cancer Prev 15: 5229–5232.

364 Raaschou-Nielsen, O.; Reynolds, P. (2006). Air pollution and childhood cancer: a review of the epidemiological literature. Int J Cancer 118: 2920–9.

365 Boothe, VL.; Boehmer, T.K.; Wendel, A.M.; Yip, F.Y. (2014) Residential traffic exposure and childhood leukemia: a systematic review and meta-analysis. Am J Prev Med 46: 413–422.

366 National Toxicology Program (2019) NTP Monograph on the Systematic Review of Traffic-related Air Pollution and Hypertensive Disorders of Pregnancy. NTP Monograph 7. *https://ntp.niehs.nih.gov/ntp/ohat/trap/mgraph/trap_final_508.pdf.*

possibility of an association with traffic-related air pollution, but insufficient evidence to draw definitive conclusions. Among these outcomes are neurological and cognitive impacts (*e.g.,* autism and reduced cognitive function, academic performance, and executive function) and reproductive outcomes (*e.g.,* preterm birth, low birth weight).[367 368 369 370 371 372]

Numerous studies have also investigated potential mechanisms by which traffic-related air pollution affects health, particularly for cardiopulmonary outcomes. For example, some research indicates that near-roadway exposures may increase systemic inflammation, affecting organ systems, including blood vessels and lungs.[373 374 375 376] Additionally, long-term exposures in near-road environments have been associated with inflammation-associated conditions, such as atherosclerosis and asthma.[377 378 379]

As described in section VIII.I of the preamble, people who live or attend school near major roadways are more likely to be people of color and/or have a low SES. Additionally, people with low SES often live in neighborhoods with multiple stressors and health risk factors, including reduced health insurance coverage rates, higher smoking and drug use rates, limited access to fresh food, visible neighborhood violence, and elevated rates of obesity and some diseases such as asthma, diabetes, and ischemic heart disease. Although questions remain, several studies find stronger associations between air pollution and health in locations with such chronic neighborhood stress, suggesting that populations in these areas may be more susceptible to the effects of air pollution.[380 381 382 383 384 385 386 387]

The risks associated with residence, workplace, or school near major roads are of potentially high public health significance due to the large population in such locations. We analyzed several data sets to estimate the size of populations living or attending school near major roads. Our evaluation of environmental justice concerns in these studies is presented in section VI.D.3 of this preamble.

Every two years from 1997 to 2009 and in 2011 and 2013, the U.S. Census Bureau's American Housing Survey (AHS) conducted a survey that includes whether housing units are within 300 feet of an ''airport, railroad, or highway with four or more lanes.'' [388] The 2013 AHS reports that 17.3 million housing units, or 13 percent of all housing units in the United States, were in such areas. Assuming that populations and housing units are in the same locations, this corresponds to a population of more than 41 million U.S. residents near high-traffic roadways or other transportation sources. According to the Central Intelligence Agency's World Factbook, based on data collected between 2012–2022, the United States had 6,586,610 km of roadways, 293,564 km of railways, and 13,513 airports.[389] As such, highways represent the overwhelming majority of transportation facilities described by this factor in the AHS.

In examining schools near major roadways, we used the Common Core of Data from the U.S. Department of Education, which includes information on all public elementary and secondary schools and school districts nationwide.[390] To determine school proximities to major roadways, we used a geographic information system (GIS) to map each school and roadway based on the U.S. Census's TIGER roadway file.[391] We estimated that about 10 million students attend public schools within 200 meters of major roads, about 20 percent of the total number of public school students in the United States.[392 393 394] About 800,000 students

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[368] Franco-Suglia, S.; Gryparis, A.; Wright, R.O.; et al. (2007). Association of black carbon with cognition among children in a prospective birth cohort study. Am J Epidemiol. doi: 10.1093/aje/kwm308. [Online at *http://dx.doi.org/10.1093/aje/kwm308*].

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[377] Adar, S.D.; Klein, R.; Klein, E.K.; et al. (2010). Air pollution and the microvasculature: a cross-sectional assessment of in vivo retinal images in the population-based Multi-Ethnic Study of Atherosclerosis. PLoS Med 7(11): E1000372. doi:10.1371/journal.pmed.1000372. Available at *http://dx.doi.org/10.1371/journal.pmed.1000372.*

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[379] McConnell, R.; Islam, T.; Shankardass, K.; et al. (2010). Childhood incident asthma and traffic-related air pollution at home and school. Environ Health Perspect 1021–1026.

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[388] The variable was known as ''ETRANS'' in the questions about the neighborhood.

[389] Central Intelligence Agenda. World Factbook: United States. [Online at *https://www.cia.gov/the-world-factbook/countries/united-states/#transportation*].

[390] *http://nces.ed.gov/ccd/.*

[391] TIGER/Line shapefiles for the year 2010. [Online at *https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.2010.html*].

[392] Pedde, M.; Bailey, C. (2011) Identification of Schools within 200 Meters of U.S. Primary and Secondary Roads. Memorandum to the docket.

[393] Here, ''major roads'' refer to those TIGER classifies as either ''Primary'' or ''Secondary.'' The Census Bureau describes primary roads as

attend public schools within 200 meters of primary roads, or about 2 percent of the total.

EPA also conducted a study to estimate the number of people living near truck freight routes in the United States, which includes many large highways and other routes where light- and medium-duty vehicles operate.[395] Based on a population analysis using the U.S. Department of Transportation's (USDOT) Freight Analysis Framework 4 (FAF4) and population data from the 2010 decennial census, an estimated 72 million people live within 200 meters of these FAF4 roads, which are used by all types of vehicles.[396] The FAF4 analysis includes the population living within 200 meters of major roads, while the AHS uses a 100-meter distance; the larger distance and other methodological differences explain the difference in the two estimates for populations living near major roads.[397]

EPA's Exposure Factor Handbook also indicates that, on average, Americans spend more than an hour traveling each day, bringing nearly all residents into a high-exposure microenvironment for part of the day.[398] [399] While near-roadway studies focus on residents near roads or others spending considerable time near major roads, the duration of commuting results in another important contributor to overall exposure to traffic-related air pollution. Studies of health that address time spent in transit have found evidence of elevated risk of cardiac impacts.[400] [401] [402]

D. Welfare Effects Associated With Exposure to Criteria and Air Toxics Pollutants Impacted by the Final Standards

This section discusses the welfare effects associated with pollutants affected by this rule, specifically particulate matter, ozone, NO_X, SO_X, and air toxics.

1. Visibility

Visibility can be defined as the degree to which the atmosphere is transparent to visible light.[403] Visibility impairment is caused by light scattering and absorption by suspended particles and gases. It is dominated by contributions from suspended particles except under pristine conditions. 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 2019 p.m. ISA.[404]

EPA is working to address visibility impairment. Reductions in air pollution from implementation of various programs associated with the Clean Air Act Amendments of 1990 provisions have resulted in substantial improvements in visibility and will continue to do so in the future. Nationally, because trends in haze are closely associated with trends in particulate sulfate and nitrate due to the relationship between their concentration and light extinction, visibility trends have improved as emissions of SO_2 and NO_X have decreased over time due to air pollution regulations such as the Acid Rain Program.[405] However, in the western part of the country, changes in total light extinction were smaller, and the contribution of particulate organic matter to atmospheric light extinction was increasing due to increasing wildfire emissions.[406]

In the Clean Air Act Amendments of 1977, Congress recognized visibility's value to society by establishing a national goal to protect national parks and wilderness areas from visibility impairment caused by manmade pollution.[407] In 1999, EPA finalized the regional haze program to protect the visibility in Mandatory Class I Federal areas.[408] There are 156 national parks, forests and wilderness areas categorized as Mandatory Class I Federal areas.[409] 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.

EPA has also concluded that $PM_{2.5}$ causes adverse effects on visibility in other areas that are not targeted by the Regional Haze Rule, such as urban areas, depending on $PM_{2.5}$ concentrations and other factors such as dry chemical composition and relative humidity (*i.e.,* an indicator of the water composition of the particles). The secondary (welfare-based) PM NAAQS provide protection against visibility effects. In recent PM NAAQS reviews, EPA evaluated a target level of protection for visibility impairment that is expected to be met through attainment of the existing secondary PM standards.

''generally divided limited-access highways within the Federal interstate system or under state management.'' Secondary roads are ''main arteries, usually in the U.S. highway, state highway, or county highway system.''

[394] For this analysis we analyzed a 200-meter distance based on the understanding that roadways generally influence air quality within a few hundred meters from the vicinity of heavily traveled roadways or along corridors with significant trucking traffic. See U.S. EPA, 2014. Near Roadway Air Pollution and Health: Frequently Asked Questions. EPA–420–F–14–044.

[395] U.S. EPA (2021). Estimation of Population Size and Demographic Characteristics among People Living Near Truck Routes in the Conterminous United States. Memorandum to the Docket.

[396] FAF4 is a model from the USDOT's Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA), which provides data associated with freight movement in the U.S. It includes data from the 2012 Commodity Flow Survey (CFS), the Census Bureau on international trade, as well as data associated with construction, agriculture, utilities, warehouses, and other industries. FAF4 estimates the modal choices for moving goods by trucks, trains, boats, and other types of freight modes. It includes traffic assignments, including truck flows on a network of truck routes. *https://ops.fhwa.dot.gov/freight/freight_analysis/faf/.*

[397] The same analysis estimated the population living within 100 meters of a FAF4 truck route is 41 million.

[398] EPA. (2011) Exposure Factors Handbook: 2011 Edition. Chapter 16. Online at *https://www.epa.gov/expobox/about-exposure-factors-handbook.*

[399] It is not yet possible to estimate the long-term impact of growth in telework associated with the COVID–19 pandemic on travel behavior. There were notable changes during the pandemic. For example, according to the 2021 American Time Use Survey, a greater fraction of workers did at least part of their work at home (38%) as compared with the 2019 survey (24%). [Online at *https://www.bls.gov/news.release/atus.nr0.htm*].

[400] Riediker, M.; Cascio, W.E.; Griggs, T.R.; et al. (2004) Particulate matter exposure in cars is associated with cardiovascular effects in healthy young men. Am J Respir Crit Care Med 169. [Online at *https://doi.org/10.1164/rccm.200310-1463OC*].

[401] Peters, A.; von Klot, S.; Heier, M.; et al. (2004) Exposure to traffic and the onset of myocardial infarction. New Engl J Med 1721–1730. [Online at *https://doi.org/10.1056/NEJMoa040203*].

[402] Adar, S.D.; Gold, D.R.; Coull, B.A.; (2007) Focused exposure to airborne traffic particles and heart rate variability in the elderly. Epidemiology 18: 95–103 [Online at 351: *https://doi.org/10.1097/01.ede.0000249409.81050.46*].

[403] 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. This book can be viewed on the National Academy Press website at *https://www.nap.edu/catalog/2097/protecting-visibility-in-national-parks-and-wilderness-areas.*

[404] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[405] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[406] Hand, JL;Prenni, AJ; Copeland, S; Schichtel, BA; Malm, WC. (2020). Thirty years of the Clean Air Act Amendments: Impacts on haze in remote regions of the United States (1990–2018). Atmos Environ 243: 117865.

[407] See Section 169(a) of the Clean Air Act.

[408] 64 FR 35714, July 1, 1999.

[409] 62 FR 38680–38681, July 18, 1997.

2. Ozone Effects on Ecosystems

The welfare effects of ozone include effects on ecosystems, which can be observed across a variety of scales, *i.e.,* subcellular, cellular, leaf, whole plant, population, and ecosystem. Ozone effects that begin at small spatial scales, such as the leaf of an individual plant, when they occur at sufficient magnitudes (or to a sufficient degree) can result in effects being propagated to higher and higher levels of biological organization. For example, effects at the individual plant level, such as altered rates of leaf gas exchange, growth, and reproduction, can, when widespread, result in broad changes in ecosystems, such as productivity, carbon storage, water cycling, nutrient cycling, and community composition.

Ozone can produce both acute and chronic injury in sensitive plant species depending on the concentration level and the duration of the exposure.[410] In those sensitive species,[411] effects from repeated exposure to ozone throughout the growing season of the plant can tend to accumulate, so even relatively low concentrations experienced for a longer duration have the potential to create chronic stress on vegetation.[412] [413] Ozone damage to sensitive plant species includes impaired photosynthesis and visible injury to leaves. The impairment of photosynthesis, the process by which the plant makes carbohydrates (its source of energy and food), can lead to reduced crop yields, timber production, and plant productivity and growth. Impaired photosynthesis can also lead to a reduction in root growth and carbohydrate storage below ground, resulting in other, more subtle plant and ecosystems impacts.[414] 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 areas with sensitive species could potentially lead to species shifts and loss from the affected ecosystems,[415] resulting in a loss or reduction in associated ecosystem goods and services. Additionally, 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 and reduced use of sensitive ornamentals in landscaping.[416] In addition to ozone effects on vegetation, newer evidence suggests that ozone affects interactions between plants and insects by altering chemical signals (*e.g.,* floral scents) that plants use to communicate to other community members, such as attraction of pollinators.

The Ozone ISA presents more detailed information on how ozone affects vegetation and ecosystems.[417] The Ozone ISA reports causal and likely causal relationships between ozone exposure and a number of welfare effects and characterizes the weight of evidence for different effects associated with ozone.[418] The Ozone ISA concludes that visible foliar injury effects on vegetation, reduced vegetation growth, reduced plant reproduction, reduced productivity in terrestrial ecosystems, reduced yield and quality of agricultural crops, alteration of below-ground biogeochemical cycles, and altered terrestrial community composition are causally associated with exposure to ozone. It also concludes that increased tree mortality, altered herbivore growth and reproduction, altered plant-insect signaling, reduced carbon sequestration in terrestrial ecosystems, and alteration of terrestrial ecosystem water cycling are likely to be causally associated with exposure to ozone.

3. Deposition

The Integrated Science Assessment for Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter—Ecological Criteria documents the ecological effects of the deposition of these criteria air pollutants.[419] It is clear from the body of evidence that oxides of nitrogen, oxides of sulfur, and particulate matter contribute to total nitrogen (N) and sulfur (S) deposition. In turn, N and S deposition cause either nutrient enrichment or acidification depending on the sensitivity of the landscape or the species in question. Both enrichment and acidification are characterized by an alteration of the biogeochemistry and the physiology of organisms, which can result in ecologically harmful declines in biodiversity in terrestrial, freshwater, wetland, and estuarine ecosystems in the United States.

Terrestrial, wetland, freshwater, and estuarine ecosystems in the United States are affected by nitrogen enrichment/eutrophication caused by nitrogen deposition. These effects, though improving recently as emissions and deposition decline, have been consistently documented across the United States for hundreds of species and have likely been occurring for decades. 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. In aquatic systems nitrogen loading can alter species assemblages and cause eutrophication. For a broader explanation of the topics treated here, refer to the description in Chapter 6 of the RIA.

The sensitivity of terrestrial and aquatic ecosystems to acidification from nitrogen and sulfur deposition is predominantly governed by the intersection of geology and deposition. 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 biodiversity of fishes, zooplankton and macroinvertebrates 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 in forests in the past have included a decline in sensitive tree species, such as red spruce (Picea rubens) and sugar maple (Acer saccharum).

[410] U.S. EPA. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[411] 73 FR 16491, March 27, 2008. Only a small percentage of all the plant species growing within the U.S. (over 43,000 species have been catalogued in the USDA PLANTS database) have been studied with respect to ozone sensitivity.

[412] U.S. EPA. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[413] The concentration at which ozone levels overwhelm a plant's ability to detoxify or compensate for oxidant exposure varies. Thus, whether a plant is classified as sensitive or tolerant depends in part on the exposure levels being considered.

[414] U.S. EPA. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[415] Ozone impacts could be occurring in areas where plant species sensitive to ozone have not yet been studied or identified.

[416] U.S. EPA. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[417] U.S. EPA. Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/012, 2020.

[418] The Ozone ISA evaluates the evidence associated with different ozone related health and welfare 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 more information on these levels of evidence, please refer to Table II of the ISA.

[419] U.S. EPA. Integrated Science Assessment (ISA) for Oxides of Nitrogen, Oxides of Sulfur and Particulate Matter Ecological Criteria (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–20/278, 2020.

Building materials including metals, stones, cements, and paints undergo natural weathering processes from exposure to environmental elements (*e.g.,* wind, moisture, temperature fluctuations, sunlight, etc.). Pollution can worsen and accelerate these effects. Deposition of PM is associated with both physical damage (materials damage effects) and impaired aesthetic qualities (soiling effects). Wet and dry deposition of PM can physically affect materials, adding to the effects of natural weathering processes, by potentially promoting or accelerating the corrosion of metals, by degrading paints and by deteriorating building materials such as stone, concrete, and marble.[420] The effects of PM are exacerbated by the presence of acidic gases and can be additive or synergistic due to the complex mixture of pollutants in the air and surface characteristics of the material. Acidic deposition has been shown to have an effect on materials including zinc/galvanized steel and other metal, carbonate stone (as monuments and building facings), and surface coatings (paints).[421] The effects on historic buildings and outdoor works of art are of particular concern because of the uniqueness and irreplaceability of many of these objects. In addition to aesthetic and functional effects on metals, stone, and glass, altered energy efficiency of photovoltaic panels by PM deposition is also an emerging consideration for impacts of air pollutants on materials.

4. Welfare Effects Associated With 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 (VOCs), some of which are considered air toxics, have long been suspected to play a role in vegetation damage.[422] In laboratory experiments, a wide range of tolerance to VOCs has been observed.[423] Decreases in harvested seed pod weight have been reported for the more sensitive plants, and some studies have reported effects on seed germination, flowering, and fruit ripening. Effects of individual VOCs or their role in conjunction with other stressors (*e.g.,* acidification, drought, temperature extremes) have not been well studied. In a recent study of a mixture of VOCs including ethanol and toluene on herbaceous plants, significant effects on seed production, leaf water content and photosynthetic efficiency were reported for some plant species.[424]

Research suggests an adverse impact of vehicle exhaust on plants, which has in some cases been attributed to aromatic compounds and in other cases to nitrogen oxides.[425] [426] [427] The impacts of VOCs on plant reproduction may have long-term implications for biodiversity and survival of native species near major roadways. Most of the studies of the impacts of VOCs on vegetation have focused on short-term exposure and few studies have focused on long-term effects of VOCs on vegetation and the potential for metabolites of these compounds to affect herbivores or insects.

III. Light- and Medium-Duty Vehicle Standards for Model Years 2027 and Later

A. Introduction and Background

This section III of the preamble outlines the final GHG and criteria pollutant standards and related provisions that are included in the rulemaking.

Throughout this section and elsewhere in this FRM, EPA uses the following conventions to identify specific vehicle technology types and groupings, also depicted schematically in Figure 2.[428]

- ICE vehicle: a vehicle powered by an internal combustion engine (ICE).
- Electrified ICE vehicle: a vehicle powered by an ICE and any amount of powertrain electrification (includes MHEV, HEV, PHEV).
- MHEV: Mild Hybrid Electric Vehicle.[429]
- HEV: Hybrid Electric Vehicle (or strong hybrid).[430]
- PHEV: Plug-in Hybrid Electric Vehicle (or near-zero emission vehicle).
- BEV: Battery Electric Vehicle.
- FCEV: Fuel Cell Electric Vehicle.
- PEV: Plug-in Electric Vehicle (refers collectively to BEVs and PHEVs).
- Hybrid: refers collectively to HEVs and MHEVs.
- Zero-emission vehicle: refers collectively to BEV and FCEV.
- Electrified vehicle: refers to any vehicle with powertrain electrification.

[420] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, 2019). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R–19/188, 2019.

[421] Irving, P.M., e.d. 1991. Acid Deposition: State of Science and Technology, Volume III, Terrestrial, Materials, Health, and Visibility Effects, The U.S. National Acid Precipitation Assessment Program, Chapter 24, page 24–76.

[422] U.S. EPA. (1991). Effects of organic chemicals in the atmosphere on terrestrial plants. EPA/600/3–91/001.

[423] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. (2003). Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343.

[424] Cape JN, ID Leith, J Binnie, J Content, M Donkin, M Skewes, DN Price AR Brown, AD Sharpe. (2003). Effects of VOCs on herbaceous plants in an open-top chamber experiment. Environ. Pollut. 124:341–343.

[425] Viskari E–L. (2000). Epicuticular wax of Norway spruce needles as indicator of traffic pollutant deposition. Water, Air, and Soil Pollut. 121:327–337.

[426] Ugrekhelidze D, F Korte, G Kvesitadze. (1997). Uptake and transformation of benzene and toluene by plant leaves. Ecotox. Environ. Safety 37:24–29.

[427] Kammerbauer H, H Selinger, R Rommelt, A Ziegler-Jons, D Knoppik, B Hock. (1987). Toxic components of motor vehicle emissions for the spruce Picea abies. Environ. Pollut. 48:235–243.

[428] More information about these vehicle technologies may be found in the 2016 EPA Draft Technical Assessment Report (EPA–420–D–16–900, July 2016).

[429] Mild hybrids most commonly operate at or about 48 volts and provide idle-stop capability and launch assistance. See also Draft Technical Assessment Report, EPA–420–D–16–900, July 2016, p. 5–11.

[430] Strong hybrids typically operate at high voltage (greater than 60 volts and most often up to several hundred volts) to provide significant engine assist and regenerative braking, and most commonly occur in what are known as P2 and power-split or other parallel/series drive configurations. See also Draft Technical Assessment Report, EPA–420–D–16–900, July 2016, pp. 5–11 and 5–12.

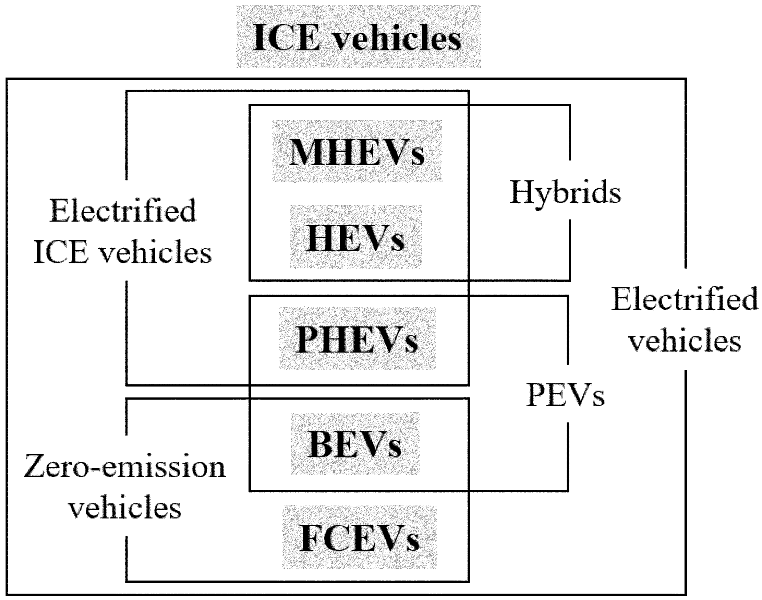

Figure 2: Vehicle technology types and groupings.

1. What vehicle categories and pollutants are covered by the rule?

EPA is establishing emissions standards for both light-duty vehicles and medium-duty (Class 2b and 3) vehicles. The light-duty vehicle category includes passenger cars, light trucks, and medium-duty passenger vehicles (MDPVs), consistent with previous EPA GHG and criteria pollutant rules.[431] In this rule, Class 2b and 3 vehicles are referred to as ''medium-duty vehicles'' (MDVs) to distinguish them from Class 4 and higher vehicles that remain under the heavy-duty program in 40 CFR parts 1036 and 1037 and to distinguish them from light-duty categories. EPA has not previously used the MDV nomenclature, referring to these larger vehicles in prior rules as either heavy-duty Class 2b and 3 vehicles or heavy-duty pickups and vans.[432] MDV nomenclature is commonly used to describe commercial use of Class 2b and Class 3 vans, pickups and incomplete vehicles. Our regulatory definition of MDV includes large pickups, vans, and incomplete vehicles with gross vehicle weight ratings of 8,501 to 14,000 pounds, but excludes MDPVs. Examples of vehicles in this category include GM or Stellantis 2500 and 3500 series, and Ford 250 and 350 series, pickups and vans.

Additionally, in the context of the criteria pollutant program, the abbreviation LDV refers to light-duty vehicles that are not otherwise designated as a light-duty truck (LDT) or medium-duty passenger vehicle (MDPV). This final rule also amends the definition of MDPV. Light-duty (unabbreviated) refers to LDV, LDT and MDPV combined. LDT with a number following (*e.g.,* LDT1, LDT2, LDT3, LDT4) refers to specific light-duty truck weight categories defined in 40 CFR 86.1803–01. LDT weight categories may be combined with text, *e.g.,* LDT3/4 refers to the weight categories LDT3 and LDT4 combined, which are also defined in 40 CFR 86.1803–01 as ''heavy-light-duty-trucks''. In this rulemaking, the new nomenclature ''medium-duty vehicle'' (MDV) refers to a combination of both Class 2b and 3 vehicles as defined in 40 CFR 86.1803–01. ''High gross combination weight medium-duty vehicle'' (high GCWR MDV) is a separate subcategory of MDV with very high tow capability, specifically defined as having a GCWR of 22,001 pounds and greater.

EPA is finalizing new standards for both light- and medium-duty vehicles for emissions of GHGs, hydrocarbons plus oxides of nitrogen (NO_X), and particulate matter (PM), and emissions requirement changes for carbon monoxide (CO) and formaldehyde (HCHO). EPA's final standards are based on an assessment of all available vehicle emissions control technologies, including advancements in gasoline vehicle technologies, hybrids, PHEVs, and BEVs over the model years affected by the rule.

EPA notes that it is not finalizing the proposed standards for high GCWR MDVs that would have required compliance with engine-based criteria pollutant emissions standards under EPA's heavy-duty engine standards under 40 CFR part 1036 rather than meeting MDV chassis-based standards. Instead, we are finalizing one of the alternatives for high GCWR MDV criteria pollutant emissions standards on which we solicited comment, specifically, as discussed in section III.D of this preamble, additional in-use standards that are comparable to those recently adopted by California.

2. Light-Duty and Medium-Duty Vehicle Standards: Background and History

i. GHG Standards

This section provides an overview of the prior rules and the standards structures for EPA's light-duty GHG emissions standards, medium-duty GHG emissions standards, and criteria pollutant emissions standards for both light- and medium-duty vehicles.[433] While this rule addresses both light- and medium-duty vehicles under a single umbrella rulemaking, EPA is finalizing standards for each class and for each

[431] Light-duty trucks (LDTs) that have gross vehicle weight ratings above 6,000 pounds and all MDVs are considered ''heavy-duty vehicles'' under the CAA. See section 202(b)(3)(C). For regulatory purposes, we generally refer to those LDTs which are above 6,000 pounds GVWR and at or below 8,500 pounds GVWR as ''heavy light-duty trucks'' made up of LDT3s and LDT4s, and we have defined MDPVs primarily as vehicles between 8,501 and 10,000 pounds GVWR designed primarily for the transportation of persons. See 40 CFR 86.1803–01.

[432] See 76 FR 57106 and 79 FR 23414. Heavy-duty vehicles subject to standards under 40 CFR part 86, subpart S, are defined at 40 CFR 86.1803–01 to include all vehicles above 8,500 pounds GVWR, and also incomplete vehicles with lower GVWR if they have curb weight above 6,000 pounds or basic vehicle frontal area greater than 45 square feet.

[433] Previously, EPA has addressed medium-duty vehicle emissions as part of regulatory programs for GHG emissions along with the heavy-duty sector, and for criteria pollutant emissions along with the light-duty sector. As a result, the program structure for medium-duty vehicles is similar to that of the light-duty program for criteria pollutants but differs from that of light-duty program for GHG emissions.

pollutant pursuant to the relevant statutory provisions for each class and pollutant based on its assessment of the feasibility of more stringent standards for each class and pollutant,[434] and the programs will continue to follow the basic structures EPA has previously adopted.

EPA has issued four rules establishing light-duty vehicle GHG standards, which EPA refers to in this rule based on the year in which the relevant final rule was issued, as shown in Table 11.[435]

TABLE 11—PREVIOUS GHG LIGHT-DUTY VEHICLES STANDARDS RULES

Rule	MYs covered	Title	**Federal Register** citation
2010 Rule	Initial 2010 rule established standards for MYs 2012–2016 and later.	Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards.	75 FR 25324, May 7, 2010.
2012 Rule	Set more stringent standards for MYs 2017–2025 and later.	2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards.	77 FR 62624, October 15, 2012.
2020 Rule	Revised the standards for MYs 2022–2025 to make them less stringent and established a new standard for MYs 2026 and later.	The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks.	85 FR 24174, April 30, 2020.
2021 Rule	Revised the standards for MYs 2023–2026 to make them more stringent, with the MY 2026 standards being the most stringent GHG standards established by EPA to date.	Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards.	86 FR 74434, December 30, 2021.

The GHG standards have all been based on fleet average CO_2 emissions. Each vehicle model is assigned a CO_2 target based on the vehicle's ''footprint'' in square feet (ft^2), generally consisting of the area of the rectangle formed by the four points at which the tires rest on the ground. Generally, vehicles with larger footprints have higher assigned CO_2 emissions targets. The most recent set of footprint curves established by the 2021 rule for model years 2023–2026 are shown in Figure 3 and Figure 4, along with the curves for MYs 2021–2022, included for comparison. As shown, passenger cars and light trucks have separate footprint standards curves, which result in separate fleet average standards for the two sets of vehicles. The fleet-average standards are the production-weighted fleet average of the footprint targets for all the vehicles in a manufacturer's fleet for a given model year. As a result, the footprint-based fleet average standards, which manufacturers are required to meet on an annual basis, will vary for each manufacturer based on its actual production of vehicles in a given model year. Individual vehicles are not required to meet their footprint-based CO_2 targets, although they are required to demonstrate compliance with applicable in-use standards.

[434] As discussed in Section IX.M of the preamble and elsewhere in this notice, EPA has independently considered and adopted each of these standards, as well as other elements of the final rule, and each is severable should there be judicial review.

[435] The first three rules were issued jointly with NHTSA, while EPA issued the 2021 Rule in coordination with NHTSA but not as a joint rulemaking.

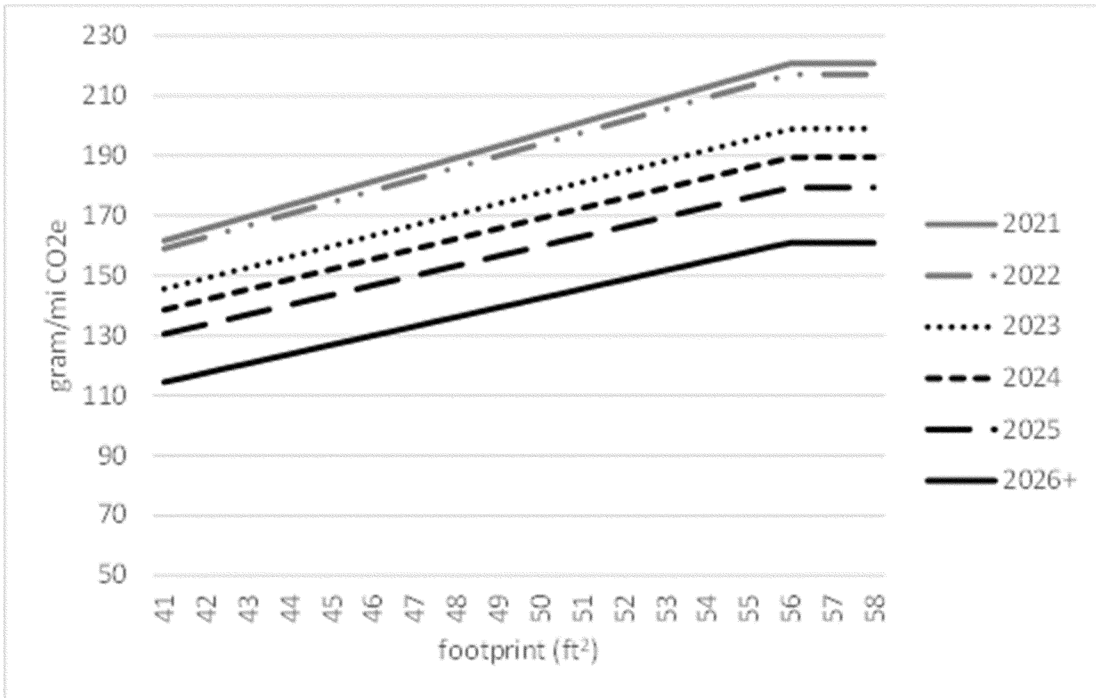

Figure 3: Car footprint curves for MYs 2021–2026.

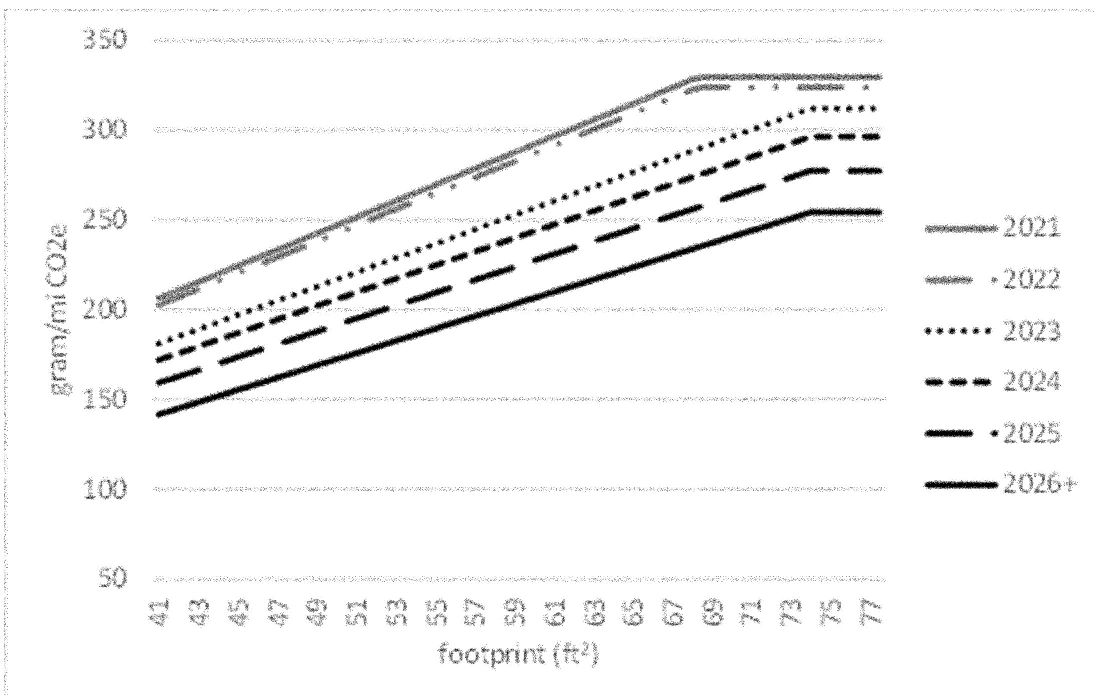

Figure 4: Truck footprint curves for MYs 2021–2026.

For medium-duty vehicles,[436] EPA has established GHG standards previously as part of our heavy-duty vehicle GHG Phase 1 and 2 rules, shown in Table 12.

TABLE 12—PRIOR HEAVY-DUTY GHG RULES COVERING MDOMVS

Rule	MYs covered	Title	**Federal Register** Citation
HD Phase 1	Initial MDV standards phased in over MYs 2014–2018.	Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles.	76 FR 57106, September 15, 2011.
HD Phase 2	More stringent MDV standards phased in over MYs 2021–2027.	Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles— Phase 2.	81 FR 73478, October 25, 2016.

The MDV standards are also attribute-based. However, they are based on a "work factor" attribute rather than the footprint attribute used in the light-duty vehicle program. Work-based measures such as payload and towing capability are two key factors that characterize differences in the design of vehicles, as well as differences in how the vehicles are expected to be regularly used. The work factor attribute combines vehicle payload capacity and vehicle towing capacity, in pounds (lb), with an additional fixed adjustment for four-wheel drive vehicles. This adjustment accounts for the fact that four-wheel drive, critical to enabling heavy-duty work (payload or trailer towing) in certain road conditions, results in additional vehicle weight. The GHG standards and work factor are calculated as follows:

CO_2 Target (g/mile) = [a × WF] + b
WF = Work Factor = [0.75 × (Payload Capacity + xwd)] + [0.25 × Towing Capacity]
Payload Capacity = GVWR (pounds) − Curb Weight (pounds)
xwd = 500 pounds for 4wd, 0 lbs. for 2wd
Towing Capacity = GCWR (pounds) − GVWR (pounds)

Coefficients a and b represent the mathematical slope and offset, respectively, that define the work-factor-based standards.

Under this approach, CO_2 targets are determined for each vehicle with a unique work factor (analogous to a target for each discrete vehicle footprint in the light-duty vehicle rules). These targets are then production weighted and summed to derive a manufacturer's annual fleet average standard for its MDVs. The current program includes separate standards for gasoline and diesel-fueled vehicles.[437] Graphical representations of the Phase 2 work factor standards are shown in Figure 5 and Figure 6.

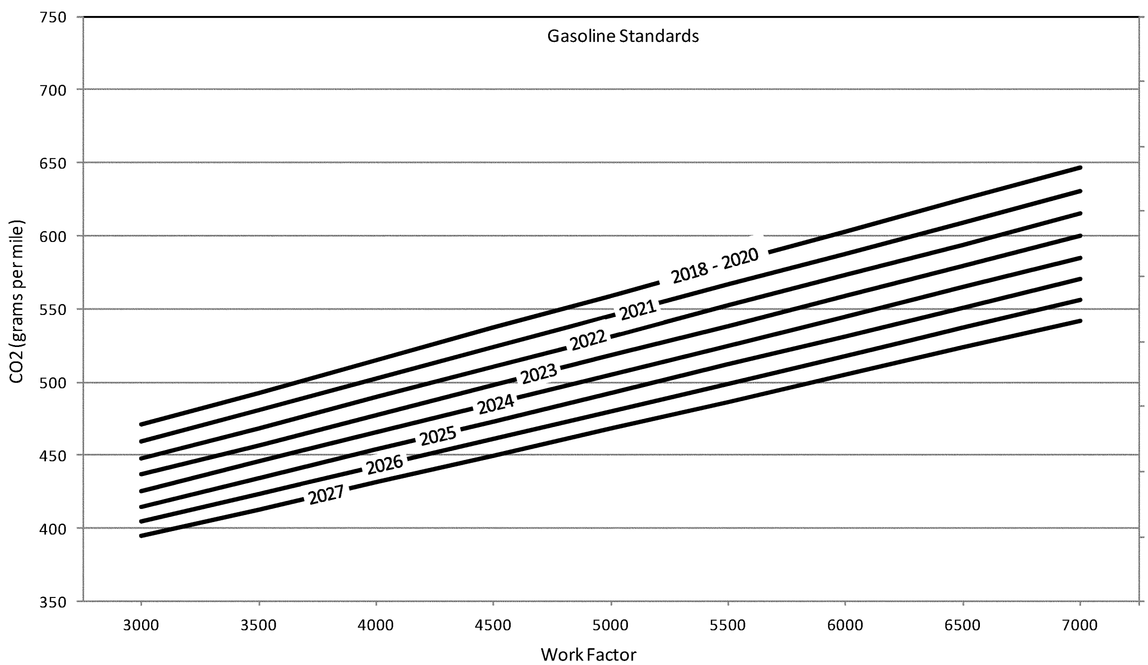

Figure 5: EPA HD Phase 2 CO_2 work factor targets for gasoline fueled MDVs.

[436] Note, the HD GHG rules referred to MDVs as HD pickups and vans.

[437] See 81 FR 73736–73739.

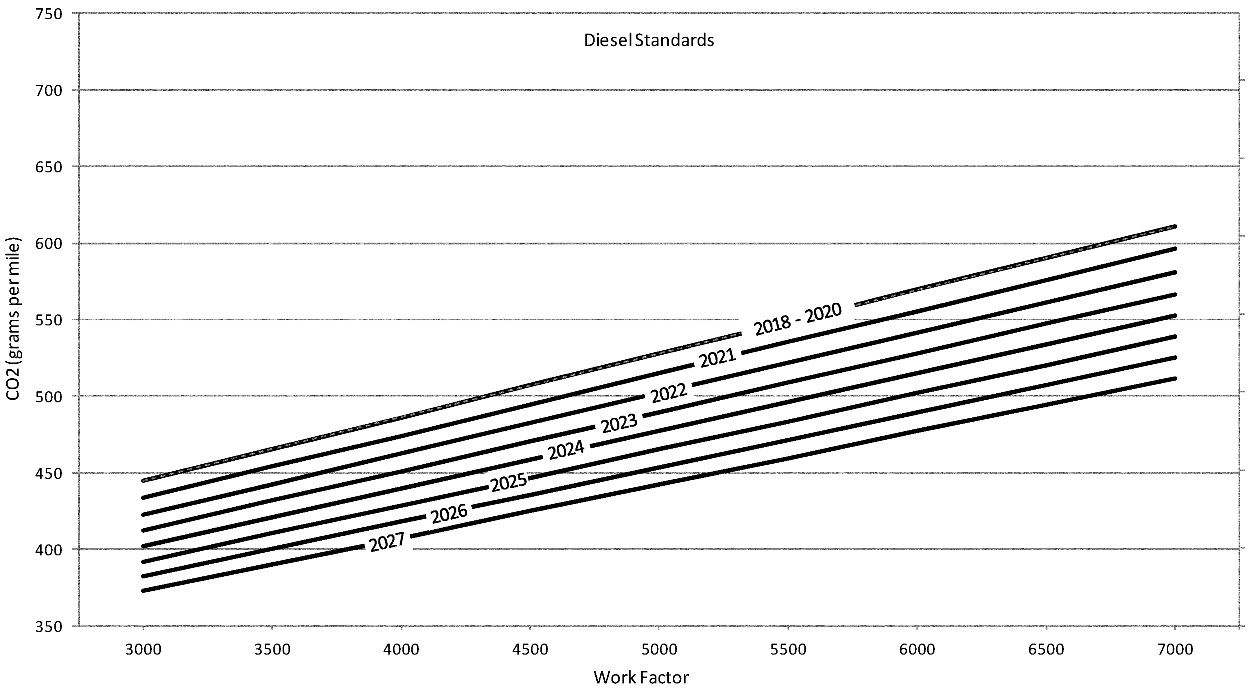

Figure 6: EPA HD Phase 2 CO_2 Work Factor Targets for Diesel Fueled MDVs.

ii. Criteria and Toxic Pollutant Emissions Standards

Since 1971, EPA has, at Congress' direction, been setting emissions standards for motor vehicles. The earliest standards were for light-duty vehicles for hydrocarbons, nitrogen oxides (NO_X), and carbon monoxide (CO), requiring a 90 percent reduction in emissions. Since then, EPA has continued to set standards achieving comparably significant reductions in criteria pollutant (and precursor) emissions for the full range of vehicle classes (including light-duty, medium-duty and heavy-duty vehicles and passenger, cargo and vocational vehicles). Over the last several decades, EPA has set progressively more stringent vehicle emissions standards for criteria pollutants.[438] For example, in 1997 EPA adopted the National Low Emission Vehicle program, which included provisions for certifying zero emissions vehicles. In 2000, EPA adopted the Tier 2 standards, which required passenger vehicles to be 77 to 95 percent cleaner (and further encouraged certification of zero emission vehicles through the establishment of ''Bin 1'', which is referred to as ''Bin 0'').

Most recently, in 2014, EPA adopted Tier 3 emissions standards, which required a further reduction of 60 to 80 percent of emissions (depending on pollutant and vehicle class). Unlike GHG standards, criteria pollutant standards are not attribute-based. The Tier 3 rule included standards for both light-duty and medium-duty vehicles. Similar to the prior Tier 2 standards, Tier 3 established ''bins'' of Federal Test Procedure (FTP) standards, shown in Table 13 Each bin contains a milligrams per mile (mg/mile) standard for non-methane organic gases (NMOG) plus oxides of nitrogen) or NMOG+NO_X, particulate matter (PM), carbon monoxide (CO), and formaldehyde (HCHO).

TABLE 13—TIER 3 FTP STANDARDS FOR LDVS AND MDPVS

[mg/mile]

	NMOG+NO_X	PM	CO	HCHO
Bin 160	160	3	4.2	4
Bin 125	125	3	2.1	4
Bin 70	70	3	1.7	4
Bin 50	50	3	1.7	4
Bin 30	30	3	1.0	4
Bin 20	20	3	1.0	4
Bin 0	0	0	0	0

Manufacturers select, or assign, a standards bin to each vehicle model and vehicles must meet all of the standards in that bin over the vehicle's full useful life. Each manufacturer must also meet a fleet average NMOG + NO_X standard each model year, which declines over a phase-in period for the Tier 3 final standards. The declining NMOG+NO_X standards are shown in Table 14. As shown, the fleet is split between two categories: 1) Passenger cars and small light trucks and 2) larger light trucks and MDPVs, with final NMOG+NO_X

[438] EPA's recent criteria pollutants rulemakings for passenger cars and light trucks can be found on our website at *https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-smog-soot-and-other-air-pollution-passenger.*

fleet average standards of 30 mg/mile for both vehicle categories.[439]

TABLE 14—TIER 3 $NMOG+NO_X$ FLEET AVERAGE FTP STANDARDS FOR LIGHT-DUTY VEHICLES AND MDPVS

[mg/mile]

	Model year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025 and later
Passenger cars and small trucks	86	79	72	65	58	51	44	37	30
Larger light trucks and MDPVs	101	93	83	74	65	56	47	38	30

The Tier 3 rule also established more stringent criteria pollutant emissions standards for MDVs. The Tier 3 MDV standards are also based on a bin structure, but with generally less stringent bin standards and with less stringent $NMOG+NO_X$ fleet average standards. As discussed in section III.A.1 of this preamble, the MDV category consists of vehicles with gross vehicle weight ratings (GVWR) between 8,501–14,000 pounds. For Tier 3, EPA set separate standards for two sub-categories of vehicles, Class 2b (8,501–10,000 pounds GVWR) and Class 3 (10,001–14,000 pounds GVWR) vehicles. Table 15 provides the final Tier 3 FTP standards bins for MDVs and Table 16 provides the $NMOG+NO_X$ fleet average standards that apply to these vehicles in MYs 2018 and later. It is important to note that MDVs are tested at a higher test weight than light-duty vehicles, as discussed in section III.C.3 of this preamble, and as such the numeric standards are not directly comparable across the light-duty and MDV categories.

TABLE 15—MDV TIER 3 FTP FINAL STANDARDS BINS

	$NMOG+NO_X$	PM	CO	HCHO
Class 2b (10,001–14,000 lb GVWR)				
Bin 250	250	8	6.4	6
Bin 200	200	8	4.2	6
Bin 170	170	8	4.2	6
Bin 150	150	8	3.2	6
Bin 0	0	0	0	0
Class 3 (8.501–10,000 lb GVWR)				
Bin 400	400	10	7.3	6
Bin 270	270	10	4.2	6
Bin 230	230	10	4.2	6
Bin 200	200	10	3.7	6
Bin 0	0	0	0	0

TABLE 16—MDV TIER 3 FINAL FLEET AVERAGE $NMOG+NO_X$ STANDARDS

[mg/mile]

	2018	2019	2020	2021	2022 and later
Class 2b	278	253	228	203	178
Class 3	451	400	349	298	247

EPA has also established supplemental Federal test procedure (SFTP) standards for light- and medium-duty vehicles, as well as cold temperature standards for CO and HC. These standards address emissions outside of the FTP test conditions such as at high vehicle speeds and differing ambient temperatures. EPA did not reopen the current SFTP standards in this rulemaking.

B. EPA's Statutory Authority Under the Clean Air Act (CAA)

This section summarizes the statutory authority for the final rule. Statutory authority for the standards EPA is finalizing is found in CAA section 202(a)(1)–(2), 42 U.S.C. 7521 (a)(1)–(2), which requires EPA to establish standards applicable to emissions of air pollutants from new motor vehicles and engines which in the Administrator's judgment cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. Section 202(a)(3) further addresses EPA authority to establish standards for emissions of NO_X, PM, HC, and CO from heavy-duty engines and vehicles.[440] Additional statutory authority for the action is found in CAA

[439] Small light trucks are those vehicles in the LDT1 class, while larger light trucks are those in the LDT2–4 classes.

[440] Light-duty trucks (LDTs) that have gross vehicle weight ratings above 6,000 pounds and all MDVs are considered ''heavy-duty vehicles'' under the CAA. See section 202(b)(3)(C).

sections 202–209, 216, and 301, 42 U.S.C. 7521–7543, 7550, and 7601.

Section III.B.1 of the preamble overviews the text of the relevant statutory provisions read in their context. We discuss the statutory definition of ''motor vehicle'' in section 216 of the Act, EPA's authority to establish emission standards for such motor vehicles in section 202, and authorities related to compliance and testing in sections 203, 206, and 207.

Section III.B.2 of the preamble addresses comments regarding our legal authority to consider a wide range of technologies, including electrified technologies that completely prevent vehicle tailpipe emissions. EPA's standard-setting authority under section 202 is not limited to any specific type of emissions control technology, such as technologies applicable only to ICE vehicles; rather, the Agency must consider all technologies that reduce emissions from motor vehicles—including technologies that allow for complete prevention of emissions such as battery electric vehicle (BEV) technologies—in light of the lead time provided and the costs of compliance. Many commenters supported EPA's legal authority to consider such technologies. At the same time, the final standards do not require the manufacturers to adopt any specific technological pathway and can be achieved through the use of a variety of technologies, including without producing additional BEVs to comply with this rule.

Section III.B.3 of the preamble summarizes our responses to certain other comments relating to our legal authority, including whether this rule implicates the major questions doctrine, whether EPA has authority for its Averaging, Banking, and Trading (ABT) program, and whether EPA properly considered BEVs as part of the class of vehicles for GHG regulation. We discuss our legal authority and rationale for battery durability and warranty separately in section III.G.2 of the preamble. Additional discussion of legal authority for the entire rule is found in section 2 of the RTC. EPA's assessment of the statutory and other factors in selecting the final standards is found in section V of this preamble, and further discussion of our statutory authority in support of all the revised compliance provisions is found in their respective sections of the preamble.

1. Summary of Key Clean Air Act Provisions

Title II of the Clean Air Act provides for comprehensive regulation of emissions from mobile sources, authorizing EPA to regulate emissions of air pollutants from all mobile source categories, including motor vehicles under CAA section 202(a). To understand the scope of permissible regulation, we first must understand the scope of the regulated sources. CAA section 216(2) defines ''motor vehicle'' as ''any self-propelled vehicle designed for transporting persons or property on a street or highway.'' [441] Congress has intentionally and consistently used the broad term ''any self-propelled vehicle'' since the Motor Vehicle Air Pollution Control Act of 1965 to include vehicles propelled by various fuels (*e.g.,* gasoline, diesel, or hydrogen) and systems of propulsion, whether they be ICE engine, hybrid, or electric motor powertrains.[442] The subjects of this rulemaking all fit that definition: they are self-propelled, via a number of different powertrains, and they are designed for transporting persons or property on a street or highway. The Act's focus is on reducing emissions from classes of motor vehicles and the ''requisite technologies'' that could feasibly reduce those emissions, giving appropriate consideration to cost of compliance and lead time.

Congress delegated to the Administrator the authority to identify available control technologies, and it did not place any restrictions on the types of emission reduction technologies EPA could consider, including different powertrain technologies. By contrast, other parts of the Act explicitly limit EPA's authority by powertrain type,[443] so Congress's conscious decision not to do so when defining ''motor vehicle'' in section 216 further highlights the breadth of EPA's standard-setting authority for such vehicles. As we explain further below, Congress did place some limitations on EPA's standard setting under CAA section 202(a),[444] but these limitations generally did not restrict EPA's authority to broadly regulate motor vehicles to any particular vehicle type or emissions control technology.

We turn now to section 202(a)(1)–(2), which provides the statutory authority for the final standards in this action. This section governs EPA's authority to establish standards for light-duty vehicles, as well as to establish GHG standards for heavy-duty vehicles. For vehicles meeting the statutory definition of heavy-duty vehicles, section 202(a)(3) provides additional and more specific criteria governing adoption of certain criteria pollutant emissions standards under section 202(a)(1); we discuss these additional criteria following our general discussion of section 202(a)(1)–(2).

Section 202(a)(1) directs the Administrator to set ''standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' This core directive has remained the same, with only minor edits, since Congress first enacted it in the Motor Vehicle Pollution Control Act of 1965.[445] Thus the first step when EPA regulates emissions from motor vehicles is a finding (the ''endangerment finding''), either as part of the initial standard setting or prior to it, that the emission of an air pollutant from a class or classes of new motor vehicles or new motor engines causes or contributes to air pollution which may reasonably be anticipated to endanger public health or welfare.

The statute directs EPA to define the class or classes of new motor vehicles for which the Administrator is making

441 EPA subsequently interpreted this provision through a 1974 rulemaking. 39 FR 32611 (Sept. 10, 1974), codified at 40 CFR 85.1703. The regulatory provisions establish more detailed criteria for what qualifies as a motor vehicle, including criteria related to speed, safety, and practicality for use on streets and ways. The regulation, however, does not draw any distinctions based on whether the vehicle emits pollutants or its powertrain.

442 The Motor Vehicle Air Pollution Act of 1965 defines ''motor vehicle'' as ''any self-propelled vehicle designed for transporting persons or property on a street or highway.'' Public Law 89–272, 79 Stat. 992, 995 (Oct. 20, 1965). *See also, e.g.,* 116 S. Cong. Rec. at 42382 (Dec. 18, 1970) (Clean Air Act Amendments of 1970—Conference Report) (''The urgency of the problems require that the industry consider, not only the improvement of existing technology, but also alternatives to the internal combustion engine and new forms of transportation.'').

443 *See* CAA section 213 (authorizing EPA to regulate ''non-road'' engines''), 216(10) (defining non-road engine to ''mean[] an internal combustion engine''). Elsewhere in the Act, Congress also specified specific technological controls, further suggesting its decision not to limit the technological controls EPA could consider in section 202(a)(1)–(2) was intentional. See, *e.g.,* CAA section 407(d) (''Units subject to subsection (b)(1) for which an alternative emission limitation is established shall not be required to install any additional control technology beyond low NO_X burners.'').

444 *See, e.g.,* CAA section 202(a)(4)(A) (''no emission control device, system, or element of design shall be used in a new motor vehicle or new motor vehicle engine for purposes of complying with requirements prescribed under this subchapter if such device, system, or element of design will cause or contribute to an unreasonable risk to public health, welfare, or safety in its operation or function''). In addition, Congress established particular limitations for discrete exercises of CAA section 202(a)(1) authority which are not at issue in this rulemaking. *See, e.g.,* CAA section 202(b)(1) (additional requirements applicable to certain model years).

445 Public Law 89–272.

the endangerment finding.[446] EPA for decades has defined ''classes'' subject to regulation according to their weight and function. This is consistent with both Congress's functional definition of a ''motor vehicle,'' as discussed above, and Congress's explicit contemplation of functional classes or categories. See CAA section 202(b)(3)(C) (defining ''heavy-duty vehicle'' with reference to function and weight), 202(a)(3)(A)(ii) (''the Administrator may base such classes or categories on gross vehicle weight, horsepower, type of fuel used, or other appropriate factors.'').[447]

In 2009, EPA made an endangerment finding for GHG and explicitly stated that ''[t]he new motor vehicles and new motor vehicle engines . . . addressed are: Passenger cars, light-duty trucks, motorcycles, buses, and medium and heavy-duty trucks.'' (74 FR 66496, 66537, December 15, 2009)[448] [449] Then EPA reviewed the GHG emissions data from ''new motor vehicles'' and determined that these classes of vehicles do contribute to air pollution that may reasonably be anticipated to endanger public health and welfare. The endangerment finding was made with regard to pollutants—in this case, GHGs—emitted from ''any class or classes of new motor vehicles or new motor vehicle engines.'' This approach—of identifying a class or classes or vehicles that contribute to endangerment—is how EPA has always implemented the statute.

For purposes of establishing GHG emissions standards, EPA has regarded passenger cars, light, medium, and heavy-duty trucks each as its own class and has then made further sub-categorizations based on weight and functionality in promulgating standards for the air pollutant. EPA's class and categorization framework allows the Agency to recognize real-world variations in how vehicles are designed to be used, as well as the lead time and costs of emissions control technology for different vehicle types. It also ensures that consumers can continue to access a wide variety of vehicles to meet their mobility needs, while enabling continued emissions reductions for all vehicle types, including to the point of completely preventing emissions where appropriate.

In setting standards, CAA section 202(a)(1) requires that any standards promulgated thereunder ''shall be applicable to such vehicles and engines for their useful life (as determined under [CAA section 202(d)], relating to useful life of vehicles for purposes of certification), whether such vehicle and engines are designed as complete systems or incorporate devices to prevent or control such pollution.''[450] In other words, Congress specifically determined that EPA's standards could be based on a wide array of technologies, including technologies for the engine and for the other (non-engine) parts of the vehicle, technologies that ''incorporate devices'' on top of an existing motor vehicle system as well as technologies that are ''complete systems'' and that may involve a complete redesign of the vehicle. Congress also determined that EPA could base its standards on both technologies that ''prevent'' the pollution from occurring in the first place—such as the zero emissions technologies considered in this rule—as well as technologies that ''control'' or reduce the pollution once produced.[451]

While emission standards set by EPA under CAA section 202(a)(1) generally do not mandate use of particular technologies, they are technology-based, as the levels chosen must be premised on a finding of technological feasibility. EPA must therefore necessarily identify potential control technologies, evaluate the rate each technology could be introduced, and its cost. Standards promulgated under CAA section 202(a) are to take effect only ''after 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.''[452] This reference to ''cost of compliance'' means that EPA must consider costs to those entities which are directly subject to the standards,[453] but ''does not mandate consideration of costs to other entities not directly subject to the standards.''[454] Given the prospective nature of standard-setting and the inherent uncertainties in predicting the future development of technology, Congress entrusted the Administrator with assessing issues of technical feasibility and availability of lead time to implement new technology. Such determinations are ''subject to the restraints of reasonableness'' but ''EPA is not obliged to provide detailed solutions to every engineering problem posed in the perfection of [a particular device]. 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. EPA is not required to rebut all speculation that unspecified factors may hinder 'real world' emission control.''[455]

Although standards under CAA section 202(a)(1) are technology-based, they are not based exclusively on technological capability. Pursuant to the broad grant of authority in section 202, when setting emission standards, EPA must consider certain factors and may also consider other relevant factors and has done so previously when setting such standards. For instance, in the

[446] *See* CAA section 202(a)(1) (''The Administrator shall by regulation prescribe . . . standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, *which in his judgment cause,* or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' (emphasis added)), 202(a)(3)(A)(ii) (''the Administrator *may* base such classes or categories on gross vehicle weight, horsepower, type of fuel used, or other appropriate factors'' (emphasis added)).

[447] Section 202(a)(3)(A)(ii) applies to standards established under section 202(a)(3), not to standards otherwise established under section 202(a)(1). However, we think it nonetheless provides guidance on what kinds of classifications and categorizations Congress generally thought were appropriate.

[448] EPA considered this list to be a comprehensive list of the new motor vehicle classes. *See id.* (''This contribution finding is for all of the CAA section 202(a) source categories.''); *id.* at 66544 (''the Administrator is making this finding for all classes of new motor vehicles under CAA section 202(a)''). By contrast, in making an endangerment finding for GHG emissions from aircraft, EPA limited the endangerment finding to engines used in specific classes of aircraft (such as civilian subsonic jet aircraft with maximum take off mass greater than 5,700 kilograms). 81 FR 54421, Aug. 15, 2016.

[449] EPA is not reopening the 2009 or any other prior endangerment finding in this action. Rather, we are discussing the 2009 endangerment finding to provide the reader with helpful background information relating to this action.

[450] *See also Engine Mfrs. Ass'n* v. *S. Coast Air Quality Mgmt. Dist.,* 541 U.S. 246, 252–53 (2004) (As stated by the Supreme Court, a standard is defined as that which ''is established by authority, custom, or general consent, as a model or example; criterion; test. . . . This interpretation is consistent with the use of 'standard' throughout Title II of the CAA. . .to denote requirements such as numerical emission levels with which vehicles or engines must comply . . ., or emission-control technology with which they must be equipped.'').

[451] Pollution prevention is a cornerstone of the Clean Air Act. The title of 42 U.S.C. chapter 85 is ''Air Pollution Prevention and Control''; *see also* CAA section 101(a)(3), (c). One of the very earliest vehicle pollution control technologies (one which is still in use by some vehicles) was exhaust gas recirculation, which reduces in-cylinder temperature and oxygen concentration, and, as a result, engine-out NO_X emissions from the vehicles. More recent examples of pollution prevention technologies include cylinder deactivation, and electrification technologies such as idle start-stop or PEVs.

[452] CAA section 202(a)(2); *see also NRDC* v. *EPA,* 655 F. 2d 318, 322 (D.C. Cir. 1981).

[453] *Motor & Equipment Mfrs. Ass'n Inc.* v. *EPA,* 627 F. 2d 1095, 1118 (D.C. Cir. 1979).

[454] *Coal. for Responsible Regulation* v. *EPA,* 684 F.3d 120, 128 (D.C. Cir. 2012).

[455] *NRDC,* 655 F. 2d at 328, 333–34.

2021 light-duty GHG rule, EPA explained that when acting under this authority EPA has considered such issues as technology effectiveness, its cost (including for manufacturers and for purchasers), the lead time necessary to implement the technology, and, based on this, the feasibility of potential standards; the impacts of potential standards on emissions reductions; the impacts of standards on oil conservation and energy security; the impacts of standards on fuel savings by vehicle operators; the impacts of standards on the vehicle manufacturing industry; as well as other relevant factors such as impacts on safety.[456] EPA has considered these factors in this rulemaking as well.

Rather than specifying levels of stringency in section 202(a)(1)–(2), Congress directed EPA to determine the appropriate level of stringency for the standards taking into consideration the statutory factors therein. EPA has clear authority to set standards under CAA section 202(a)(1)–(2) that are technology forcing when EPA considers that to be appropriate,[457] but is not required to do so. The statute directs EPA to give appropriate consideration to cost and lead time necessary to allow for the development and application of such technology. The breadth of this delegated authority is particularly clear when contrasted with sections 202(b), (g), (h), which identify specific levels of emissions reductions on specific timetables for past model years.[458] In determining the level of the standards, CAA section 202(a) does not specify the degree of weight to apply to each factor such that the Agency has the authority to choose an appropriate balance among factors and may decide how to balance stringency and technology considerations with cost and lead time.[459] [460]

We now turn to the more specific statutory authority for the heavy-duty criteria pollutant standards found in section 202(a)(3). This more specific statutory authority applies only for heavy-duty vehicles, which include light-duty trucks (LDTs) that have gross vehicle weight ratings above 6,000 pounds and all MDVs.[461] In addition, it only applies for certain criteria pollutant standards, including the PM, NMOG+NO_X, and CO standards, EPA is establishing in today's final rule, but does not apply to any GHG standards. For applicable standards, section 202(a)(3)(A) requires that they ''reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology.'' Section 202(a)(3)(C) further provides that standards set under section 202(a)(3) shall apply for a period of no less than three model years beginning no earlier than the model year commencing four years after promulgation.

We now turn from section 202(a) to overview several other sections of the Act relevant to this action. CAA section 202(d) directs EPA to prescribe regulations under which the ''useful life'' of vehicles and engines shall be determined for the purpose of setting standards under CAA section 202(a)(1). Useful life standards for LDV and MDV are described in 40 CFR 86.1805–17.

Additional sections of the Act provide authorities relating to compliance, including certification, testing, and warranty. Under section 203 of the CAA, sales of vehicles are prohibited unless the vehicle is covered by a certificate of conformity, and EPA issues certificates of conformity pursuant to section 206 of the CAA. based on 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. To assure each vehicle complies during its useful life, EPA may apply an adjustment factor to account for vehicle emission control deterioration or variability in use. EPA also establishes the test procedures under which compliance with the CAA emissions standards is measured. EPA has also developed tests with additional cycles (the so-called 5-cycle tests) which are used for purposes of fuel economy labeling, SFTP standards, and extending off-cycle credits under the light-duty vehicle GHG program. The regulatory provisions for demonstrating compliance with emissions standards have been successfully implemented for decades, including compliance through our Averaging, Banking, and Trading (ABT) program.[462]

Under CAA section 207(a), manufacturers are required to provide emission-related warranties. The generally applicable emission-related warranty period for new LD vehicles and engines under section 207(i)(1) is 2 years or 24,000 miles. For components designated by the Administrator as ''specified major emission control component[s]'' under section 207(i)(2), the warranty period is 8 years or 80,000 miles. The emission-related warranty period for HD engines and vehicles under CAA section 207(i)(1) is ''the period established by the Administrator by regulation (promulgated prior to November 15, 1990) for such purposes unless the Administrator subsequently modifies such regulation.'' CAA section 207 also grants EPA broad authority to require manufacturers to remedy

[456] 86 FR 74434, 74436.

[457] Indeed, the D.C. Circuit has repeatedly cited *NRDC* v. *EPA,* which construes section 202(a)(1), as support for EPA's actions when EPA acted pursuant to other provisions of section 202 or Title II that are explicitly technology forcing. *See, e.g., NRDC* v. *Thomas,* 805 F. 2d 410, 431–34 (D.C. Cir. 1986) (section 202 (a)(3)(B), 202 (a)(3)(A)); *Husqvarna AB* v. *EPA,* 254 F. 3d 195, 201 (D.C. Cir. 2001) (section 213(a)(3)); *Nat'l Petroleum and Refiners Ass'n* v. *EPA,* 287 F. 3d 1130, 1136 (D.C. Cir. 2002) (section 202(a)(3)).

[458] *See also* CAA 202(a)(3)(A).

[459] *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''); *Nat'l Petrochemical and Refiners Ass'n* v. *EPA,* 287 F.3d 1130, 1135 (D.C. Cir. 2002) (EPA decisions, under CAA provision authorizing technology-forcing standards, based on complex scientific or technical analysis are accorded particularly great deference); *see also 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); *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.'').

[460] Additionally, with respect to regulation of vehicular GHG emissions, EPA is not ''required to treat NHTSA's . . . regulations as establishing the baseline for the [section 202(a) standards].'' *Coal. for Responsible Regulation,* 684 F.3d at 127 (noting that the section 202(a) standards provide ''benefits above and beyond those resulting from NHTSA's fuel-economy standards'').

[461] *See* CAA section 202(b)(3)(C).

[462] EPA's consideration of averaging in standard-setting dates back to 1985. 50 FR 10606 (Mar. 15, 1985) (''Emissions averaging, of both particulate and oxides of nitrogen emissions from heavy-duty engines, is allowed beginning with the 1991 model year. Averaging of NO, emissions from light-duty trucks is allowed beginning in 1988.''). The availability of averaging as a compliance flexibility has an even earlier pedigree. See 48 FR 33456 (July 21, 1983) (EPA's first averaging program for mobile sources); 45 FR 79382 (Nov. 28, 1980) (advance notice of proposed rulemaking investigating averaging for mobile sources). We have included banking and trading in our rules dating back to 1990. 55 FR 30584 (July 26, 1990) (''This final rule announces new programs for banking and trading of particulate matter and oxides of nitrogen emission credits for gasoline-, diesel- and methanol-powered heavy-duty engines.''). Since that time, ABT has been a regular feature of EPA's vehicle rules promulgated under section 202(a) including the Tier 2 and Tier 3 criteria pollutant standards, and all of the GHG standards.

nonconformity if EPA determines there are a substantial number of noncomplying vehicles. These warranty and remedy provisions have also been applied for decades under our regulations, including where compliance occurs through use of ABT provisions. Further discussion of these sections of the Act, including as they relate to the compliance provisions we are finalizing, is found in section III.G of the preamble.

2. Authority To Consider Technologies in Setting Motor Vehicle GHG Standards

Having provided an overview of the key statutory authorities for this action, we now elaborate on the specific issue of the types of control technology that are to be considered in setting standards. EPA's position on this issue is consistent with our position in our prior GHG and criteria pollutant rules, and with the historical exercise of the Agency's authority over the last five decades, including under section 202(a)(1)–(2) as well as section 202(a)(3)(A). That is, EPA's standard-setting authority under section 202(a)(1)–(2) is not *a priori* limited to consideration of specific types of emissions control technology; rather, in determining the level of the standards, the agency must account for emissions control technologies that are available or will become available for the relevant model year.[463] In this rulemaking, EPA has accounted for a wide range of emissions control technologies, including ICE engine and vehicle technologies (*e.g.,* engine, transmission, drivetrain, aerodynamics, tire rolling resistance improvements, the use of low carbon fuels like CNG and LNG), advanced ICE technologies (which include advanced turbocharged downsized engines, advanced Atkinson engines, and Miller cycle engines), hybrid technologies (*e.g.,* HEV and PHEV), and zero-emission vehicle technologies (*e.g.,* BEV). These include technologies applied to motor vehicles with ICE (including hybrid powertrains) and without ICE, and a range of electrification across the technologies.

In response to the proposed rulemaking, the agency received numerous comments on this issue, specifically on our consideration of BEV technologies. Comments of regulated entities relating to these technologies, and those of many stakeholders, were often technical and policy in nature; for example, relating to the pace at which manufacturers could adopt and deploy such technologies in the real world or the pace at which enabling infrastructure could be deployed. We address these comments in detail in section III.C and III.D of this preamble and sections 3 and 17 of the RTC and have revised the standards from those proposed after consideration of comments.

A few commenters, however, alleged that the agency lacked statutory authority altogether to consider BEVs because they believed the Act limited EPA to considering only technologies applicable to ICE vehicles or to technologies that reduce, rather than altogether prevent, pollution. EPA disagrees. The constraints they would impose have no foundation in the statutory text, are contrary to the statutory purpose, are undermined by a substantial body of statutory and legislative history, and are inconsistent with how the agency has applied the statute in numerous rulemakings over five decades. The following discussion elaborates our position on this issue; further discussion is found in section 2 of the RTC.

The text of the Act directly addresses this issue and unambiguously provides authority for EPA to consider all motor vehicle technologies, including a range of electrified technologies such as fully-electrified vehicle technologies without an ICE that achieve zero vehicle tailpipe emissions (*e.g.,* BEVs), plug-in hybrid partially electrified technologies, and other ICE vehicles across a range of electrification. As described earlier in this section, the Act directs EPA to prescribe emission standards for ''motor vehicles,'' which are defined broadly in CAA section 216(2) and do not exclude any forms of vehicle propulsion. The Act then directs EPA to promulgate emission standards for such vehicles, ''whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution,'' based on the ''development and application of the requisite technology.'' There is no question that electrified technologies, including various ICE, hybrid and BEV technologies, meet all of these specific statutory criteria. They apply to ''motor vehicles'', are systems and incorporate devices that ''prevent'' and ''control'' emissions,[464] and qualify as ''technology.''

While the statute also imposes certain specific limitations on EPA's consideration of technology, none of these statutory limitations preclude the consideration of electrified technologies, a subset of electrified technologies, or any other technologies that achieve zero vehicle tailpipe emissions. Specifically, the statute states that the following technologies cannot serve as the basis for the standards: first, technologies which cannot be developed and applied within the relevant time period, giving appropriate consideration to the cost of compliance; and second, technologies that ''cause or contribute to an unreasonable risk to public health, welfare, or safety in [their] operation or function.'' CAA section 202(a)(2), (4).[465]

[463] For example, in 1998, EPA published regulations for the voluntary National Low Emission Vehicle (NLEV) program that allowed LD motor vehicle manufacturers to comply with tailpipe standards for cars and light-duty trucks more stringent than that required by EPA in exchange for credits for such low emission and zero emission vehicles. 63 FR 926 (Jan. 7, 1998). In 2000, EPA promulgated LD Tier 2 emission standards which built upon ''the recent technology improvements resulting from the successful [NLEV] program.'' 65 FR 6698 (Feb. 10, 2000).

[464] The statute emphasizes that the agency must consider emission reductions technologies regardless of ''whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution.'' CAA section 202(a)(1); *see also* CAA section 202(a)(4)(B) (describing conditions for ''any device, system, or element of design'' used for compliance with the standards''; *Truck Trailer Manufacturers Ass'n, Inc* v. *EPA,* 17 F.4th 1198, 1202 (D.C. Cir. 2021) (the statute ''created two categories of complete motor vehicles. Category one: motor vehicles with built-in pollution control. Category two: motor vehicles with add-in devices for pollution control.''). While the statute does not define system, section 202 does use the word expansively, to include ''vapor recovery system[s]'' (CAA section 202(a)(5)(A)), ''new power sources or propulsion systems'' (CAA section 202(e)), and onboard diagnostics systems (CAA section 202(m)(1)(D)). In any event, the intentional use of the phrase ''complete systems'' shows that Congress expressly contemplated as methods of pollution control not only add-on devices (like catalysts that control emissions after they are produced by the engine), but wholesale redesigns of the motor vehicle and the motor vehicle engine to prevent and reduce pollution. Many technologies that reduce vehicle GHG emissions today can be characterized as systems that reduce or prevent GHG emissions, including advanced engine designs in ICE and hybrid vehicles; integration of electric drive units in hybrids, PHEVs, BEV and FCEV designs; high voltage batteries and controls; redesigned climate control systems improvements, and more.

[465] In addition, under section 202(a)(3)(A), EPA must promulgate under section 202(a)(1) certain criteria pollutant standards for ''classes or categories'' of heavy-duty vehicles that ''reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available . . . giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology.'' EPA thus lacks discretion to base such standards on a technological pathway that reflects less than the greatest degree of emission reduction achievable for the class (giving consideration to cost, energy, and safety). In other words, where EPA has identified available control technologies that can completely prevent pollution and otherwise comport with the statute, the agency lacks the discretion to rely on less effective control technologies to set weaker standards that achieve fewer emissions reductions. And while section 202(a)(3)(A) does not govern standards for light-

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EPA has undertaken a comprehensive assessment of the statutory factors, further discussed in sections III, IV, and V of the preamble and throughout the RIA and the RTC, and has found that the CAA plainly authorizes the consideration of electrification technologies, including BEV technologies, at the levels that support the modeled potential compliance pathway to achieve the final standards.

Having discussed what the statutory text does say, we note what the statutory text does not say. Nothing in section 202(a)(1)–(2) distinguishes technologies that prevent vehicle tailpipe emissions from other technologies as being suitable for consideration in establishing the standards. Moreover, nothing in the statute suggests that certain kinds of electrified technologies are appropriate for consideration while other kinds of electrified technologies are not.[466] While some commenters suggest that BEVs represent a difference in kind from all other emissions control technologies, that is simply untrue. As we explain in section III.A of this preamble and RIA Chapter 3, electrified technologies comprise a large range of motor vehicle technologies. In fact, all new motor vehicles manufactured in the United States today have some degree of electrification and rely on electrified technology to control emissions.

ICE vehicles are equipped with alternators that generate electricity and batteries that store such electricity. The electricity in turn is used for numerous purposes, such as starting the ICE and powering various vehicle electronics and accessories. More specifically, electrified technology is a vital part of controlling emissions on all new motor vehicles produced today: motor vehicles rely on electronic control modules for controlling and monitoring their operation, including the fuel mixture (whether gasoline fuel, diesel fuel, natural gas fuel, etc.), ignition timing, transmission, and emissions control system. In enacting the Clean Air Act Amendments of 1990, Congress itself recognized the great importance of this particular electrified technology for emissions control in certain vehicles.[467] It would be impossible to drive any ICE vehicle produced today or to control the emissions of such a vehicle without such electrified technology.

Indeed, many of the extensive suite of technologies that manufacturers have devised for controlling emissions rely on electrified technology and do so in a host of different ways. These include technologies that improve the efficiency of the engine and system of propulsion, such as the electronic control modules, electronically-controlled fuel injection (for all manners of fuel including but not limited to gasoline, diesel, natural gas, propane, and hydrogen), and automatic transmission; technologies that reduce the amount of ICE engine use such as engine start-stop technology and other idle reduction technologies; add-on technologies to control pollution after it has been generated by the engine, such as gasoline three-way catalysts, and diesel selective catalytic reduction and particulate filters that rely on electrified technology to control and monitor their performance; non-engine technologies that rely on electrified systems to improve vehicle aerodynamics; technologies related to vehicle electricity production, such as high efficiency alternators; and engine accessory technologies that increase the efficiency of the vehicle, such as electric coolant pumps, electric steering pumps, and electric air conditioning compressors. Because electrified technologies reduce emissions, EPA has long considered them relevant for regulatory purposes under Title II. For example, EPA has relied on various such technologies to justify the feasibility of the standards promulgated under section 202(a), promulgated requirements and guidance related to testing involving such technologies under section 206, required manufacturers to provide warranties for them under section 207, and prohibited their tampering under section 203.

Certain vehicles rely to a greater extent on electrification as an emissions control strategy. These include (1) hybrid vehicles, which rely principally on an ICE to power the wheels, but also derive propulsion from an on-board electric motor, which can charge batteries through regenerative braking, and feature a range of larger batteries than non-hybrid ICE vehicles;[468] (2) plug-in hybrid vehicles (PHEV), which have an even larger battery that can also be charged by plugging it into an outlet and can rely principally on electricity for propulsion, along with an ICE; (3) hydrogen fuel-cell vehicles (FCEV), which are fueled by hydrogen to produce electricity to power the wheels and have a range of larger battery sizes; and (4) battery electric vehicles (BEV), which rely entirely on plug-in charging and the battery to provide the energy for propulsion. Manufacturers may choose to sell different models of the same vehicle with different levels of electrification.[469] In many but not all cases,[470] electrified technologies are systems which "prevent" (partially or completely) the emission of pollution from the motor vehicle engine.[471] Nothing in the statute indicates that EPA is limited from considering any of these technologies. For instance, nothing in the statute says that EPA may only consider emissions control technologies with a certain kind or level of electrification, *e.g.,* where the battery is smaller than a certain size, where the energy derived from the battery is less than a certain percentage of total vehicle energy, where certain energy can be recharged by plugging the vehicle into an outlet as opposed to running the internal combustion engine, etc. The statute does not differentiate in terms of such details, but simply commands EPA to adopt emissions standards based on the "development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period."

EPA's interpretation also accords with the purpose and primary operation of section 202(a), which is to reduce emissions of air pollutants from motor vehicles that are anticipated to endanger public health or welfare.[472] This statutory purpose compels EPA to consider available technologies that reduce emissions of air pollutants most effectively, including vehicle

duty vehicles or any GHG standards, which are established only under section 202(a)(1)–(2), we think it is also informative as to the breadth of EPA's authority under those provisions.

[466] Congress' approach here is notably distinct from its approach under EPCA, where it specified that DOT should not consider fuel economy of alternative fuel vehicles in determining fuel economy standards. See 49 U.S.C. 32902(h)(1).

[467] *See* CAA 207(i)(2) (for light-duty vehicles, statutorily designating "specified major emission control components" subject to extended warranty provisions as including "an electronic emissions control unit"). Congress also designated by statute "onboard emissions diagnostic devices" as "specified major emission control components"; OBD devices also rely on electrified technology.

[468] Hybrid vehicles include both mild hybrids, which have a relatively smaller battery and can use the electric motor to supplement the propulsion provided by the ICE, as well as strong hybrids, which have a relatively larger battery and can drive for limited distances entirely on battery power.

[469] For example, Hyundai has offered the Ioniq as an HEV, PHEV, and BEV. One automaker stated in comments that "[b]y the end of the decade, every model will be available with a fully electric version." Docket No. EPA–HQ–OAR–2022–0829–0744 at 2 (Comments of Jaguar Land Rover).

[470] For example, some vehicles also use electrified technology to preheat the catalyst and improve catalyst efficiency especially when starting in cold temperatures.

[471] CAA section 202(a)(1).

[472] *See also Coal. for Responsible Regul., Inc.* v. *EPA,* 684 F.3d 102, 122 (D.C. Cir. 2012), aff'd in part, rev'd in part sub nom. *Util. Air Regul. Grp.* v. *EPA.,* 573 U.S. 302 (2014), and amended sub nom. *Coal. for Responsible Regul., Inc.* v. *EPA,* 606 F. App'x 6 (D.C. Cir. 2015) (the purpose of section 202(a) is "utilizing emission standards to prevent reasonably anticipated endangerment from maturing into concrete harm").

technologies that result in no vehicle tailpipe emissions of GHGs and completely ''prevent'' such emissions.[473] And, given Congress's directive to reduce air pollution, it would make little sense for Congress to have authorized EPA to consider technologies that achieve 99 percent pollution reduction (for example, as some PM filter technologies do to control criteria pollutants, see section III.D of this preamble), but not 100 percent pollution reduction. At minimum, the statute allows EPA to consider such technologies. Today, many of the available technologies that can achieve the greatest emissions control are those that rely on greater levels of electrification, with BEV technologies capable of completely preventing vehicle tailpipe emissions.

The surrounding statutory context further highlights that Congress intended section 202 to lead to reductions to the point of complete pollution prevention. Consistent with section 202(a)(1), section 101(c) of the Act states ''A primary goal of this chapter is to encourage or otherwise promote reasonable Federal, State, and local governmental actions, consistent with the provisions of this chapter, for pollution prevention.'' [474] Section 101(a)(3) further explains the term ''air pollution prevention'' (as contrasted with ''air pollution control'') to mean ''the reduction or elimination, through any measures, of the amount of pollutants produced or created at the source.'' That is to say, EPA is not limited to requiring small reductions, but instead has authority to consider technologies that may entirely prevent the pollution from occurring in the first place. Congress also repeatedly amended the Act to itself impose extremely large reductions in motor vehicle pollution.[475] Similarly, Congress prescribed EPA to set standards achieving specific, numeric levels of emissions reductions (which in many instances cumulatively amount to multiple orders of magnitude),[476] while explicitly stating that EPA's 202(a) authority allowed the agency to go still further.[477] Consistent with these statutory authorities, prior rulemakings have also required very large emissions reductions, including to the point of completely preventing certain types of emissions.[478]

This reading of the statute accords with the practical reality of administering an effective emissions control program, a matter in which the Agency has developed considerable expertise over the last five decades. Such a program is necessarily predicated on the continuous development of increasingly effective emissions control technologies. In determining the standards, EPA appropriately considers updated data and analysis on pollution control technologies, without *a priori* limiting its consideration to a particular set of technologies. Given the continuous development of pollution control technologies since the early days of the CAA, this approach means that EPA has routinely considered new and projected technologies developed or refined since the time of the CAA's enactment, including for instance, electrification technologies.[479] The innumerable technologies on which EPA's standards have been premised, or which EPA has otherwise incentivized, are presented in summary form later in this section and then in full in Chapter 3 of the RIA. This approach is inherent in the statutory text of section 202(a)(2): in requiring EPA to consider lead time for the development and application of technology before standards may take effect, Congress directed EPA to consider future technological advancements and innovation rather than limiting the Agency to only those technologies in place at the time the statute was enacted. The text of section 202(a)(3)(A) is even more clear on this point: EPA must establish standards that ''reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply. . . .'' In other words, the Administrator is mandated to make a predictive judgment about technology availability in a future year, and then establish the standards based on such technologies. In the report accompanying the Senate bill for the 1965 legislation establishing section 202(a), the Senate Committee wrote that it ''believes that exact standards need not be written legislatively but that the Secretary should adjust to changing technology.'' [480] This forward-looking regulatory approach keeps pace with real-world technological developments that have the potential to reduce emissions and comports with Congressional intent and precedent.[481]

For all these reasons, EPA's consideration of electrified technologies and technologies that prevent vehicle tailpipe emissions in establishing the standards is unambiguously permitted by the Act; indeed, given the Act's purpose to use technology to prevent air pollution from motor vehicles, and the agency's factual finding based on voluminous record evidence that BEV technologies are the most effective and available technologies for doing so, the Agency's consideration of such technologies is compelled by the statute. Because the statutory text in its context is plain, we could end our interpretive inquiry here. However, we have taken the additional step of reviewing the extensive statutory and legislative history regarding the kinds of technology, including electric vehicle technology, that Congress expected EPA to consider in exercising its section 202(a) authority. Over six decades of Congressional enactments and statements provide overwhelming support for EPA's consideration of electrified technologies and technologies that prevent vehicle

[473] CAA section 202(a)(1); *see also* CAA section 202(a)(4)(B) directing EPA to consider whether a technology ''eliminates the emission of unregulated pollutants'' in assessing its safety.

[474] Clean Air Act Amendments, 104 Stat. 2399, 2468 (Nov. 15, 1990); *see also* 42 U.S.C. chapter 85 title (''Air Pollution Prevention and Control'').

[475] *See, e.g.,* CAA section 202(a)(3)(A)(i) (directed EPA to promulgate standards that ''reflect the greatest decree of emission reduction achievable'' for certain pollutants).

[476] CAA section 202(a), (g)–(h), and (j).

[477] *See, e.g.,* CAA section 202(b)(1)(C) (''The Administrator may promulgate regulations under subsection (a)(1) revising any standard prescribed or previously revised under this subsection. . . . Any revised standard shall require a reduction of emissions from the standard that was previously applicable.''), (i)(3)(B)(iii) (''Nothing in this paragraph shall prohibit the Administrator from exercising the Administrator's authority under subsection (a) to promulgate more stringent standards for light-duty vehicles and light-duty . . . at any other time thereafter in accordance with subsection (a).'').

[478] *See, e.g.,* 31 FR 5171 (Mar. 30, 1966) (''No crankcase emissions shall be discharged into the ambient atmosphere from any new motor vehicle or new motor vehicle engine subject to this subpart.'').

[479] For example, when EPA issued its Tier 2 standards for light-duty and medium-duty vehicles in 2000, the Agency established ''bins'' of standards in addition to a fleet average requirement. 65 FR 6698, 6734–35, February 10, 2000. One ''bin'' was used to certify electric vehicles that have zero criteria pollutant emissions. *Id.* Under the Tier 2 program, a manufacturer could designate which bins their different models fit into, and the weighted average across bins was required to meet the fleet average standard. *Id.* at 6746.

[480] S. Rep. No. 89–192, at 4 (1965). Likewise, the report accompanying the House bill stated that ''the objective of achieving fully effective control of motor vehicle pollution will not be accomplished overnight. . . . [T]he techniques now available provide only a partial reduction in motor vehicle emissions. For the future, better methods of control will clearly be needed; the committee expects that [the agency] will accelerate its efforts in this area.'' H.R. Rep. No. 89–899, at 4 (1965).

[481] *See also NRDC,* 655 F.2d at 328 (EPA is ''to project future advances in pollution control capability. It was 'expected to press for the development and application of improved technology rather than be limited by that which exists today.' '' To do otherwise would thwart Congressional intent and leave EPA ''unable to set pollutant levels until the necessary technology is already available.'').

tailpipe emissions in establishing the final standards.

As explained, section 202 does not specify or expect any particular type of motor vehicle propulsion system to remain prevalent, and it was clear to Congress as early as the 1960s that ICE vehicles might be inadequate to achieve the country's air quality goals. In 1967, the Senate Committees on Commerce and Public Works held five days of hearings on ''electric vehicles and other alternatives to the internal combustion engine,'' which Chairman Magnuson opened by saying ''The electric [car] will help alleviate air pollution and urban congestion. The consumer will benefit from instant starting, reduced maintenance, long life, and the economy of electricity as a fuel. . . . The electric car does not mean a new way of life, but rather it is a new technology to help solve the new problems of our age.''[482] In a 1970 message to Congress seeking a stronger CAA, President Nixon stated he was initiating a program to develop ''an unconventionally powered, virtually pollution free automobile'' because of the possibility that ''the sheer number of cars in densely populated areas will begin outrunning the technological limits of our capacity to reduce pollution from the internal combustion engine.''[483]

Since the earliest days of the CAA, Congress has also emphasized that the goal of section 202 is to address air quality hazards from motor vehicles, not to simply reduce emissions from internal combustion engines to the extent feasible. In the Senate Report accompanying the 1970 CAA Amendments, Congress made clear EPA ''is expected to press for the development and application of improved technology rather than be limited by that which exists'' and identified several ''unconventional'' technologies that could successfully meet air quality-based emissions targets for motor vehicles.[484] In the 1970 amendments, Congress further demonstrated its recognition that developing new technology to ensure that pollution control keeps pace with economic development is not merely a matter of refining the ICE, but requires considering new types of motor vehicle propulsion.[485] Congress provided EPA with authority to fund the development of ''low emission alternatives to the present internal combustion engine'' as well as a program to encourage Federal purchases of ''low-emission vehicles.'' See CAA section 104(a)(2) (previously codified as CAA section 212).[486] As discussed further in RTC section 2.3, Congress also adopted section 202(e) expressly to grant the Administrator discretion under certain conditions regarding the certification of vehicles and engines based on ''new power sources or propulsion system[s],'' that is to say, power sources and propulsion systems beyond the existing internal combustion engine and fuels available at the time of the statute's enactment. As the D.C. Circuit stated in 1975, ''We may also note that it is the belief of many experts—both in and out of the automobile industry—that air pollution cannot be effectively checked until the industry finds a substitute for the conventional automotive power plant—the reciprocating internal combustion (*i.e.,* 'piston') engine. . . . It is clear from the legislative history that Congress expected the Clean Air Amendments to force the industry to broaden the scope of its research—to study new types of engines and new control systems.''[487]

Moreover, Congress believed that the motor vehicle emissions program could achieve enormous emissions reductions, not merely modest ones, through the application and development of ever-improving emissions control technologies. For example, the Clean Air Act of 1970 required a 90 percent reduction in emissions, which was to be achieved with less lead time than this rule provides for its final standards.[488] Ultimately, although the industry was able to meet the standard using ICE technologies, the standard drove development of entirely new engine and emission control technologies such as exhaust gas recirculation and catalytic converters, which in turn required a switch to unleaded fuel and the development of massive new infrastructure (not present at the time the standard was finalized) to support the distribution of this fuel.[489]

Since that time, Congress has continued to emphasize the importance of technology development to achieving the goals of the CAA.[490] In the 1990 amendments, Congress determined that evolving technologies could support further order of magnitude reductions in emissions. For example, the statutory Tier I light-duty standards required (on top of the existing standards) a further 30 percent reduction in nonmethane hydrocarbons, 60 percent reduction in NO_X, and 80 percent reduction in PM for diesel vehicles. The Tier 2 light-duty standards in turn required passenger vehicles to be 77 to 95 percent cleaner.[491] Congress instituted a clean fuel vehicles program to promote further progress in emissions reductions, which also applied to motor vehicles as

[482] *Electric Vehicles and Other Alternatives to the Internal Combustion Engine: Joint Hearings before the Comm. On Commerce and the Subcomm. On Air and Water Pollution of the Comm. On Pub. Works,* 90th Cong. (1967).

[483] Richard Nixon, Special Message to the Congress on Environmental Quality (Feb. 10, 1970), *https://www.presidency.ucsb.edu/documents/special-message-the-congress-environmental-quality.*

[484] S. Rep. No. 91–1196, at 24–27 (1970).

[485] In the lead up to enactment of the CAA of 1970, Senator Edmund Muskie, Chair of the Subcommittee on Environmental Pollution of the Committee on Public Works (now the Committee on Environment and Public Works), stated that ''[t]he urgency of the problems required that the industry consider, not only the improvement of existing technology, but also alternatives to the internal combustion engine and new forms of transportation.'' 116 Cong. Rec. 42382 (Dec. 18, 1970).

[486] A Senate report on the Federal Low-Emission Vehicle Procurement Act of 1970, the standalone legislation that ultimately became the low-emission vehicle procurement provisions of the 1970 CAA, stated that the purpose of the bill was to direct federal procurement to ''stimulate the development, production and distribution of motor vehicle propulsion systems which emit few or no pollutants'' and explained that ''the best long range method of solving the vehicular air pollution problem is to substitute for present propulsion systems a new system which, during its life, produces few pollutants and performs as well or better than the present powerplant.'' S. Rep. No. 91–745, at 1, 4 (Mar. 20, 1970).

[487] *Int'l Harvester Co.* v. *Ruckelshaus,* 478 F.2d 615, 634–35 (D.C. Cir. 1975).

[488] *See* Clean Air Act Amendments of 1970, Public Law 91–604, at sec. 6, 84 Stat. 1676, 1690 (Dec. 31, 1970) (amending section 202 of the CAA and directing EPA to issue regulations to reduce carbon monoxide and hydrocarbons from LD vehicles and engines by 90 percent in MY 1975 compared to MY 1970 and directing EPA to issue regulations to reduce NO_X emissions from LD vehicles and engines by 90 percent in MY 1976 when compared with MY 1971).

[489] Since the new vehicle technology required on all model year 1975–76 vehicles would be poisoned by the lead in the existing gasoline, it required the rollout of an entirely new fuel to the marketplace with new refining technology needed to produce it. It was not possible for refiners to make the change that quickly to all of the nation's gasoline production, so this in turn required installation of a new parallel fuel distribution infrastructure to distribute and new retail infrastructure to dispense unleaded gasoline to the customers with MY1975 and later vehicles while still supplying leaded gasoline to the existing fleet. In order to ensure availability of unleaded gasoline across the nation, all refueling stations with sales greater than 200,000 gallons per year were required to dispense the new unleaded gasoline. In 1974, less than 10 percent of all gasoline sold was unleaded gasoline, but by 1980 nearly 50 percent was unleaded. See generally Richard G. Newell and Kristian Rogers, The U.S. Experience with the Phasedown of Lead in Gasoline, Resources for the Future (June 2003), available at *https://web.mit.edu/ckolstad/www/Newell.pdf.*

[490] For example, in the lead up to the CAA Amendments of 1990, the House Committee on Energy and Commerce reported that ''[t]he Committee wants to encourage a broad range of vehicles using electricity, improved gasoline, natural gas, alcohols, clean diesel fuel, propane, and other fuels.'' H. Rep. No. 101–490, at 283 (May 17, 1990).

[491] *See* 65 FR 28 (Feb. 10, 2000).

defined under section 216, see CAA section 241(1), and explicitly defined motor vehicles qualifying under the program as including vehicles running on an alternative fuel or ''power source (including electricity),'' CAA section 241(2).[492]

Congress also directed EPA to phase-in certain section 202(a) standards in CAA section 202(g)–(j).[493] In doing so, Congress recognized that certain technologies, while extremely potent at achieving lower emissions, would be difficult for the entire industry to adopt all at once. Rather, it would be more appropriate for the industry to gradually implement the standards over a longer period of time. This is directly analogous to EPA's assessment in this final rule, which finds that industry will gradually shift to more effective emissions control technologies over a period of time. Generally speaking, phase-ins, fleet averages, and ABT all are means of addressing the question, recognized by Congress in section 202, of how to achieve emissions reductions to protect public health when it may be difficult to implement a stringency increase across the entire fleet simultaneously.

Similar to EPA's ABT program, these statutory phase-in provisions also evaluated compliance with respect to a manufacturers' fleet of vehicles over the model year. More specifically, CAA section 202(g)–(j) each required a specified percentage of a manufacturer's fleet to meet a specified standard for each model year (*e.g.,* 40 percent of a manufacturer's sales volume must meet certain standards by MY 1994). This made the level of a manufacturer's production over a model year a core element of the standard. In other words, the form of the standard mandated by Congress in these sections recognized that pre-production certification would be based on a projection of production for the upcoming model year, with actual compliance with the required percentages not demonstrated until after the end of the model year. Compliance was evaluated not only with respect to individual vehicles, but with respect to the fleet as a whole. EPA's ABT provisions use this same approach, adopting a similar, flexible form, that also makes the level of a manufacturer's production a core element of the standard and evaluates compliance at the fleet level, in addition to at the individual vehicle level.

In enacting the Energy Independence and Security Act of 2007, Congress also recognized the possibility of fleet-average standards. The statute barred Federal agencies from acquiring ''a light duty motor vehicle or medium duty passenger vehicle that is not a low greenhouse gas emitting vehicle.'' [494] It directed the Administrator to promulgate guidance on such ''low greenhouse gas emitting vehicles,'' but explicitly prohibited vehicles from so qualifying ''if the vehicle emits greenhouse gases at a higher rate than such standards allow for the *manufacturer's fleet average grams per mile of carbon dioxide-equivalent emissions for that class of vehicle,* taking into account any emissions allowances and adjustment factors such standards provide.'' [495] Congress thus explicitly contemplated the possibility of motor vehicle GHG standards with a fleet average form.[496]

The recently-enacted IRA[497] demonstrates Congress's continued resolve to drive down emissions from motor vehicles through the application of the entire range of available technologies, and specifically highlights the importance of ZEV technologies. The IRA ''reinforces the longstanding authority and responsibility of [EPA] to regulate GHGs as air pollutants under the Clean Air Act,'' [498] and ''the IRA clearly and deliberately instructs EPA to use'' this authority by ''combin[ing] economic incentives to reduce climate pollution with regulatory drivers to spur greater reductions under EPA's CAA authorities.'' [499] To assist with this, as described in sections I, III, and IV of the preamble, and RIA Chapter 2, the IRA provides a number of economic incentives for BEVs and the infrastructure necessary to support them, and specifically affirms Congress's previously articulated statements that non-ICE technologies will be a key component of achieving emissions reductions from the mobile source sector.[500] The legislative history reflects that ''Congress recognizes EPA's longstanding authority under CAA section 202 to adopt standards that rely on zero emission technologies, and Congress expects that future EPA regulations will increasingly rely on and incentivize zero-emission vehicles as appropriate.'' [501] These developments further confirm that the focus of CAA section 202 is on application of innovative technologies to reduce vehicular emissions, and not on the means by which vehicles are powered.

This statutory and legislative history, beginning with the 1960s and through the recently enacted IRA, demonstrate Congress's historical and contemporary commitment to reducing motor vehicle emissions through the application of increasingly advanced technologies. Consistent with Congress's intent and this legislative history, EPA's rulemakings have taken the same approach, basing standards on ever-

[492] *See also* CAA section 246(f)(4) (under the clean fuels program, directing the Administrator to issue standards ''for Ultra-Low Emission Vehicles ('ULEV's) and Zero Emissions Vehicles ('ZEV's)'' and to conform certain such standards ''as closely as possible to standards which are established by the State of California for ULEV and ZEV vehicles in the same class.'').

[493] CAA section 202(g) required a phase in for LD trucks up to 6,000 lbs GVWR and LD vehicles beginning with MY 1994 for emissions of nonmethane hydrocarbons (NMHC), carbon monoxide (CO), nitrogen oxides (NO_X), and particular matter (PM). These standards phased in over several years. Similarly, CAA section 202(h) required standards to be phased in beginning with MY 1995 for LD trucks of more than 6,000 lbs GVWR for the same pollutants. CAA section 202(i) required EPA to study whether further emission reductions should be required with respect to MYs after January 1, 2003 for certain vehicles. CAA section 202(j) required EPA to promulgate regulations applicable to CO emissions from LD vehicles and LD trucks when operated under ''cold start'' conditions *i.e.,* when the vehicle is operated at 20 degrees Fahrenheit. Congress directed EPA to phase in these regulations beginning with MY 1994 under Phase I, and to study the need for further reductions of CO and the maximum reductions achievable for MY 2001 and later LD vehicles and LD trucks when operated in cold start conditions. In addition, Congress specified that any ''revision under this subchapter may provide for a phase-in of the standard.'' CAA 202(b)(1)(C).

[494] 42 U.S.C. 13212(f)(2)(A).

[495] 42 U.S.C. 13212(f)(3)(C) (emphasis added).

[496] 42 U.S.C. 13212 does not specifically refer back to section 202(a). However, we think it is plain that Congress intended for EPA in implementing section 13212 to consider relevant CAA section 202(a) standards as well as standards issued by the State of California. See 42 U.S.C. 13212(f)(3)(B) (''In identifying vehicles under subparagraph (A), the Administrator shall take into account the most stringent standards for vehicle greenhouse gas emissions applicable to and enforceable against motor vehicle manufacturers for vehicles sold anywhere in the United States.''). As explained in the text, EPA has historically set fleet average standards under CAA section 202(a) for certain emissions from motor vehicles. Under section 209(b) of the Clean Air Act, EPA may also authorize the State of California to adopt and enforce its own motor vehicle emissions standards subject the statutory criteria. California has also adopted certain fleet average motor vehicle emissions standards. No other Federal agency or State government has authority to establish emissions standards for new motor vehicles, although certain States may choose to adopt standards identical to California's pursuant to CAA section 177.

[497] Inflation Reduction Act, Public Law 117–169, 136 Stat. 1818, (2022), available at *https://www.congress.gov/117/bills/hr5376/BILLS-117hr5376enr.pdf.*

[498] 168 Cong. Rec. E868–02 (daily ed. Aug. 12, 2022) (statement of Rep. Pallone, Chairman of the House Energy and Commerce Committee).

[499] 168 Cong. Rec. E879–02, at 880 (daily ed. Aug. 26, 2022) (statement of Rep. Pallone).

[500] *See* Inflation Reduction Act, Public Law 117–169, at §§ 13204, 13403, 13404, 13501, 13502, 50142–50145, 50151–50153, 60101–60104, 70002 136 Stat. 1818, (2022), available at *https://www.congress.gov/117/bills/hr5376/BILLS-117hr5376enr.pdf.*

[501] 168 Cong. Rec. E879–02, at 880 (daily ed. Aug. 26, 2022) (statement of Rep. Pallone).

evolving technologies that have allowed for enormous emissions reductions. As required by the Act, EPA has consistently considered the lead time and costs of control technologies in determining whether and how they should be included in the technological packages for the standards, along with other factors that affect the real-world adoption or impacts of the technologies as appropriate. Over time, EPA's motor vehicle emission standards have been based on and stimulated the development of a broad set of advanced technologies—such as electronic fuel injection systems, gasoline catalytic convertors, diesel particulate filters, diesel NO_X reduction catalysts, gasoline direct injection fuel systems, and advanced transmission technologies—which have been the building blocks of vehicle designs and have yielded not only lower pollutant emissions, but improved vehicle performance, reliability, and durability. Many of these technologies did not exist when Congress first granted EPA's section 202(a) authority in 1965, but these technologies nonetheless have been successfully adopted and reduced emissions by multiple orders of magnitude.

As previously discussed, beginning in 2010, EPA has set vehicle and engine standards under section 202(a)(1)–(2) for GHGs.[502] Manufacturers have responded to these standards over the past decade by continuing to develop and deploy a wide range of technologies, including more efficient engine designs, transmissions, aerodynamics, tires, and air conditioning systems that contribute to lower GHG emissions, as well as vehicles based on methods of propulsion beyond diesel- and gasoline-fueled ICE vehicles, including ICE running on alternative fuels, as well as various levels of electrified vehicle technologies from mild hybrids, to strong hybrids, and up through battery electric vehicles and fuel-cell vehicles.

EPA has long established performance-based emissions standards that anticipate the use of new and emerging technologies. In each of EPA's earlier GHG rules, as in this rule, EPA specifically considered the availability of electrified technologies, including BEV technologies.[503] In the 2010 LD GHG rule, EPA determined based on the record before it that BEVs should not be part of the technology packages to support the feasibility of the standards given that they were not expected to be sufficiently available during the model years for those rules, giving consideration to lead time and costs of compliance. Instead, recognizing the possible future use of those technologies and their potential to achieve very large emissions reductions, EPA incentivized their development and deployment through advanced technology credit multipliers, which give manufacturers additional ABT credits for producing such vehicles. In the 2012 rule which set standards for MYs 2017–2025 light-duty vehicles, EPA included BEV and PHEV technologies in its analysis, and projected that by MY 2025 BEV penetrations would reach 2 percent.[504] By the time of the 2021 LD GHG rule, the increasing presence of PEVs in the market led EPA to judge that additional ABT credits for PEVs would no longer be warranted after MY 2024. Accordingly, EPA's technology pathway supporting the feasibility of the standards accounted for the increasing penetrations of such technologies, along with improved ICE technologies, in establishing the most protective LD GHG standards to date. In this rule, EPA continues to consider these technologies, and based on the updated record, finds that such technologies will be available at a reasonable cost during the timeframe for this rule, and therefore has included them in the technology packages to support the level of the standards under the modeled potential compliance pathway.

The above analysis of the statutory text, purpose and history, as well as EPA's history of implementing the statute, demonstrate that the agency must, or at a minimum may, appropriately consider available electrified technologies that completely prevent emissions in determining the final standards. In this rulemaking, EPA has done so. The agency has made the necessary predictive judgments as to potential technological developments that can support the feasibility of the final standards, and also as to the availability of supporting infrastructure and critical minerals necessary to support those technological developments, as applicable. In making these judgments, EPA has adhered to the long-standing approach established by the D.C. Circuit, identifying a reasonable sequence of future developments, noting potential difficulties, and explaining how they may be obviated within the lead time afforded for compliance. EPA has also consulted with other organizations with relevant expertise such as the Departments of Energy and Transportation, including through careful consideration of their reports and related analytic work reflected in the administrative record for this rulemaking.

Although the standards are supported by the Administrator's predictive judgments regarding pollution control technologies and the modeled potential compliance pathway, we emphasize that the final standards are not a mandate for a specific type of technology. They do not legally or de facto require a manufacturer to follow a specific technological pathway to comply. Consistent with our historical practice, EPA is finalizing performance-based standards that provide compliance flexibility to manufacturers. While EPA projects that manufacturers may comply with the standards through the use of certain technologies, including a mix of ICE vehicles, advanced ICE, HEVs, PHEVs, and BEVs, manufacturers may select any technology or mix of technologies that would enable them to meet the final standards.

These choices are real and valuable to manufacturers, as attested to by the historical record. The real-world results of our prior rulemakings make clear that industry sometimes chooses to comply with our standards in ways that the Agency did not anticipate, presumably because it is more cost-effective for them to do so. In other words, while EPA sets standards that are feasible based on our modeling of potential compliance pathways, manufacturers may find what they consider to be better pathways to meet the standards and may opt to comply by following those pathways instead.

For example, in promulgating the 2010 LD GHG rule, EPA modeled a technology pathway for compliance with the MY 2016 standards. In actuality, manufacturers diverged from EPA's projections across a wide range of technologies, instead choosing their own technology pathways best suited for their fleets.[505] [506] For example, EPA projected greater penetration of dual-clutch transmissions than ultimately occurred in the MY 2016 fleet; by contrast, use of 6-speed automatic transmissions was twice what EPA had predicted. Both transmission

[502] 75 FR 25324, May 7, 2010; *see also* 76 FR 57106, September 15, 2011 (establishing first ever GHG standards for heavy-duty vehicles).

[503] These include the 2010, 2012, 2020, and 2021 LD GHG rules, as well as the 2011 and 2016 HD GHG rules.

[504] EPA's projection turned out to be an underestimate, as PEVs comprised 7.5 percent of new vehicle sales in MY 2022 and sales are expected to continue to grow. See 2023 EPA Automotive Trends Report.

[505] *See* EPA Memorandum to the docket for this rulemaking, ''Comparison of EPA CO_2 Reducing Technology Projections between 2010 Light-duty Vehicle Rulemaking and Actual Technology Production for Model Year 2016''.

technologies represented substantial improvements over the existing transmission technologies, with the manufacturers choosing which specific technology was best suited for their products and customers. Looking specifically at electrification technologies, start-stop systems were projected at 45 percent and were used in 10 percent of vehicles, while strong hybrids were projected to be 6.5 percent of the MY 2016 fleet and were actually only 2 percent.[507] Notwithstanding these differences between EPA's projections and actual manufacturer decisions, the industry as a whole was not only able to comply with the standards during the period of those standards (2012–2016), but to generate substantial additional credits for overcompliance.[508]

In support of the final standards, EPA has also performed additional modeling demonstrating that the standards can be met in multiple ways. As discussed in section IV.F–G of the final rule preamble and Chapter 2 of the RIA, while our modeled potential compliance pathway includes a mix of ICE, HEV, PHEV and BEV technologies, we also evaluated several examples of potential technology packages and potential compliance pathways. These include sensitivity analyses that account for the implementation of the Advanced Clean Car II program, lower and higher battery costs, faster and slower BEV acceptance, no credit trading, lower BEV production, and no additional BEV production beyond the No-Action case.[509] Likewise, we have concluded based on the record that the final GHG, $NMOG+NO_X$ and PM standards can also be met solely with vehicles containing internal combustion engines.[510] We conclude that per vehicle costs are also reasonable and lead time is sufficient for all of the sensitivity analyses, including those with higher cost impacts. Overall, the sensitivity analyses demonstrate that the final standards are achievable under a wide range of differing assumptions and lend additional support for the feasibility of the final standards, considering costs and lead time.

3. Response to Other Comments Raising Legal Issues

In this section, EPA summarizes our response to certain other comments relating to our legal authority. These include three comments relating to our legal authority to consider certain technologies discussed in section III.B.1 of this preamble above: whether this rule implicates the major questions doctrine, whether EPA has authority for its Averaging, Banking, and Trading (ABT) program, and whether EPA erred in considering BEVs as part of the same class as other vehicles in setting the standards. We separately discuss our legal authority and rationale for battery durability and warranty in section III.G.2–3 of the preamble.

Major questions doctrine. While many commenters recognized EPA's legal authority to adopt the final standards, certain commenters claimed that this rule asserts a novel and transformative exercise of regulatory power that implicates the major questions doctrine and exceeds EPA's legal authority. These arguments were intertwined with arguments challenging EPA's consideration of electrified technologies. Some commenters claimed that the agency's decision to do so and the resulting standards would mandate a large increase in electric vehicles. According to these commenters, this in turn would cause indirect impacts, including relating to issues allegedly outside EPA's traditional areas of expertise, such as to the petroleum refining industry, electricity transmission and distribution infrastructure, grid reliability, and U.S. national security.

EPA does not agree that this rule implicates the major questions doctrine, as that doctrine has been elucidated by the Supreme Court in *West Virginia* v. *EPA* and related cases.[511] The Court has made clear that the doctrine is reserved for extraordinary cases involving assertions of highly consequential power beyond what Congress could reasonably be understood to have granted. This is not such an extraordinary case in which Congressional intent is unclear. Here, EPA is acting within the heartland of its statutory authority and faithfully implementing Congress's precise direction and intent.

First, as we explain in section III.B.2 of the preamble, the statute provides clear Congressional authorization for EPA to consider updated data on pollution control technologies—including BEV technologies—and to determine the emission standards accordingly. In section 202(a), Congress made the major policy decision to regulate air pollution from motor vehicles. Congress also prescribed that EPA should accomplish this mandate through a technology-based approach, and it plainly entrusted to the Administrator's judgment the evaluation of pollution control technologies that are or will become available given the available lead-time and the consequent determination of the emission standards. In the final rule, the Administrator determined that a wide variety of technologies exist to further control GHGs from light- and medium-duty vehicles—including various ICE, hybrid, PHEV, and BEV technologies—and that such technologies could be applied at a reasonable cost to achieve significant reductions of GHG emissions

[506] Similarly, in our 2001 final rule promulgating heavy-duty nitrogen oxide (NO_X) and particulate matter (PM) standards, for example, we predicted that manufacturers would comply with the new nitrogen oxide (NO_X) standards through the addition of NO_X absorbers or "traps." 66 FR 5002, 5036 (Jan. 18, 2001) ("[T]he new NO_X standard is projected to require the addition of a highly efficient NO_X emission control system to diesel engines."). We stated that we were not basing the feasibility of the standards on selective catalytic reduction (SCR) noting that SCR "was first developed for stationary applications and is currently being refined for the transient operation found in mobile applications." *Id.* at 5053. However, industry's approach to complying with the 2001 standards ultimately included the use of SCR for diesel engines. We also projected that manufacturers would comply with the final PM standards through the addition of PM traps to diesel engines; however, industry was able to meet the PM standards without the use of PM traps or any other PM aftertreatment systems.

[507] Although in 2010, EPA overestimated technology penetrations for strong hybrids, in 2012, we underestimated technology penetrations for PEVs, projecting on 1 percent penetration by MY 2021, while actual sales exceeded 4 percent. Compare 2012 Rule RIA, table 3.5–22 with 2022 Automotive Trends Report, table 4.1.

[508] *See* 2022 Automotive Trends Report, Fig. ES–8 (industry generated credits each year from 2012–2015 and generated net credits for the years 2012–2016).

[509] We stress, however, that these additional pathways are not necessary to justify this rulemaking; the statute requires EPA to demonstrate that the standards can be met by the development and application of technology, but it does not require the agency to identify multiple technological solutions to the pollution control problem before mandating more stringent standards. That EPA has done so in this rulemaking, identifying a wide array of technologies capable of further reducing emissions, only highlights the feasibility of the standards and the significant practical flexibilities manufacturers have to attain compliance. We observe that some past standards have been premised on the application of a single known technology at the time, such as the catalytic converter. *See Int'l Harvester* v. *Ruckelshaus*, 478 F.2d 615, 625 (D.C. Cir. 1973) (in setting standards for light duty vehicles, the Court upheld EPA's reliance on a single kind of technology); *see also* 36 FR 12657 (1971) (promulgating regulations for light duty vehicles based on the catalytic converter).

[510] EPA notes that all of its compliance path modeling is based on an expectation that there will be at least some BEVs in the fleet, since BEVs are a cost-effective compliance strategy and represented over 9 percent of new light-duty vehicles sales in 2023. However, EPA has also assessed the technical feasibility of vehicles with ICE meeting both the GHG and criteria pollutant standards and has concluded that across the range of vehicle footprints it would be feasible for manufacturers to produce vehicles with internal combustion engines (*e.g.,* PHEVs) that meet their CO_2 footprint targets (*see* RIA Chapter 3.5.5) and criteria pollutant standards (see RIA Chapter 3.2).

[511] *W. Virginia* v. *Env't Prot. Agency*, 142 S. Ct. 2587, 2605, 2610 (2022).

that contribute to the ongoing climate crisis. These subsidiary technical and policy judgments were clearly within the Administrator's delegated authority.

Second, the agency is not invoking a novel authority. As described above, EPA has been regulating emissions from motor vehicles based upon the availability of feasible technologies to reduce vehicle emissions for over five decades. EPA has regulated GHG emissions since 2010 and criteria pollutant emissions since the 1970s. Our rules have consistently considered available technology to reduce or prevent emissions of the relevant pollutant, including technologies to reduce or completely prevent GHGs. Our consideration of zero-emitting technologies specifically has a long pedigree, beginning with the 1998 National Low Emission Vehicle (NLEV) program. The administrative record here indicates the industry will likely choose to deploy an increasing number of vehicles with emissions control technologies such as PHEV and BEV, in light of new technological advances, the IRA and other government programs, as well as this rule. That the industry will continue to apply the latest technologies to reduce pollution is no different than how the industry has responded to EPA's rules for half a century. The agency's factual findings and resulting determination of the degree of stringency do not represent the exercise of a newfound power. Iterative increases to the stringency of an existing program based on new factual developments hardly reflect an unprecedented expansion of agency authority.

Not only does this rule not invoke any new authority, it also falls well within EPA's traditionally delegated powers. Through five decades of regulating vehicle emissions under the CAA, EPA has developed great expertise in the regulation of motor vehicle emissions. The agency's expertise is reflected in the comprehensive analyses present in the administrative record. The courts have recognized the agency's authority in this area.[512] The agency's analysis includes our assessment of available pollution control technologies; the design and application of a quantitative model for assessing feasible rates of technology adoption; the economic costs of developing, applying, and using pollution control technologies; the context for deploying such technologies (*e.g.*, the supply of raw materials and components, and the availability of supporting charging and refueling infrastructure); the impacts of using pollution control technologies on emissions, and consequent impacts on public health, welfare, and the economy. While each rule necessarily deals with different facts, such as advances in new pollution control technologies at the time of that rule, the above factors are among the kinds of considerations that EPA regularly evaluates in its motor vehicle rules, including all our prior GHG rules.

Third, this rule does not involve decisions of vast economic and political importance exceeding EPA's delegated authority. To begin with, commenters err in characterizing this rule as a ban on gasoline engines or a zero-emission vehicle mandate. That is false as a legal matter and a practical matter. As a legal matter, this rule does not mandate that any manufacturer use any specific technology to meet the standards in this rule; nor does the rule ban gasoline engines. And as a practical matter, as explained in section IV.F–G of the preamble and Chapter 2 of the RIA, manufacturers can adopt a wide array of technologies, including various ICE, HEV, PHEV, and BEV technologies, to comply with this rule.

Specifically, EPA has concluded that the standards could be met by additional PHEVs and has identified several additional compliance pathways, with a wide range of BEVs, that can be achieved in the lead-time provided and at a reasonable cost. In all of these pathways, manufacturers continue to produce gasoline engine vehicles. Indeed, EPA's central case modeling shows that over 84 percent of the on-road fleet will still use gasoline or diesel in 2032, and 58 percent will in 2055. Moreover, the adoption of additional control technologies, including BEVs, are complementary to what the manufacturers are already doing regardless of this rule. As explained under section I.A.2 of the preamble, the production of new PEVs is growing steadily, and even without this rule, is expected to reach 11.8 percent of U.S. light-duty vehicle production for MY 2023,[513] up from 6.7 percent in MY 2022, 4.4 percent in MY 2021 and 2.2 percent in MY 2020—this reflects a growth of over 400 percent in three years. On a sales basis, U.S. new PEV sales in calendar year 2023 alone surpassed 1.4 million,[514] [515] an increase of more than 50 percent over the 807,000 sales that occurred in 2022.[516] Looking to the future under the No Action case, we project that by 2030, 42 percent of new vehicles will be PEVs, while mid-range third-party projections we have reviewed range from 48 to 58 percent in 2030.

Manufacturers have made significant commitments regarding increased production of PEVs as well as supporting announcements that the vast majority of their research and development funding will go towards PEVs, not ICE. These efforts are spurred by a wide range of factors, including the IRA, decreasing costs of producing electric vehicles and their batteries, and more protective GHG standards and EV requirements established by other jurisdictions. To the extent that commenters are concerned about vehicle electrification, that phenomenon is already occurring and accelerating regardless of this final rule. As such, the

[512] *See, e.g., Massachusetts* v. *E.P.A.,* 549 U.S. 497, 532 (2007) (''Because greenhouse gases fit well within the Clean Air Act's capacious definition of ''air pollutant,'' we hold that EPA has the statutory authority to regulate the emission of such gases from new motor vehicles.'').

[513] At time of this publication, MY 2023 production data is not yet final. Manufacturers will be confirming production volumes delivered for sale in MY 2023 later in calendar year 2024.

[514] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates,'' January 30, 2024. Accessed on March 7, 2024 at *https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates*.

[515] Department of Energy, ''FOTW #1327, January 29, 2024: Annual New Light-Duty EV Sales Topped 1 Million for the First Time in 2023,'' January 29, 2024. Accessed on February 2, 2024 at *https://www.energy.gov/eere/vehicles/articles/fotw-1327-january-29-2024-annual-new-light-duty-ev-sales-topped-1-million*.

[516] Colias, M., ''U.S. EV Sales Jolted Higher in 2022 as Newcomers Target Tesla,'' Wall Street Journal, January 6, 2023.

absence of this rule is not a world with ICE vehicles being produced at the same high rates as in prior years; rather, it is a world with rapidly declining production of ICE vehicles and increasing production of PEVs. The final rule builds on these industry trends. It will likely cause some manufacturers to adopt control technologies more rapidly than they otherwise would (particularly in the later model years covered by this rule), and this will result in significant pollution reductions and large public health and welfare benefits. However, that is the entire point of section 202(a); that the regulated industry will deploy additional technology to comply with EPA's standards and further Congress's purposes does not mean the agency has exceeded its delegated authority.

The regulatory burdens of this rule are also reasonable and not different in kind from prior exercises of EPA's authority under section 202. The regulated community of vehicle manufacturers in this rule was also regulated by earlier rules. In terms of costs of compliance for regulated entities, the average costs per-vehicle in the final year of the phase-in ($2,100 in MY 2032) fall within the range of prior rules, for example less than that of the 2012 rule ($2,400 in MY 2025).[517] The per-vehicle costs, moreover, are small relative to what Congress itself accepted in enacting section 202.[518] We acknowledge that the total costs of compliance for this rule are greater than for prior rules, for example slightly over 10% higher than the costs for the 2012 rule after adjusting for inflation ($760 billion versus $689 billion in 2022$ (3% PV)). The moderately higher compliance costs of this rule hardly amount to an unprecedented and transformative change, but merely reflect an ordinary fluctuation in regulatory impacts in response to changed circumstances. The rule also does not create any other excessive regulatory burdens on regulated entities; for example, the rule does not require any manufacturer to shut down, or to curtail or delay production.

While section 202 does not require EPA to consider consumer impacts, the agency recognizes that consumer acceptance of new pollution control technologies can affect the adoption of such technologies. As such, EPA carefully evaluated these issues. In the final rule, EPA considered the upfront costs associated with purchasing cleaner vehicles as well as the costs of operating such vehicles over their lifetime. EPA found that lower operating costs for vehicles substantially outweigh the increased technology costs of meeting the standards over the life of the vehicles. EPA also carefully designed the final rule to avoid any other kinds of disruptions to purchasers. For example, we recognize that light- and medium-duty vehicles represent a diverse array of vehicles and use cases, and we carefully tailored the standards to ensure that purchasers could obtain the kinds of vehicles they need. We also recognized that vehicles require supporting infrastructure (*e.g.*, charging infrastructure) to operate, and we accounted for sufficient lead-time for the development of that infrastructure. We also identified numerous industry standards and safety protocols to ensure the safety of vehicles, including BEVs.

We acknowledge the rule may have other impacts beyond those on regulated entities and their customers (for purposes of discussion here, referred to as ''indirect impacts''). But indirect impacts are inherent in section 202 rulemakings, including past rulemakings going back half a century. As the D.C. Circuit has observed, in the specific context of EPA's Clean Air Act Title II authority to regulate motor vehicles, ''[e]very effort at pollution control exacts social costs. Congress . . . made the decision to accept those costs.'' [519] In EPA's long experience of promulgating environmental regulations, the presence of indirect impacts does not reflect the extraordinary nature of agency action, but rather the ordinary state of the highly interconnected and global supply chain for motor vehicles. In any event, EPA has considerable expertise in evaluating the broader social impacts of the agency's regulations, for example on public health and welfare, safety, energy, employment, and national security. Congress has recognized the agency's expertise in many of these areas in the Clean Air Act, including in section 202(a) itself,[520] and EPA has regularly considered such indirect impacts in our prior rules.

EPA carefully analyzed indirect impacts and coordinated with numerous Federal and other partners with relevant expertise, as described in sections III.I–J of the preamble.[521] The consideration of many indirect impacts is included in our assessment of the rule's costs and benefits. We estimate annualized net benefits of $110 billion through the year 2055 when assessed at a 2 percent discount rate (2022$). The net benefits are not different in kind from prior rules; they are also a small fraction when compared to the size of the regulated industry itself, which grossed $1.21 trillion in 2022 and is rapidly

[517] We provide detailed numerical comparisons of costs and other metrics between this rule and prior rules in RTC Section 2.3.

[518] See *Motor & Equip. Mfrs. Ass'n, Inc.* v. *EPA*, 627 F.2d 1095, 1118 (D.C. Cir. 1979) (''Congress wanted to avoid undue economic disruption in the automotive manufacturing industry and also sought to avoid doubling or tripling the cost of motor vehicles to purchasers.'').

[519] *Motor & Equip. Mfrs. Ass'n, Inc.* v. *EPA*, 627 F.2d 1095, 1118 (D.C. Cir. 1979); *see also id.* (''There is no indication that Congress intended section 202's cost of compliance consideration to embody social costs of the type petitioners advance,'' and holding that the statute does not require EPA to consider antitrust concerns*); Coal. for Responsible Regulation Inc.* v. *EPA*, 684 F.3d 102, 128 (D.C. Cir. 2012) (holding that the statute ''does not mandate consideration of costs to other entities not directly subject to the proposed standards''); *Massachusetts* v. *EPA*, 549 U.S. 497, 534 (2007) (impacts on ''foreign affairs'' are not sufficient reason for EPA to decline making the endangerment finding under section 202(a)(1)).

[520] *See, e.g.,* CAA section 202(a)(1) (requiring EPA Administrator to promulgate standards for emissions from motor vehicles ''which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare''), 202(a)(3)(A) (requiring the agency to promulgate certain motor vehicle emission standards ''giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology''), 203(b)(1) (authorizing the Administrator to ''exempt any new motor vehicle or new motor vehicle engine'' from certain statutory requirements ''upon such terms and conditions as he may find necessary . . . for reasons of national security''), 312(a) (directing EPA to conduct a ''comprehensive analysis of the impact of this chapter on the public health, economy, and environment of the United States'').

[521] For example, we consulted with the following Federal agencies and workgroups on their relevant areas of expertise: National Highway Traffic Safety Administration (NHTSA) at the Department of Transportation (DOT), Department of Energy (DOE) including several national laboratories (Argonne National Laboratory (ANL), National Renewable Energy Laboratory (NREL), and Oak Ridge National Laboratory (ORNL)), United States Geological Survey (USGS) at the Department of Interior (DOI), Joint Office of Energy and Transportation (JOET), Federal Energy Regulatory Commission (FERC), Department of Commerce (DOC), Department of Defense (DOD), Department of State, Federal Consortium for Advanced Batteries (FCAB), and Office of Management and Budget (OMB). We also consulted with State and regional agencies, and we engaged extensively with a diverse set of stakeholders, including vehicle manufacturers, labor unions, technology suppliers, dealers, utilities, charging providers, environmental justice organizations, environmental organizations, public health experts, tribal governments, and other organizations.

expanding,[522] and a tiny fraction of the size of the U.S. economy.[523]

EPA also carefully evaluated many indirect impacts outside of the net benefits assessment and we identified no significant indirect harms and the potential for indirect benefits. Based on our analysis, EPA projects that this rulemaking will not cause significant adverse impacts on electric grid reliability or resource adequacy, that there will be sufficient battery production and critical minerals available to support increasing electric vehicle production including due to large increases in domestic battery and critical mineral production, that there will be sufficient lead-time to develop charging infrastructure, and that the rule will have significant positive national security benefits. We also identified significant initiatives by the Federal government (such as the BIL and IRA), State and local government, and private firms, that complement EPA's final rule, including initiatives to reduce the costs to purchase PEVs; support the development of domestic critical mineral, battery, and PEV production; improve the electric grid, and accelerate the establishment of charging infrastructure.

These and other kinds of indirect impacts, moreover, are similar in kind to the impacts of past EPA motor vehicle rules. For example, this rule may reduce the demand for gasoline and diesel for light-duty and medium-duty vehicles domestically and affect the petroleum refining industry, but that has been the case for all of EPA's past GHG vehicle rules, which also reduced demand for liquid fuels through advances in ICE engine and vehicle technologies and corresponding fuel efficiency. And while production of PEVs does rely on a global supply chain, that is true for all motor vehicles, whose production rely extensively on imports, from raw materials like aluminum to components like semiconductors; addressing supply chain vulnerabilities is a key component of managing any significant manufacturing operation in today's global world. Further, while PEVs may require supporting infrastructure to operate, the same is true for ICE vehicles; indeed, supporting infrastructure for ICE vehicles has changed considerably over time in response to environmental regulation, for example, with the elimination of lead from gasoline, the provisioning of diesel exhaust fluid (DEF) at truck stops to support selective catalytic reduction (SCR) technologies, and the introduction of low sulfur diesel fuel to support diesel particulate filter (DPF) technologies.

As with prior vehicle rules, many indirect impacts are positive: [524] foremost, the significant benefits of mitigating air pollution including both criteria pollutants, which contribute to a range of adverse effects on human health including premature mortality, and GHGs, which contribute to climate change and pose catastrophic risks for human health and the environment, water supply and quality, storm surge and flooding, electricity infrastructure, agricultural disruptions and crop failures, human rights, international trade, and national security. Other positive indirect impacts include reduced dependence on foreign oil and increased energy security and independence; increased regulatory certainty for domestic production of pollution control technologies and their components (including PEVs, batteries, battery components, and critical minerals) and for the development of electric charging infrastructure, with attendant benefits for employment and US global competitiveness in these sectors; and increased use of electric charging and potential for vehicle-to-grid technologies that can benefit electric grid reliability.

Moreover, many of the indirect impacts find close analogs in the impacts Congress itself recognized and accepted. For instance, in 1970 Congress debated whether to adopt standards that would depend heavily on platinum-based catalysts in light of a world-wide shortage of platinum,[525] and in the leadup to the 1977 and 1990 Amendments, Congress recognized that increasing use of three-way catalysts to control motor vehicle pollution risked relying on foreign sources of the critical mineral rhodium.[526] In each case, Congress nonetheless enacted statutory standards premised on this technology. Similarly, Congress recognized and accepted the potential for employment impacts caused by the Clean Air Act; it then chose to address such impacts not by limiting EPA's authority to promulgate motor vehicle rules, but by other measures, such as funding training and employment services for affected workers.[527]

In sum, the final rule is a continuation of what the Administrator has been doing for over fifty years: evaluate updated data on pollution control technologies and set emissions standards accordingly. The rule maintains the fundamental regulatory structure of the existing program and iteratively strengthens the standards from its predecessor rules. The consequences of the rule are analogous to and not different in kind from those of prior rules. And while the rule is associated with indirect impacts, EPA comprehensively assessed such impacts and found that the final rule does not cause significant indirect harms as alleged by commenters and on balance creates net benefits for society. We further discuss our response to the major questions doctrine comments in section 2 of the RTC.

ABT. Some commenters claim that the ABT program, or fleetwide averaging, or both, exceed EPA's statutory authority. As further explained in sections III.C.4 and III.D.2.v of the preamble, EPA has long employed fleetwide averaging and ABT compliance provisions, particularly with respect to the GHG and NMOG+NO_X standards. In upholding the first HD final rule that included an averaging provision, the D.C. Circuit rejected a petitioner's challenge to EPA's statutory authority for averaging. *NRDC* v. *Thomas,* 805 F.2d 410, 425 (D.C. Cir. 1986).[528] In the subsequent 1990 amendments, Congress, noting *NRDC* v. *Thomas* and

[522] *See* Alliance for Automotive Innovation, Economic Insights Map, *available at https://www.autosinnovate.org/resources/insights.*

[523] U.S. GDP reached $25.46 trillion dollars in 2022. *See* Bureau of Economic Analysis, *Gross Domestic Product, Fourth Quarter and Year* 2022 (Second Estimate) (Feb. 23, 2023), available at *https://www.bea.gov/news/2023/gross-domestic-product-fourth-quarter-and-year-2022-third-estimate-gdp-industry-and.*

[524] As noted above, our use of ''indirect impacts'' in this section refers to impacts beyond those on regulated entities.

[525] *See, e.g.*, Environmental Policy Division of the Congressional Research Service Volume 1, 93d Cong., 2d Sess., A Legislative History of the Clean Air Amendments of 1970 at 307 (Comm. Print 1974) (Senator Griffin opposed the vehicle emissions standards because the vehicle that had been shown capable of meeting the standards used platinum-based catalytic converters and ''[a]side from the very high cost of the platinum in the exhaust system, the fact is that there is now a worldwide shortage of platinum and it is totally impractical to contemplate use in production line cars of large quantities of this precious material. . . .'').

[526] *See, e.g.*, 136 Cong. Rec. 5102–04 (1990) and 123 Cong. Rec. 18173–74 (1977) (In debate over both the 1977 and 1990 amendments to the Clean Air Act, some members of Congress supported relaxing NO_X controls from motor vehicles due to concerns over foreign control of rhodium supplies); see also EPA, Tier 2 Report to Congress, EPA420–R–98–008, July 1998, p. E–13 (describing concerns about potential shortages in palladium that could result from the Tier 2 standards).

[527] Public Law 101–549, at sec. 1101, amending the Job Training Partnership Act, 29 U.S.C. 1501 *et seq.* (since repealed).

[528] The court explained that ''[l]acking any clear congressional prohibition of averaging, the EPA's argument that averaging will allow manufacturers more flexibility in cost allocation while ensuring that a manufacturer's overall fleet still meets the emissions reduction standards makes sense.'' *NRDC* v. *Thomas,* 805 F.2d at 425.

EPA's ABT program, ''chose not to amend the Clean Air Act to specifically prohibit averaging, banking and trading authority.'' [529] ''The intention was to retain the status quo,'' *i.e.*, EPA's existing authority to allow ABT and establish fleet average standards.[530] Since then the agency has routinely used ABT in its motor vehicle programs, including in all of our motor vehicle GHG rules, and repeatedly considered the availability of ABT in determining the level of stringency of fleet average standards. Manufacturers have come to rely on ABT in developing their compliance plans. The agency did not reopen the ABT regulations in this rulemaking, with discrete exceptions in the criteria pollutant program corresponding to changes in the transition from Tier 3 to Tier 4 standards. Comments challenging the agency's authority for ABT regulations and use of fleet averaging are therefore beyond the scope of the rulemaking.

In any event, the CAA authorizes EPA to establish an ABT program and fleet average standards.[531] Section 202(a)(1) directs EPA to set standards ''applicable to the emission of any air pollutant from any class or classes of new motor vehicles'' that cause or contribute to harmful air pollution. The term ''class or classes'' refers expressly to groups of vehicles, indicating that EPA may set standards based on the emissions performance of the class as a whole, which is precisely what ABT and fleet averaging enable. Moreover, as we detail in section III.C.4 of the preamble and section 2 of the RTC, consideration of ABT in standard setting relates directly to considerations of technical feasibility, cost, and lead time, the factors EPA is required to consider under CAA section 202(a)(2) in setting standards.[532] For decades, EPA has found that considering ABT, particularly the averaging provisions, is consistent with the statute and affords regulated entities more flexibility in phasing in technologies in a way that is economically efficient, promotes the goals of the Act, supports vehicle redesign cycles, and responds to market fluctuations, allowing for successful deployment of new technologies and achieving emissions reductions at lower cost and with less lead time.[533]

ABT and fleet average standards are also consistent with other provisions in Title II, including those related to compliance and enforcement in CAA sections 203, 206, and 207. Commenters who alleged inconsistency with the compliance and enforcement provisions fundamentally misapprehend the nature of EPA's motor vehicle program and the ABT regulations, where compliance and enforcement do in fact apply to individual vehicles consistent with the statute. It is true that ABT allows manufacturers to meet emissions standards by offsetting emissions credits and debits for individual vehicles. However, individual vehicles must also continue to themselves comply with in-use standards applicable on a vehicle-by-vehicle basis throughout that vehicle's useful life. As appropriate, EPA can suspend, revoke, or void certificates for individual vehicles. Manufacturers' warranties, which are mandated under CAA section 207, apply to individual vehicles. EPA and manufacturers perform testing on individual vehicles, and recalls can be implemented based on evidence of non-conformance by a substantial number of individual vehicles within the class. We further discuss our response to this comment, including detailed exposition of each of the relevant statutory provisions, in RTC section 2.

BEVs as part of the regulated class. We now address the related comment that EPA cannot consider averaging, especially of BEVs, in supporting the feasibility of the standards. The comments allege that because BEVs do not emit the relevant air pollutants they are not part of the ''class'' of vehicles that can be regulated by EPA under section 202(a)(1); therefore EPA should not establish standards based on manufacturers' ability to produce BEVs. We disagree with these commenters' reading of the statute, and moreover, as we explain further below, their underlying factual premise—that BEVs do not emit the relevant air pollutants—is incorrect.

As discussed in section III.B.1 of the preamble, Congress required EPA to prescribe 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 endangers public health and welfare. Congress defined ''motor vehicles'' by their function: ''any self-propelled vehicle designed for transporting persons or property on a street or highway.'' [534] Likewise, with regard to classes, Congress explicitly contemplated functional categories: ''the Administrator may base such classes or categories on gross vehicle weight, horsepower, type of fuel used, or other appropriate factors.'' [535] It is indisputable that electric vehicles are ''new motor vehicles'' as defined by the statute and that they fall into the weight-based ''classes'' that EPA established with Congress's explicit support.

In making the GHG Endangerment Finding in 2009, EPA defined the classes of motor vehicles and engines as ''Passenger cars, light-duty trucks, motorcycles, buses, and medium and heavy-duty trucks.'' [536] Light- and medium-duty BEVs fall within the classes of passenger cars, light-duty trucks, and medium and heavy-duty trucks. EPA did not reopen the 2009 Endangerment Finding in this rulemaking, and therefore comments on whether BEVs are part of the ''class or classes'' subject to GHG regulation are beyond the scope of this rulemaking.

Some commenters nonetheless contend that BEVs fall outside of EPA's regulatory reach under this provision because they do not cause, or contribute to, air pollution which endangers human health and welfare. That misreads the statutory text. As we explained above in regard to ABT, section 202(a)(1)'s focus on regulating emissions from ''class or classes'' indicates that Congress was concerned by the air pollution problem generated by a class of vehicles, as opposed to from individual vehicles. Accordingly, Congress authorized EPA to regulate *classes* of vehicles, and EPA has concluded that the *classes* of passenger cars, light-duty trucks, and medium and heavy-duty trucks, cause or contribute to dangerous pollution. As noted, the *classes* of these vehicles include BEVs,

[529] 136 Cong. Rec. 35,367, 1990 WL 1222469, at *1.

[530] 136 Cong. Rec. 35,367, 1990 WL 1222469 at *1; *see also* 136 Cong. Rec. 36,713, 1990 WL 1222468 at *1.

[531] As we explain in Section V.B of the preamble, EPA finds that the standards are feasible and appropriate even in the absence of trading. Thus, trading is an optional compliance flexibility for this rule and severable from the standards.

[532] While we specifically address section 202(a)(1)–(2) in this response regarding ABT and the following response regarding BEVs as part of the regulated class, the same arguments apply to standards under section 202(a)(3)(A)(i), which are also promulgated pursuant to section 202(a)(1), address standards for ''classes'' (or ''categories'') of vehicles and require EPA to consider feasibility, costs, and lead-time.

[533] Beyond the statute's general provisions regarding cost and lead time, Congress has also repeatedly endorsed the specific concept of phase-in of advanced emissions control technologies throughout section 202, which is analogous to ABT in that it considers a manufacturer's production volume and the performance of vehicles across the fleet in determining compliance. See discussion above citing provisions including 202(g)–(j), 202(b)(1)(C).

[534] CAA section 216(2).

[535] CAA section 216(a)(3)(A)(ii). This section applies to standards established under section 202(a)(3), not to standards otherwise established under section 202(a)(1). But it nonetheless provides guidance on what kinds of classifications and categorizations Congress thought were appropriate.

[536] 74 FR 66496, 66537 (Dec. 15, 2009).

along with ICE and hybrid vehicles. And EPA has consistently viewed passenger cars, light-duty trucks, and medium and heavy-duty trucks as classes of motor vehicles for regulatory purposes, including in our prior GHG rules. As discussed in section III.B.1 of the preamble, in designing its emissions standards, EPA has reasonably further subcategorized vehicles within the class based on weight and functionality to recognize real-world variations in emission control technology, ensure consumer access to a wide variety of vehicles to meet their mobility needs, and secure continued emissions reductions for all vehicle types.

These commenters also misunderstand the broader statutory scheme. Congress directed EPA to apply the standards to vehicles whether they are designed as complete systems or incorporate devices to prevent or control pollution. Thus, Congress understood that the standards may be premised on and lead to technologies that prevent pollution in the first place. It would be perverse to conclude that in a scheme intended to control the emissions of dangerous pollution, Congress would have prohibited EPA from premising its standards on controls that completely prevent pollution, while also permitting the agency to premise them on a technology that reduces 99 percent of pollution. Such a nonsensical reading of the statute would mean that the availability of technology that can reduce 99 percent of pollution could serve as the basis for highly protective standards, while the availability of a technology that completely prevents the pollution could not be relied on to set emission standards at all. Such a reading would also create a perverse safe harbor allowing polluting vehicles to be perpetually produced, resulting in harmful emissions and adverse impacts on public health, even where available technology permits the complete prevention of such emissions and adverse impacts at a reasonable cost. That result cannot be squared with section 202(a)(1)'s purpose to reduce emissions that ''cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare,'' [537] or with the statutory directive to not only ''control'' but also ''prevent'' pollution.

Commenters' suggestion that EPA define the class to exclude BEVs would also be unreasonable and unworkable. *Ex ante,* EPA does not know which vehicles a manufacturer may produce and, without technological controls including add-on devices and complete systems, *all* of the vehicles have the potential to emit dangerous pollution.[538] Therefore, EPA establishes standards for the entire class of vehicles, based upon its consideration of all available technologies. It is only after the manufacturers have applied those technologies to vehicles in actual production that the pollution is prevented or controlled. To put it differently, even hypothetically assuming EPA could not set standards for vehicles that manufacturers intend to build as electric vehicles—a proposition which we do not agree with—EPA could still regulate vehicles manufacturers intend *not* to build as electric vehicles and that would emit dangerous pollution in the absence of EPA regulation.[539] When regulating those vehicles, Congress explicitly authorized EPA to premise its standards for those vehicles on a ''complete system'' technology that prevents pollution entirely, like BEV technologies.

Finally, the commenters' argument is factually flawed. All vehicles, including BEVs, do in fact produce vehicle emissions. For example, all BEVs produce emissions from brake and tire wear, as discussed in RIA Chapter 7.2.1.4. Furthermore, BEVs have air conditioning units, which may produce GHG emissions from leakages, and these emissions are subject to regulation under the Act, for instance, as described in section III.C.5 of the preamble. Indeed, EPA has consistently regulated GHG emissions from LD vehicle refrigerants since 2010 through A/C credits. Thus, even under the commenter's reading of the statute, BEVs would be part of the class for regulation.[540] We further address this issue in RTC section 2, where we also discuss the related contention that BEVs cannot be part of the same class because electric and ICE powertrains are fundamentally different.

C. GHG Standards for Model Years 2027 and Later

1. Overview

This section III.C of this preamble provides details regarding EPA's GHG standards and related program provisions under this rulemaking.

For light-duty vehicles, EPA is finalizing standards that land at the same footprint target CO_2 levels as our proposal in MY 2032 but have a more linear ramp rate of standards stringency from MYs 2027–2032 (via slower increases in stringency in the earlier years). Specifically, the final standards are consistent with the proposal's Alternative 3 footprint standards curves. The final standards also include extensions of the phase-down for off-cycle credits and air conditioning leakage credits, which provide further flexibility for manufacturers to meet the standards, especially in earlier years of the program. The final standards were developed in response to public comments, including those from the auto industry and labor groups which expressed concern that the proposed standards were challenging especially in the early years of the program. For example, many automakers expressed concern that more lead time was necessary in MYs 2027–2029 to allow for the necessary scale up of battery supply chains and PEV manufacturing. The changes from the proposal address this concern by providing significant additional lead time. Section III.C.2 of this preamble provides details regarding the structure and level of the light-duty vehicle standards.

For medium-duty vehicles, EPA is finalizing work factor-based GHG standards that land at the same stringency as the proposal in MY 2032, but which have a more gradual rate of stringency increase from MYs 2027–2031 than the proposed standards in order to provide additional lead time for compliance. EPA is also phasing in a work factor upper cutpoint at or above 5,500 lb work factor, coinciding with the removal of the proposed 22,000 lb maximum GCWR cap used in the calculation of the work factor. These changes are responsive to concerns from manufacturers over inadequate lead time and comments addressing the targets for the higher capability vehicles. Section III.C.3 of this preamble provides

[537] *See also Coal. for Responsible Regulation,* 684 F. 3d at 122 (explaining that the statutory purpose is to *prevent reasonably anticipated endangerment from maturing into concrete harm*).

[538] As noted above, manufacturers in some cases choose to offer different models of the same vehicle with different levels of electrification. And it is the manufacturer who decides whether a given vehicle will be manufactured to produce no emissions, low emissions, or higher emissions controlled by add-on technology.

[539] In other words, the additional BEVs EPA projecs in the modeled central case analysis exist in the baseline case as pollutant-emitting vehicles with ICE. We further note that it would be odd for EPA to have authority to regulate a given class of motor vehicles so long as those vehicles emit air pollution at the tailpipe, but to lose its authority to regulate those very same vehicles should they install emission control devices to limit such pollution or be designed to prevent the endangering polution in the first place.

[540] Moreover, as already explained, manufacturers do not have to produce any additional BEVs to comply with the final standards. EPA's modeling of the alternate compliance pathway in Section IV of the preamble demonstrates that manufacturers could meet the standard using solely advanced technologies with ICEs.

details regarding EPA's GHG standards for MDVs.

For light-duty vehicles, the final standards will further reduce the fleet average GHG emissions target levels by nearly 50 percent from the MY 2026 standards. For MDVs, the standards represent a reduction of 44 percent compared to the current MY 2026 standards, which is the final year for Phase 2 standards applying to Class 2b and Class 3 vehicles now that we are finalizing a revised MY 2027 MDV GHG standard.

Additional GHG program provisions are discussed in sections III.C.4–III.C.9 of this preamble, including averaging, banking, and trading, air conditioning system requirements, phase out of off-cycle credits, treatment of PEVs and FCEVs in the GHG fleet average, and interim alternative standards for small volume manufacturers.

While the final standards are more stringent than the prior standards, EPA applied numerous conservative approaches throughout our analysis (as identified in sections III and IV of this preamble and throughout the RIA) and the final standards additionally are less stringent than those proposed during the first several years of implementation leading to MY 2032. The Administrator concludes that this approach is appropriate based on his evaluation of the record and within the discretion provided under and consistent with the text and purpose of CAA section 202(a)(1)–(2).

2. Light-Duty Vehicle GHG Standards

i. Structure of the Light-Duty Vehicle CO_2 Standards

Since MY 2012, EPA has adopted attribute-based standards for passenger cars and light trucks. The CAA has no requirement to promulgate attribute-based standards, though in past rules EPA has relied on both universal and attribute-based standards (*e.g.,* for nonroad engines, EPA uses the attribute of horsepower). However, given the advantages of using attribute-based standards,[541] from MY 2012 onward EPA has adopted and maintained vehicle footprint as the attribute for the GHG standards. Footprint is defined as a vehicle's wheelbase multiplied by its track width—in other words, the area enclosed by the points at which the wheels meet the ground.

EPA has implemented footprint-based standards since MY 2012 by establishing two kinds of standards—fleet average standards determined by a manufacturer's fleet makeup, and in-use standards that will apply to the individual vehicles that make up the manufacturer's fleet. Under the footprint-based standards, each manufacturer has a CO_2 emissions performance target unique to its fleet, depending on the footprints of the vehicles produced by that manufacturer. While a manufacturer's fleet average standard could be estimated before and throughout the model year based on projected production volume of its vehicle fleet, the fleet average standard to which the manufacturer must comply is based on its final model year production figures. Each vehicle in the fleet has a compliance value which is used to calculate both the in-use standard applicable to that vehicle and the fleet average emissions. A manufacturer's calculation of fleet average emissions at the end of the model year will thus be based on the production-weighted average emissions of each vehicle in its fleet. EPA did not reopen the footprint-based structure for the standards.

Each manufacturer has separate footprint-based standards for cars and for trucks. EPA did not reopen the provision for separate standard curves for cars and trucks. EPA also did not reopen the existing regulatory definitions of passenger cars and light trucks; we will continue to reference the NHTSA regulatory class definitions as EPA has done since the inception of the GHG program.

ii. How did EPA determine the slopes and relative stringencies of the car and truck footprint standards curves?

In the proposal, EPA requested comment on its methodology for establishing the slopes for the car and truck curves. As discussed further below, upon evaluating the comments, EPA is finalizing our proposed approach of establishing the car and truck footprint curve slopes, as well as the offset between the car and truck footprint standards curves.

In the NPRM, we discussed a methodology for determining the shape of the footprint-based curves for cars and for trucks (a more detailed description of the truck curve as it relates to the car curve, and a discussion of the empirical and modeling data used in developing these offsets is presented in RIA Chapter 1.1.3.2). In general, the slopes of the car and truck curve were reduced for the proposed standards and the alternatives along with a decreased offset between the car and truck curves. We proposed these changes based on our evaluation of updated data, finding that reduced slopes were consistent with manufacturers' increased adoption of more advanced emissions control technologies to meet more stringent standards, as well as our policy goal that manufacturers comply with the emissions standards by adopting advanced emission control technologies as contemplated by the statute, as opposed to engaging in intentional upsizing or downsizing of their fleets.

EPA received a range of comments on the proposed slopes of the car and truck curves.[542] Some individual auto manufacturers directionally supported EPA's rationale for the derivation of the curves and slopes. While noting that the proposed approach was a significant change from prior rulemakings, the Alliance for Automotive Innovation did not object to EPA's methodology. Some commenters (such as ICCT) preferred a single curve approach, which would essentially eliminate separate regulatory classes for cars vs. trucks (an issue that EPA did not reopen in the proposal[543]) but believed that the proposed approach of deriving the truck curve from the car curve was generally sound.

In its comments, NADA expressed opposition to EPA's consideration of electric vehicles in the derivation of the flatter footprint curve slopes. In contrast, many commenters recommended flattening the curves or setting a flat (zero slope) curve for both cars and trucks. ICCT suggested that EPA should establish an even flatter and ''neutral'' slope that does not incentivize upsizing. As we explain further below, the proposal and our final decision to flatten the footprint curves is not dependent on any manufacturer adopting BEVs or any other electric vehicle technologies. Rather, vehicles with more advanced control technologies of any kind to meet more stringent emission standards will inherently show less sensitivity of CO_2 emissions to footprint. The more effective the vehicle is at controlling emissions, the less sensitivity its emissions will have to footprint, with vehicles that produce no tailpipe emissions having no sensitivity to footprint. Conversely, retaining the existing curve slopes in light of more advanced control technologies would provide a significant perverse incentive for manufacturers to adopt upsizing—as opposed to more effective emissions control technologies—as a compliance strategy.

Comments related to the magnitude of the truck offset were also mixed. The

[541] *See* 75 FR 25324, 25354–25355 (May 7, 2010).

[542] *See* Section 3.2.1 of the RTC.

[543] Further discussion for why EPA is maintaining separate car and truck curves was provided in a Memo to Docket, ID No. EPA–HQ–OAR–2022–0829 titled ''Fleet and Vehicle Attribute Analysis for the Development of Standard Curves.''

truck offset consists of two separate offsets: one for all-wheel drive (AWD), and one for the additional utility associated with towing and hauling capabilities. The truck offset recognizes that these characteristics tend to increase emissions while also providing additional mobility and utility benefits for the consumer. EPA received only a few comments on the AWD offset, which were generally supportive although some commenters requested that the offset be scaled down based on the proportion of AWD vehicles in the light truck fleet.[544] We also received varied feedback on EPA's assumptions used to calculate the utility-based offset in the derivation of the truck slope. Some commenters suggested the utility offset should be increased as they believed tow rates are higher than EPA's assumptions. Other commenters suggested the offset should be reduced as they believed actual in-use towing rates are lower than EPA's assumptions; these commenters also believed the offset should be scaling down proportionally across truck footprints.

The intent of the proposed AWD offset was to separately and explicitly account for the tailpipe CO_2 difference between otherwise identical 2WD and AWD vehicles, with the value of the offset intended to be representative of an average increase observed over current models. While commenters expressed views on EPA's assumptions for deriving the utility offset (and one OEM provided technical suggestions), they did not submit additional data to support their views. EPA's assessment is that the data used to derive the utility offset (as described in RIA Chapter 1.1.3) continues to be the best available data upon which to determine the utility offset. EPA is therefore finalizing its proposed utility offset for the truck curve. EPA believes the overall truck offset provides a difference in CO_2 targets between cars and trucks of similar footprint that appropriately accounts for differences in utility.

Taking all of these comments into consideration, and for the reasons explained above (and in the RTC), EPA considers the proposed approach for determination of the slope of the car and truck curves, appropriate. Therefore, we are finalizing the shape of the footprint curves as proposed, and as discussed in further detail below.

When setting GHG standards, EPA recognizes the current diversity and distribution of vehicles in the market and that Americans have widely varying preferences in vehicles and that GHG control technology is feasible for a wide variety of vehicles. This is one of the primary reasons for adopting attribute-based standards and is also an important consideration in choosing specific attribute-based standards (*i.e.,* the footprint curves). Over time, vehicle footprint sizes have steadily increased.[545] This has partially offset gains in fuel economy and reductions in emissions. For example, in MY 2021, average fuel economy and emissions were essentially flat (despite improvements in emissions for all classes of vehicles) because of increases in the sizes of vehicles purchased. In developing footprint curves for this rule, EPA's intent was to establish slopes that would not (of their own accord) initiate overall fleet upsizing[546] or downsizing as a compliance strategy. We have updated the slopes accordingly, recognizing that a slope too flat would incentivize overall fleet downsizing, while a slope too steep would foster upsizing. Fuller details on the analysis that was used to determine the revised slope determination is provided in RIA Chapter 1.1.3.

The slopes in the latter years of this rulemaking period are flatter than those of prior standards. This is by design and reflects a continuation of the proportional reduction in targets that has been a fundamental feature of EPA's prior footprint standards, in which as program stringency is increased year over year, the g/mile change is greater for larger footprints than for smaller footprints.[547] If this were not the case, vehicles with different footprints could be subject to inconsistent and possibly nonsensical targets as the standard curves become progressively lower. Consider that for the 2012 rule, the footprint-based curves were originally developed for a fleet that was completely made up of internal combustion engine (ICE) vehicles. From a physics perspective, a positive footprint slope for ICE vehicles makes sense because as a vehicle's size increases, its mass, road loads, and required power (and corresponding tailpipe CO_2 emissions) will increase accordingly. When emissions reducing technology is applied, such as advanced ICE, or HEV or PHEV or BEV electrification technologies, the relationship between increased footprint and tailpipe emissions is reduced. This is because the emissions measured for certification arise primarily from overcoming loads of the drive cycles,[548] and thus will scale with increases or decreases in the loads associated with changes in footprint. In other words, there is a physical rationale for why the increasing adoption of more effective emissions reducing technologies should cause the slope of the footprint curve to become flatter. Moreover, as the emissions control technology becomes increasingly more effective, the relationship between tailpipe emissions and footprint decreases proportionally; in the limiting case of vehicles with 0 g/mile tailpipe emissions such as BEVs, there is no relationship at all between tailpipe emissions and footprint.

Having discussed our rationale for the flatter slopes, we turn now to change in the truck offset. As noted above, the truck offset consists of both an AWD and a utility offset (which we consider here to include towing and hauling capability). All-wheel drive (AWD) is one of the defining features for crossover vehicles (typically, small to mid-size CUVs, *e.g.,* the Ford Escape, Chevy Equinox, Honda CR–V, etc) to be classified as light trucks,[549] and for this reason the offset in tailpipe emissions targets (*i.e.,* between the car and truck regulatory classes) for these vehicles should be appropriately set. The design differences for many crossover vehicle models that are offered in both a two-wheel drive (2WD) and an AWD version (aside from their driveline) are difficult to detect. They often have the same engine, similar curb weight (except for the additional weight of an AWD system), and similar operating features (although AWD versions might be offered at a premium trim level that is not required of the drivetrain). EPA analyzed empirical data (reference Figure 1–6 in Chapter 1.1.3 of the RIA) for models that were offered in both 2WD and AWD versions to quantify the average increase in tailpipe emissions due to addition of AWD for an otherwise identical vehicle model.

[544] Trucks over 6000 lbs. GVWR including many full-size utility vehicles and pickup trucks, do not require AWD to meet NHTSA's definition of a Light Truck. 49 CFR 523.5.

[545] The 2022 EPA Automotive Trends Report, *https://www.epa.gov/system/files/documents/2022-12/420r22029.pdf.*

[546] EPA notes that section 202(a)'s purpose is to reduce vehicular emissions through the development and application of emissions control technologies. The regulatory scheme should therefore induce manufacturer action that actually reduces pollution. By contrast, a footprint curve that permits manufacturers to achieve compliance significantly through producing larger vehicles that produce more pollution would not be appropriate.

[547] See 75 FR 25324, 25333–38 (2010 Rule discussion of footprint standards).

[548] As opposed to emissions that arise from idling or accessory losses during the certification tests.

[549] We use the term AWD to include all types of four-wheel drive systems, consistent with SAE standard J1952.

The light truck classification consists of crossovers (ranging from compact up through large crossovers), sport utility vehicles and pickup trucks. Many crossover vehicles and SUVs exhibit similar towing capability between their 2WD and AWD versions (there are some exceptions in cases where AWD is packaged with a larger more powerful engine than the base 2WD version). However, full size pickup trucks are the light-duty market segment with the most towing and hauling capability.

As proposed, EPA is finalizing that the truck curve be based on the car curve (to represent the base utility across all vehicles for carrying people and their light cargo), but with the additional allowance of increased utility (including AWD) that distinguishes these vehicles used for more work-like activity. EPA determined a relationship between gross combined weight rating (GCWR) (which combines the cumulative utility for hauling and towing to a vehicle's curb weight) and required engine torque. EPA then used its ALPHA model to predict how the tailpipe emissions at equivalent test weight (ETW) (curb weight + 300 pounds) would increase as a function of increased utility (GCWR) based on required engine torque and assumed modest increases in vehicle weight and road loads commensurate with a more tow-capable vehicle.

EPA also assessed the relative magnitude of tow rating across the light truck fleet as a function of footprint. Vehicles with the greatest utility are full size pickup trucks, while light trucks with the least utility tend to be the smaller crossovers, with an increased tow or haul rating near zero. As a result, EPA is finalizing an offset for the truck curve, compared to the car curve, that increases with footprint. That is, as the footprint of the truck increases, we expect that on average its utility would increase proportionally, and therefore the truck curve has a steeper slope than the car curve. Figure 1–9 in RIA Chapter 1 shows the general trend of increased tow rating with increasing footprint. Put more simply, bigger trucks generally have more utility than smaller trucks, so bigger trucks get a bigger utility offset.

In summary, the truck curve is, mathematically, the sum of the scaled AWD and utility-based offsets to the car curve. A more thorough description of the truck curve as it relates to the car curve, and a discussion of the empirical and modeling data used in developing these offsets is presented in RIA Chapter 1.1.3.2.

iii. How did EPA determine the cutpoints for the footprint standards curves?

The cutpoints are defined as the footprint boundaries (low and high) within which the sloped portion of the footprint curve resides. Above the high, and below the low, cutpoints, the curves are flat. The rationale for the setting of the original cutpoints for the MYs 2017–2025 standards was based on analysis of the distribution of vehicle footprint for the 2008 fleet and is discussed in the 2012 proposal [550] and the Technical Support Document (TSD).[551]

EPA is finalizing, as proposed, an increase to the lower cutpoint for the car curve by 1 square foot per year from MY 2027 through MY 2030 from 41 to 45 square feet. This will provide relatively slightly less stringent targets for the smallest vehicles (compared to the structure of the MY 2023–2026 footprint targets), which we believe is important so as not to disincentivize manufacturers from offering these smallest vehicles which are among the cleanest vehicles. EPA received only supportive comments for the increase of the car lower cutpoint; one commenter requested this change to be immediate. The upper cutpoint for cars (56 feet) will remain unchanged.

EPA also is finalizing, as proposed, a change in the upper cutpoint for trucks. This cutpoint is 74 square feet for the MYs 2023–2026 standards, and under this final rule will decrease by 1.0 square foot per year from MYs 2027 through MY 2030, to a level of 70.0 square feet for MY 2030 and later. EPA is making this change in upper truck cutpoint to ensure no loss of emissions reductions in the future through continued upsizing of the truck fleet. EPA reviewed sales data from recent model years comparing the average footprint of full-size pickup trucks with the upper truck cutpoint. As the upper cutpoint for trucks increased (under past rules) from 66.0 square feet in MY 2016 to 69.0 square feet in MYs 2020–2021, we have observed the average footprint of full-size pickup trucks increasing similarly. The truck size trend and its relationship to the upper cutpoint is detailed in RIA Chapter 1.1.3.4. Because we have observed the trend of trucks upsizing up to the cutpoint, our goal is to bring the upper cutpoint back down to a level that represents a balance between setting an appropriate CO_2 emissions target recognizing the utility of the largest trucks, while at the same time preventing the potential loss in emissions reductions that could result from truck upsizing.

We consider the MY 2030 and beyond upper truck cutpoint of 70.0 square feet to be appropriate. EPA's assessment is that it is feasible for trucks greater than 70.0 square feet to meet the CO_2 targets of the footprint curves at 70.0 square feet (*i.e.,* the upper flat part of the footprint curve). This cutpoint of 70.0 square feet is consistent with the sales-weighted average footprint of current full-size pickups.

Some automakers were opposed to the reduction in the upper cutpoint for the truck footprint curve, although several NGOs supported the change in helping to counter the observed trend in upsizing and the associated increase in emissions. EPA agrees that a reduction in the cutpoint (more accurately, returning it close to the current level) should help mitigate the incentive for continued upsizing as a compliance mechanism. EPA notes that the final cutpoint value does not prevent any manufacturer from producing vehicles that have a larger footprint to satisfy customer demand. Rather, it simply ensures that the standards themselves do not incentivize manufacturers to upsize vehicles larger than the upper cutpoint as a compliance strategy. Moreover, as with any CO_2 target along the footprint standards curves, the CO_2 target level that is defined by the upper cutpoint does not necessarily need to be met by the individual vehicles with footprints above that cutpoint.

Based on the review of the comments related to cutpoints for car and truck curves, EPA is finalizing as proposed the changes to the lower car cutpoint and the upper truck cutpoint. We are implementing the revised cutpoints in a gradual manner over four years to allow manufacturers time to adjust to changes in the relative stringency of CO_2 target levels for vehicles with footprints impacted by the changes in cutpoints.

iv. What are the light-duty vehicle CO_2 standards?

a. What CO_2 footprint standards curves is EPA establishing?

EPA is setting separate car and light truck standards—that is, vehicles defined as passenger vehicles (''cars'') have one set of footprint-based standards curves, and vehicles defined as light trucks have a different set.[552] In general, for a given footprint, the CO_2 g/

[550] See Section II.C.6 of the preamble.

[551] 2017–2025 TSD.

[552] See 49 CFR part 523. Gernally, passenger cars include cars and smaller crossovers and SUVs, while the truck category includes larger corssovers and SUVs, minivans, and pickup trucks.

mile target[553] for trucks is higher than the target for a car with the same footprint. The curves are described mathematically in EPA's regulations by a family of piecewise linear functions (with respect to vehicle footprint) that gradually and continually ramp down from the MY 2026 curves established in the 2021 rule. EPA's minimum and maximum footprint targets and the corresponding cutpoints are provided for cars and trucks, respectively, in Table 17 and Table 18 for MYs 2027–2032 along with the slope and intercept defining the linear function for footprints falling between the minimum and maximum footprint values. For footprints falling between the minimum and maximum, the targets are calculated as follows: Slope × Footprint + Intercept = Target.

TABLE 17—FOOTPRINT-BASED STANDARD CURVE COEFFICIENTS FOR CARS: FINAL STANDARDS

	2027	2028	2029	2030	2031	2032
MIN CO_2 (g/mile)	135.9	123.8	110.6	98.2	85.3	71.8
MAX CO_2 (g/mile)	145.2	131.6	117.0	103.4	89.8	75.6
Slope (g/mile/ft2)	0.66	0.60	0.54	0.47	0.41	0.35
Intercept (g/mile)	108.0	97.9	87.0	76.9	66.8	56.2
MIN footprint (ft2)	42	43	44	45	45	45
MAX footprint (ft2)	56	56	56	56	56	56

TABLE 18—FOOTPRINT-BASED STANDARD CURVE COEFFICIENTS FOR LIGHT TRUCKS: FINAL STANDARDS

	2027	2028	2029	2030	2031	2032
MIN CO_2 (g/mile)	150.3	136.8	122.7	108.8	91.8	75.7
MAX CO_2 (g/mile)	239.9	211.7	184.0	158.3	133.5	110.1
Slope (g/mile/ft2)	2.89	2.58	2.27	1.98	1.67	1.38
Intercept (g/mile)	28.9	25.8	22.7	19.8	16.7	13.8
MIN footprint (ft2)	42	43	44	45	45	45
MAX footprint (ft2)	73.0	72.0	71.0	70.0	70.0	70.0

Figure 7 and Figure 8 show the finalized car and truck curves, respectively, for MY 2027 through MY 2032. Included for reference is the current MY 2026 (No Action) curve for each.[554]

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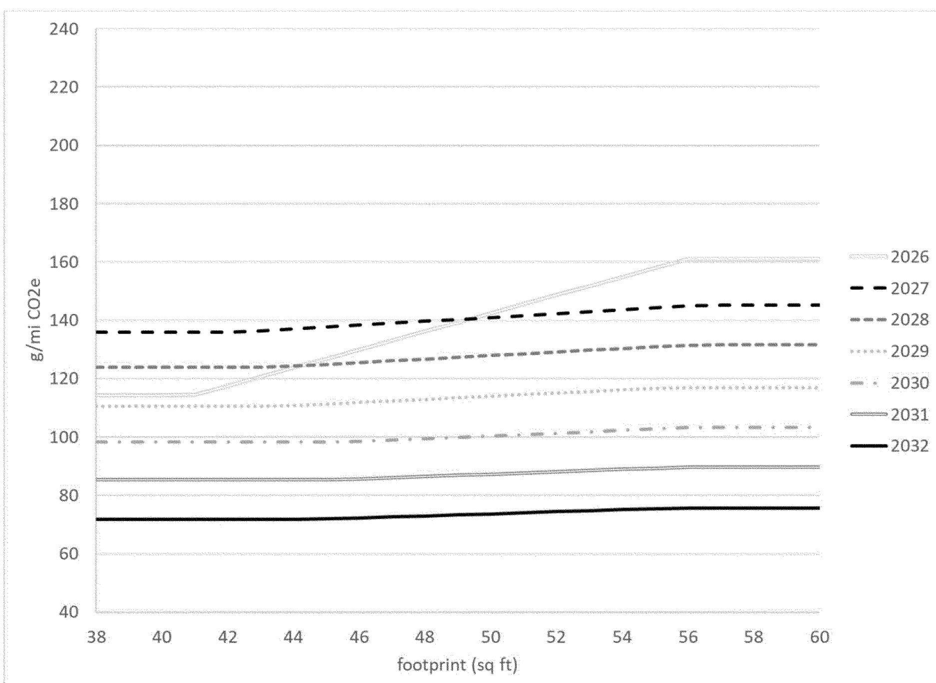

Figure 7: Final Standards for Cars, MY 2027–2032

[553] Because compliance is based on a sales-weighting of the full range of vehicles in a manufacturer's car and truck fleets, the footprint-based CO_2 emission levels of specific vehicles within the fleet are referred to as targets, rather than standards.

[554] We have removed the 2026 adjusted curve that was included in Figure 8 and 9 from the NPRM. It was intended to show the effect of removal of flexibilities in the proposed standards between 2026 and 2027. With the more gradual phase-out of flexibilities in the final and alternative standards, we now present fleet average adjusted target values in section III.F of this preamble.

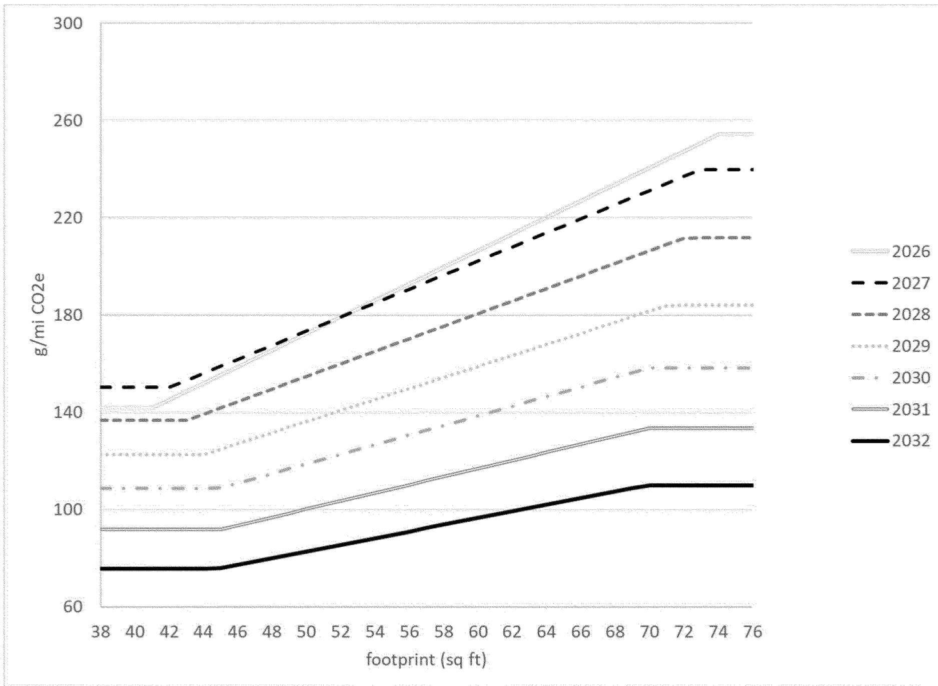

Figure 8: Final Standards for Trucks, MY 2027–2032

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As discussed in section III.C.2.ii of the preamble, the slope of the car curve is significantly flatter in 2027 and continues to flatten progressively each year through 2032. The truck curve, largely driven by the allowance for towing utility, has a similar shape as in past rulemakings although its slope also flattens progressively each year from 2027 through 2032.

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

EPA is finalizing more stringent standards for MYs 2027–2032 that are projected to result in an industry-wide average target for the light-duty fleet of 85 g/mile of CO_2 in MY 2032. The projected average annual decrease in combined industry average targets from the current standards in MY 2026 to the new standards in MY 2032 is nearly 11 percent per year. Compared to past GHG rulemakings, the annual percentage reductions are higher. These reductions are justified by our feasibility assessment, which we discuss briefly below and at length in section IV of this preamble.

Since the first GHG rule in 2010, EPA's feasibility assessments have consistently considered the full range of technologies available to reduce GHG emissions.[555] The range of technologies that were available even in 2010 to reduce GHG emissions was quite wide—from low rolling resistance tires, low friction lubricants and improved electrical accessories, to new and improved transmission technologies (including turbo/downsizing, gasoline direct injection and dual clutch transmissions), to stop-start, hybrid and electric vehicles. Since then, there have been significant advancements in further developing and deploying technologies to reduce GHGs. Manufacturers have augmented GHG reductions from advanced gasoline engines with more use of electrification, including more hybrids, more PHEVs and more BEVs. Greater use of electrification technology (including the increasing feasibility of PHEVs and BEVs) has changed the magnitude of the emissions reductions that will be achievable during the timeframe of this rulemaking compared to prior rules. These market changes are already occuring, and we expect the trend toward greater electrification to continue. The combination of economic incentives provided in the IRA and the auto manufacturers' stated plans for producing significant volumes of zero and near-zero emission vehicles in the timeframe of this rule supports EPA's ability to finalize standards at a level of stringency greater than was feasible in past rules. While tailpipe emissions controls for criteria pollutants from ICE-based vehicles can have effectiveness values greater than 90 percent under certain circumstances, electrification provides 100 percent effectiveness under all operating and environmental conditions. This is nearly two orders of magnitude more effective than the historical improvements in GHG emission reductions.

As in our past GHG rules, EPA has analyzed the feasibility of achieving the final CO_2 standards, accounting for projections of available technology to reduce emissions of CO_2, the projected penetration of such technologies, the normal redesign process for cars and trucks, and the effectiveness and costs of such technology. The results of these analyses are discussed in detail in section IV of this preamble and in Chapter 12 of the RIA. EPA notes that the technologies needed for compliance with these standards have already been developed and deployed in the on-road fleet in a wide variety of vehicle types. Moreover, although EPA has done extensive modeling to support its conclusion that the standards are feasible taking into account the cost of the technology and the available lead time, EPA notes that its primary compliance path modeling simply represents one possible approach the industry could take in achieving compliance with the standards at a reasonable cost, and that even within that modeling EPA anticipates different manufacturers will adopt different compliance strategies. EPA has also modeled a number of other potential compliance paths for manufacturers, reflecting potential differences in strategies, costs, consumer acceptance of BEVs, higher battery costs, etc. The standards are performance-based and do

[555] See e.g., 75 FR 25324, 25448–25450 (May 7, 2010), 77 FR 62624, 62846–62852; see also Draft TAR.

not dictate any particular compliance strategy for manufacturers. EPA also presents the overall estimated costs and benefits of the final car and truck CO_2 standards in section VIII of this preamble.

The derivation of the 85 g/mile estimated industry-wide target for MY 2032 noted in the previous paragraph is based on EPA's updated fleet mix projections for MY 2032 (approximately 30 percent cars and 70 percent trucks, based on AEO 2023), and is described further in section IV.D of this preamble. EPA aggregated the estimates for individual manufacturers based on projected production volumes into the fleet-wide averages for cars, trucks, and the entire fleet.[556] As is the nature of attribute-based standards, the final fleet average standards for each manufacturer ultimately will depend on each manufacturer's actual rather than projected production in each MY from MY 2027 to MY 2032 under the sales-weighted footprint-based standard curves for the car and truck regulatory classes.

Table 19 shows the overall fleet average target levels for both cars and light trucks that are projected for the final standards. A more detailed breakdown of how each manufacturer could potentially choose to achieve the projected CO_2 targets and achieved levels is provided in RIA Chapter 12. The actual fleet-wide average g/mile level that will be achieved in any year for cars and trucks will depend on the actual production of vehicles for that year, as well as the use of the various optional credit and averaging, banking, and trading provisions. For example, in any year, manufacturers will be able to generate credits from cars and use them for compliance with the truck standard, or vice versa. In RIA Chapter 8.6, EPA discusses the year-by-year estimate of GHG emissions reductions that are projected to be achieved by the final standards.

EPA has estimated the overall fleet-wide CO_2 emission levels that correspond with the attribute-based footprint standards, based on projections of the composition of each manufacturer's fleet in each year of the program. As shown in Table 19, for passenger cars, the MY 2032 standards are projected to result in CO_2 fleet-average levels of 72 g/mile in MY 2032, which is 53 percent lower than that of the MY 2026 standards. For trucks, the projected MY 2032 fleet average CO_2 target is 90 g/mile which is 54 percent lower than that of the MY 2026 standards. The projected MY 2032 combined fleet target of 85 g/mile is 49 percent lower than that of the MY 2026 standards.

TABLE 19—PROJECTED FLEET-WIDE CO_2 TARGETS CORRESPONDING TO THE FINAL STANDARDS [a] [b]

Model year	Cars CO_2 (g/mile)	Trucks CO_2 (g/mile)	Total fleet CO_2 (g/mile)
2026	131	184	168
2027	139	184	170
2028	125	165	153
2029	112	146	136
2030	99	128	119
2031	86	109	102
2032 and later	73	90	85

[a] MY 2026 targets are provided for reference. This table does not reflect changes in credit flexibilities such as the phase-out of available off-cycle and A/C credits as finalized for MY 2027.
[b] Fleet CO_2 targets are calculated based on projected car and truck share. Truck share for the fleet is expected to increase to 69 percent by MY 2026 (up from 64 percent in MY 2022) and to 70 percent by MY 2030 and later.

EPA is finalizing standards that set increasingly stringent levels of CO_2 emissions control from MY 2027 through MY 2032. Applying the CO_2 footprint curves applicable in each MY to the vehicles (and their footprint distributions) expected to be sold in each MY produces progressively lower levels of fleetwide CO_2 emissions. EPA believes manufacturers can achieve the standards' important CO_2 emissions reductions through the application of available control technology at reasonable cost, as well as the use of program averaging, credit banking and trading, and optional off-cycle credits, air conditioning leakage credits, and air conditioning efficiency credits, as available.

One important change between the proposed standards and the final standards is related to the phaseout of two optional credit flexibilities: off-cycle credits and A/C leakage credits. As discussed in section III.C.5–6 of this preamble, EPA is finalizing a phase-down of A/C refrigerant-based credits from MY 2027–2030, and thereafter (for MY 2031 and beyond), we are retaining a small optional A/C leakage credit. EPA is finalizing a phase-out of the off-cycle credits which is slower than what we proposed. EPA also is finalizing its proposal to eliminate off-cycle credits and A/C efficiency credits for BEVs beginning in MY 2027.[557] Table 20 shows the total off-cycle and A/C credits available to manufacturers under the final standards and Table 21 shows available credits under the No Action case. These tables represent the maximum credits attainable in each category. Credits marked with an asterisk in Table 20 are not eligible for BEVs starting in MY 2027.

TABLE 20—TOTAL AVAILABLE CREDITS TO MANUFACTURERS, FINAL STANDARDS, EXPRESSED IN CO_2 g/mile
[*Not eligible for BEVs starting in MY 2027]

MY	Off-cycle*	A/C efficiency*		A/C leakage		Total possible			
	Fleet	Car	Truck	Car	Truck	Car (ICE)	Car (BEV)	Truck (ICE)	Truck (BEV)
2026	15.0	5.0	7.2	13.8	17.2	33.8	33.8	39.4	39.4

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

[557] As explained below in Sections III.C.5 and III.C.6 of the preamble, these credits were intended to incentivize efficiency gains that reduce emissions produced by an ICE and the value of such credits was based on the amount of ICE emissions. Because BEVs do not produce any engine emissions, such credits are not necessary or appropriate.

TABLE 20—TOTAL AVAILABLE CREDITS TO MANUFACTURERS, FINAL STANDARDS, EXPRESSED IN CO_2 g/mile—Continued

[*Not eligible for BEVs starting in MY 2027]

MY	Off-cycle*	A/C efficiency*		A/C leakage		Total possible			
	Fleet	Car	Truck	Car	Truck	Car (ICE)	Car (BEV)	Truck (ICE)	Truck (BEV)
2027	10.0	5.0	7.2	11.0	13.8	26.0	11.0	31.0	13.8
2028	10.0	5.0	7.2	8.3	10.3	23.3	8.3	27.5	10.3
2029	10.0	5.0	7.2	5.5	6.9	20.5	5.5	24.1	6.9
2030	10.0	5.0	7.2	2.8	3.4	17.8	2.8	20.6	3.4
2031	8.0	5.0	7.2	1.6	2.0	14.6	1.6	17.2	2.0
2032	6.0	5.0	7.2	1.6	2.0	12.6	1.6	15.2	2.0
2033	0.0	5.0	7.2	1.6	2.0	6.6	1.6	9.2	2.0

TABLE 21—TOTAL AVAILABLE CREDITS FOR MANUFACTURERS, NO ACTION CASE, EXPRESSED IN CO_2 g/mile

MY	Off-cycle	A/C efficiency		A/C leakage		Total possible	
	Fleet	Car	Truck	Car	Truck	Car	Truck
2026	15.0	5.0	7.2	13.8	17.2	33.8	39.4
2027	10.0	5.0	7.2	13.8	17.2	28.8	34.4
2028	10.0	5.0	7.2	13.8	17.2	28.8	34.4
2029	10.0	5.0	7.2	13.8	17.2	28.8	34.4
2030	10.0	5.0	7.2	13.8	17.2	28.8	34.4
2031	10.0	5.0	7.2	13.8	17.2	28.8	34.4
2032	10.0	5.0	7.2	13.8	17.2	28.8	34.4
2033	10.0	5.0	7.2	13.8	17.2	28.8	34.4

As with prior rulemakings, our consideration of the level of the standards is based in part on EPA's projection of average industry-wide CO_2-equivalent emission reductions from A/C and off-cycle improvements. This approach results in footprint curves that are numerically lower than they would otherwise be without consideration of these improvements. As described above, the final standards and No Action case have different provisions for the allowable A/C and off-cycle credits. In order to compare the stringencies of these two different policy cases on an equivalent basis, we show adjusted targets that are calculated by adding projected credits to the unadjusted targets. Figure 9 shows these adjusted industry-average CO_2 targets for the final standards and the No Action Case through MY 2032, compared to the unadjusted targets.

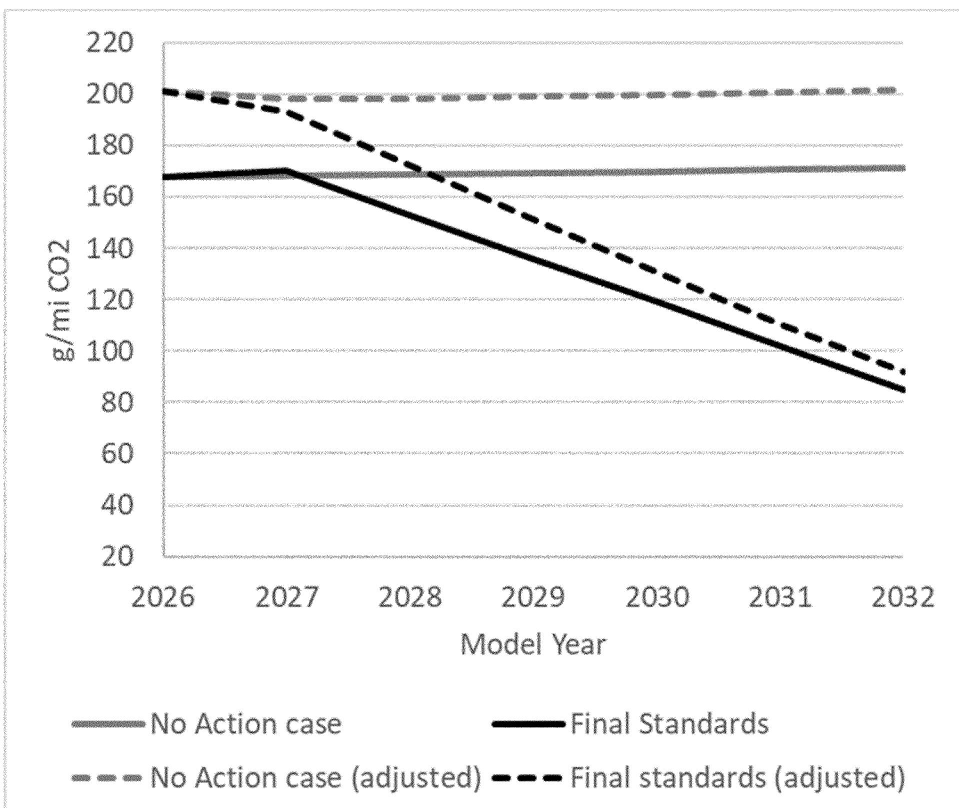

Figure 9: Projected Industry Average Targets Under the Final 2027–2032 Standards Compared to the Current MY 2026 Standards. Adjusted Targets Include Effects of Projected Off-Cycle, A/C Efficiency and A/C Leakage Credits

Table 22 shows the adjusted targets for cars and trucks based on our modeling of the final standards.

TABLE 22—PROJECTED ADJUSTED FLEET-WIDE CO_2 TARGETS CORRESPONDING TO THE FINAL STANDARDS

Model year	Cars CO_2 (g/mile)	Trucks CO_2 (g/mile)	Total fleet CO_2 (g/mile)
2026	161	220	201
2027	158	209	193
2028	142	186	172
2029	125	163	151
2030	108	141	131
2031	93	118	111
2032 and later	78	98	92

In general, the structure of the final standards allows an incremental phase-in to the MY 2032 level and reflects consideration of the appropriate lead time for manufacturers to take actions necessary to meet the standards. The technical feasibility of the standards is discussed in section IV.A of this preamble and in the RIA Chapter 3.6. Note that MY 2032 is the final MY in which the CO_2 standards would become more stringent. The MY 2032 standards will remain in place for later MYs, unless and until revised by EPA in a future rulemaking.

c. Timeframe of the Standards and Alternate Pathway Concepts

In the NPRM, EPA requested comment on two additional issues regarding the structure of the program: (1) whether the timeframe for the standards should extend beyond MY 2032, and (2) whether there is merit to considering alternative pathways for compliance with the EPA program. This section discusses EPA's consideration of the public comments received on these two topics.

EPA requested comment on whether the trajectory (*i.e.,* the levels of year-over-year stringency rates) of the standards for MYs 2027 through 2032 should be extended through MYs 2033, 2034 or 2035, or whether EPA should consider additional approaches to the trajectory of any standards that were to continue increasing in stringency beyond MY 2032.

A few commenters supported setting standards through MY 2035 as part of this rulemaking. These commenters believed standards through 2035 would set a clear market signal that would provide certainty to manufacturers in their long-term emissions reduction targets. Such commenters also believed that EPA should set standards that achieve zero emissions by 2035 and pointed to consistency with the ACC II program which has been adopted by California and several other states.

Other commenters believed that EPA ultimately should set standards beyond MY 2032, but that it should be done as part of a separate future rulemaking effort. Some commenters believed that EPA should not set standards through MY 2035 as part of this rule, but it was important to them that the final standards are sufficiently stringent through MY 2032 to ensure that the U.S. is on track to reach a zero emissions target by 2035.

Most commenters did not support extending standards beyond MY 2032 at this time. Many of these commenters pointed to the lack of certainty in how the EV market and supporting conditions (like infrastructure) will develop beyond MY 2032. Other commenters suggested that if standards were extended beyond MY 2032, that some form of a mid-course review might be necessary given what they perceived as significant uncertainty in that longer time frame. Other commenters believed that EPA's standards through MY 2032 were important in establishing a trajectory of emission reductions upon which EPA could come back with a future rule to establish appropriate standards for MYs 2033 and beyond. EPA understands commenters' concerns about uncertainty out to the MY 2035 timeframe, and believes it is appropriate to consider standards for MY 2033 and beyond in a future rulemaking. Thus, after considering all of these comments, EPA is finalizing standards for MYs 2027 through MY 2032 for both light-duty and medium-duty vehicles.

While EPA believes the standards are appropriate for light-duty vehicle manufacturers on an overall industry basis, we recognize that some companies today only sell BEVs and others have made public announcements for plans for various advanced technologies, including near-zero and zero-emission vehicle product launches (as discussed in section I.A.2.ii of this preamble) that may lead to CO_2 emissions even lower than those projected under the final standards. The program's existing averaging, banking, and trading provisions allow manufacturers to earn credits for overcompliance with the standards that can be banked for the company's future use (up to five model years) or traded to other companies (as discussed further in section III.C.4 of this preamble). EPA did not reopen these provisions.

EPA sought public comments on whether there might be merit in establishing additional ways in which the program could provide for alternative compliance pathways that could encourage manufacturers to achieve even lower CO_2 emissions than required by EPA standards. EPA received comment on such an approach from the Environmental Defense Fund (EDF), which suggested that EPA adopt a voluntary alternative ''leadership pathway'' that allows manufacturers to comply with EPA's standards by meeting California's ACC II standards nationwide. GM also commented in support of such a concept, suggesting that a leadership pathway would exceed the criteria pollutant and GHG emissions goals and reward automakers that are accelerating the transition to zero-emission vehicles with less complexity and with fewer certification requirements. The commenters did not, however, provide details on how such a concept could be constructed including the many implementation provisions that would need to be developed. EPA appreciates the spirit of these suggestions and the interest of certain stakeholders in exploring such alternative compliance pathways that might incentivize manufacturers to reduce emissions even sooner than required under our final program and considering the relationship to state programs. However, at this time, we believe that such concepts would need additional exploration and assessment. Although we are not finalizing such an alternate pathway in this rulemaking, EPA is open to continued dialog with all stakeholders on how such concepts might be structured for a potential future action.

d. Useful Life Standards and Test Procedures

The current program includes additional provisions that we did not reopen and so will continue to be implemented during the timeframe of this rule. We describe them briefly here for informational purposes.

Consistent with the requirement of CAA section 202(a)(1) that standards be applicable to vehicles ''for their useful life,'' the MY 2027–2032 vehicle standards will apply for the useful life of the vehicle.[558]

The existing program also requires certain test procedures over which emissions are measured and weighted to determine compliance with the GHG standards. These procedures are the Federal Test Procedure (FTP or ''city'' test) and the Highway Fuel Economy Test (HFET or ''highway'' test). EPA is making only minor changes to the GHG test procedures in this rulemaking. Namely, EPA will require manufacturers to use the same Tier 3 test fuel already specified for demonstrating compliance with criteria pollutant standards, as described in the next section. We are also revising the fleet utility factor for plug-in hybrid electric vehicles as described in section III.B.8 of the preamble and referencing an updated version of SAE J1711 to reflect the latest developments in measurement procedures for all types of hybrid electric vehicles as described in section IX.I of the preamble.

[558] The GHG emission standards apply for a useful life of 10 years or 120,000 miles for LDVs and LLDTs and 11 years or 120,000 miles for HLDTs and MDPVs. See 40 CFR 86.1805–17.

e. What test fuel is EPA finalizing?

Within the structure of the footprint-based GHG standards, EPA is also finalizing that gasoline powered vehicle compliance with the standards be demonstrated on Tier 3 test fuel. The previous GHG standards for light-duty gasoline vehicles are set on the required use of Indolene, or Tier 2 test fuel. Tier 3 test fuel more closely represents the typical market fuel available to consumers in that it contains 10 percent ethanol. EPA had previously proposed an adjustment factor to allow demonstration of compliance with the existing GHG standards using Tier 3 test fuel but did not adopt those changes (85 FR 28564, May 13, 2020). This rule does not require an adjustment factor for tailpipe GHG emissions, but rather requires manufacturers to test on Tier 3 test fuel and use the resultant tailpipe emissions directly in their compliance calculation. Such an adjustment factor is not required because the technology penetrations, feasibility, and cost estimates in this rule are based on compliance using Tier 3 test fuel.

Both the Tier 3 and these Tier 4 criteria pollutant standards were based on vehicle performance with Tier 3 test fuel; as a result, manufacturers currently use two different test fuels to demonstrate compliance with GHG and criteria pollutant standards. Setting new GHG standards based on Tier 3 test fuel is intended to address concerns regarding test burden related to using two different test fuels and using a test fuel which is dissimilar to market fuels. Accordingly, we expect this change to streamline manufacturer testing and reduce the costs of demonstrating compliance with the final rule.

The difference in GHG emissions between the two fuels is small but significant. EPA estimates that testing on Tier 3 test fuel will result in about 1.66 percent lower CO_2 emissions.[559] Because this difference in GHG emissions between the two fuels is significant in the context of measuring compliance with previous GHG standards, but small relative to the change in stringency of the finalized GHG standards in this rule, and because the cost of compliance on Tier 3 test fuel is reflected in this analysis for this rule, EPA believes that this rulemaking and the associated new GHG standards create an opportune time to shift compliance to Tier 3 fuel.

EPA is applying the change from Indolene to Tier 3 test fuel for demonstrating compliance with GHG standards starting in model year 2027.

[559] EPA–420–R–18–004, ''Tier 3 Certification Fuel Impacts Test Program,'' January 2018.

This is the same year as the new standards in this final rule begin, and we expect this model year alignment will facilitate a smooth transition for manufacturers. We accordingly allow manufacturers to continue to rely on the interim provisions adopted in 40 CFR 600.117 through model year 2026. These interim provisions address various testing concerns related to the arrangement for using different test fuels for different purposes. At the same time, we recognize that transitioning to a new test fuel is a change from how things have worked in the past, so we are providing additional flexibilities during the early years of the transition. Namely, manufacturers may optionally carry-over Indolene-based test results for model years 2027 through 2029.

For manufacturers that rely on Indolene-based test results in model years 2027 through 2029, we require a downward adjustment by 1.66 percent to GHG emission test results (*i.e.,* Tier 3 value = Tier 2 value ÷ 1.0166)) as a correction to correlate with test results that will be expected when testing with Tier 3 test fuel.

We separately proposed to apply an analogous correction for the opposite arrangement—testing with Tier 3 test fuel to demonstrate compliance with a GHG standard referenced to Indolene test fuel (85 FR 28564, May 13, 2020). We did not separately finalize the provisions in that proposed rule, and there is no longer a need to consider that provision now that vehicles are to be tested with the Tier 3 test fuel to demonstrate compliance with GHG standards.

Similar considerations apply for measuring fuel economy, both to meet Corporate Average Fuel Economy (CAFE) requirements and to determine values for fuel economy labeling. In this case, EPA is applying the calculation adjustments described in the 2020 proposal. This is necessary because fuel economy standards are set through a different regulatory process that has not been updated to accommodate the change to Tier 3 test fuel. These adjustments include: (1) New test methods for specific gravity and carbon mass (or weight) fraction of Tier 3 test fuel to calculate emissions in a way that accounts for ethanol blending while also remaining consistent with the calculations used to establish the CAFE standards, (2) a revised equation for calculating fuel economy that uses an ''R-factor'' of 0.81 to account for the difference in engine performance between Tier 3 and Tier 2 test fuels, and (3) amended instructions for calculating fuel economy label values based on 5-cycle values and derived 5-cycle values.

Our overall goal is for manufacturers to transition to fuel economy testing with Tier 3 test fuel on the same schedule as described for demonstrating compliance with GHG standards in the preceding paragraphs.

To reiterate, for the GHG compliance program, we are evaluating GHG compliance with standards that are set using Tier 3 fuel starting in MY 2027; therefore, any vehicles that continue to be tested on Indolene, will need to have the results adjusted to be consistent with results on Tier 3 fuel. For the CAFE standards, we are continuing to evaluate fuel economy compliance with standards that are established on Indolene; therefore, any vehicles that are tested on Tier 3 fuel will need to have the results adjusted to be consistent with results on Indolene. Similar to the CAFE fuel economy standards, we are keeping the fuel economy label consistent with the current program; therefore, any vehicles that are tested on Tier 3 fuel will need to have the results adjusted to be consistent with results on Indolene.

EPA is adopting the following (Table 23) to address fuel-related testing and certification requirements through the transition to the new standards. As noted above, for both GHG and fuel economy standards, vehicle manufacturers may choose to test their vehicles with either Indolene or Tier 3 test fuel through MY 2026. Manufacturers must certify all vehicles to GHG standards using Tier 3 test fuel starting in MY 2027; however, manufacturers may continue to meet fuel economy requirements through MY 2029 for any appropriate vehicles based on carryover data from testing performed before MY 2027.

The Alliance for Automotive Innovation requested EPA continue to allow automakers the option to retest on E0 for the litmus assessment [560] to determine whether to use the 5-cycle or 2-cycle testing methodology until the implications of the new E10 test fuel on the complex 5-cycle and litmus methodology can be fully examined and addressed. EPA will allow testing for determining the fuel economy label calculation method under 40 CFR 600.115–11 using either Tier 2 (Indolene) or Tier 3 test fuel provided that the same test fuel must be used for all 5 cycles until such time that EPA updates the 5-cycle adjustment factors through guidance, at which point Tier 3 test fuel must be used.

TABLE 23—FINAL FUEL-RELATED TESTING AND CERTIFICATION REQUIREMENTS

Test fuel	GHG standards			Fuel economy standards			Criteria for determining the fuel economy label calculation method "litmus test"		Fuel economy and environment label values		
	Pre-MY 2027	MY 2027–2029	MY 2030 and later	Pre-MY 2027	MY 2027–2029	MY 2030 and later	Pre-MY 2027	MY 2027 and later [a]	Pre-MY 2027	MY 2027–2029	MY 2030 and later
Indolene	No CO_2 adjustment required.	Carry-over test results only; Divide CO_2 test results by 1.0166.	Not allowed	No adjustment required.	Carry-over results only; No adjustment required.	Not allowed	Optional: No adjustment required **.	Optional: No adjustment required [b].	No adjustment required.	Carry-over results only; No CO_2 adjustment required.	Not allowed.
Tier 3	Apply proposed CO_2 adjustment (multiply test results by 1.0166).	No CO_2 adjustment required		Apply revised FE equation proposed in 2020 rule			Apply revised FE equation proposed in 2020 rule		Apply revised FE equation proposed in 2020 rule; Apply proposed CO_2 adjustment (multiply test results by 1.0166).[a]		

[a] Until EPA updates the 5-cycle adjustment factors through guidance.
[b] When performing testing for determining the fuel economy label calculation method under § 600.115–11, the same test fuel must be used for all 5 cycles.

The Alliance for Automotive Innovation (AAI) submitted comments that are nearly identical to the comments they submitted for the original 2020 Tier 3 Test Fuel NPRM. AAI submitted five specific comments on this rulemaking, each of which we have addressed in this FRM:

- Do Not Adjust the Tailpipe CO_2 Value for E10: EPA has addressed this comment in this FRM by not adjusting CO_2 values when vehicles are tested using Tier 3 test fuel. The GHG standards finalized in this FRM reflect the use of Tier 3 test fuel as does the feasibility analysis supporting this rule. No adjustment is required when testing on Tier 3 fuel.
- Set the R-Factor Equal to 1.0 for CAFE Performance on E10: EPA is finalizing an R-Factor of 0.81 based on the technical analysis provided in the 2020 Tier 3 Test Fuel NPRM.
- Delay E10 Phase-in, Allow Optional E0 Testing and Carryover of E0 Data and Revisit Any Adjustment as a Part of the Next CAFE/GHG Rulemaking: EPA accepted AAI's recommendation and is finalizing the Tier 3 test fuel change as part of this GHG standard setting rulemaking. In addition, this FRM includes provisions for phase-in of Tier 3 test fuel and the carry-over of data during the phase-in.
- Address the Impact of the E10 Transition on 5-cycle Testing and Litmus Test: EPA accepted this recommendation and has included provisions for addressing 5-cycle testing and the litmus test in this FRM.
- Consider Fuel Economy and Environmental Performance Labeling Impacts: EPA has considered impacts to the label and has included specific provisions in this FRM to address the use of E10 for vehicle testing and the resultant label values.

Several other commenters advised that adjusting CO_2 measurements from Tier 3 test fuel upward by 1.6 percent is improper since E10 test fuel represents market fuel. They also suggest that the proposed adjusted R-value of 0.81 is too low, stating that

[560] The "Litmus test" is the commonly known term used to describe the criteria for determining the fuel economy label calculation method (mpg based derived 5-cycle method or vehicle specific 5-cycle method or the modified 5-cycle method) for 2011 and later model year vehicles, as outlined in 40 CFR 600.115–08.

values around 0.9 have been published in recent literature, and that a value of 1.0 would be optimal as it avoids penalizing ethanol blends. One commenter explained that the computation of the test fuel's heating value and carbon mass fraction should be done using the original ASTM methods used in characterizing the historical reference fuel rather than the more modern methods we proposed, and that those values should account for sulfur and water content.

See section 6.3 of the RTC for a more detailed discussion of comments related to test fuel for fuel economy measurements.

3. Medium-Duty Vehicle GHG Standards

i. What CO_2 standards curves is EPA finalizing?

Medium-duty vehicles (8,501 to 14,000 pounds GVWR) that are not categorized as MDPVs utilize a ''work-factor'' metric for determining GHG targets. Unlike the light-duty attribute metric of footprint, which is oriented around a vehicle's usage for personal transportation, the work-factor metric is designed around work potential for commercially oriented vehicles and accounts for a combination of payload, towing and 4-wheel drive equipment.

We received comments from the Alliance for Automotive Innovation (Alliance), GM, Ford, and Stellantis that opposed changes to the work factor definition that capped GCWR within the WF calculation to no greater than 22,000 pounds. Both the Alliance and Stellantis opposed the GHG standards for MDV, stating that were too stringent and with Stellantis further characterizing the standards as ''infeasible''. The Alliance and Stellantis specifically cited a 37 percent reduction in GHG from MY 2028 through MY 2032 as too stringent, and that the assumption of 98 percent electrification of van applications within the technology feasibility analysis for the proposal was too high. Stellantis requested that the Agency include PHEV technology for MDVs within its analysis for the final rule. Conversely, ICCT and ACEEE commented that too few MDV BEVs were included within the analysis and argued for more stringent GHG standards for MDV.

Taking all of these comments into consideration, and for the reasons explained below (and in the RTC), we are finalizing the coefficients of the 2032 GHG standards as proposed for work factors less than 5,500 pounds, and we are finalizing the following changes relative to the proposal:

1. We have eliminated the proposed GCWR cap within the work factor equation and have returned to a definition and equation for work factor identical to the one used chassis-certified Class 2b and 3 vehicles under the Heavy-duty Phase 2 GHG Program. Instead, we modified the structure of the MDV GHG standards directly and introduced a flattening of standards above specific work factor set-points.

2. We are finalizing a more gradual and evenly-spaced change in GHG stringency from MY 2027 through 2031.

3. The flattening of standards above specific work factor set-points is phased-in gradually from MY 2028 through 2030.

Our GHG standards for MDVs continue to be entirely chassis-dynamometer based and continue to be work-factor-based as with the previous Heavy-duty Phase 2 standards. We are not finalizing our proposed 22,000-pound GCWR limit within the work factor equation. EPA had proposed this provision with the goal of preventing increases in the GHG emissions not fully captured within the loads and operation reflected during chassis dynamometer GHG emissions testing. Automaker commenters expressed concern that the proposal would disrupt vehicle categories, particularly when taking into consideration updates to the MDPV definition (see section III.E of this preamble). In response to comments, we are finalizing changes to the CO_2 targets which flatten the standards in the following manner:

- At or above a work factor of 8,000 pounds in 2028.
- At or above a work factor of 6,800 pounds in 2029.
- At or above a work factor of 5,500 pounds for model years 2030 and later.

The final standards will continue to use the same work factor (WF) and GHG target definitions (81 FR 73478, October 25, 2016). The testing methodology does not directly incorporate any GCWR (*i.e.,* trailer towing) related direct load or weight increases, however, flattening the standards above a 5,500-pound work factor upper cutpoint addresses concerns of potential windfall compliance credits for higher GCWR ratings and approximately reflects a GCWR of 22,000 pounds. Thus we are finalizing both a CO_2 target equation and WF equation for determining GHG standards that are identical to those used in the heavy-duty Phase 2 GHG program, except with updated coefficients:[561]

CO_2 Target (g/mile) = [a × WF] + b

WF = [0.75 × (Payload Capacity + xwd)] + [0.25 × Towing Capacity]

Payload Capacity = GVWR (pounds) − Curb Weight (pounds)

xwd = 500 pounds for 4wd, 0 lbs. for 2wd

Towing Capacity = GCWR (pounds) − GVWR (pounds)

Final MDV GHG standards for model years 2027 and later are shown in Table 24 and Table 25.

TABLE 24—FINAL COEFFICIENTS FOR MDV GHG STANDARDS

Model year	a	b
2027	0.0348	268
2028[a]	0.0339	270
2029[b]	0.0310	246
2030[c]	0.0280	220
2031[c]	0.0251	195
2032[c]	0.0221	170

Applicable WF Thresholds:
[a] Only applicable at WF <8,000 pounds.
[b] Only applicable at WF <6,800 pounds.
[c] Only applicable at WF <5,500 pounds.

TABLE 25—FINAL MDV GHG STANDARDS ABOVE WF THRESHOLDS REFERENCED IN TABLE 24

Model year	WF threshold	GHG standards, g CO_2/mi
2028	WF ≥8,000 lbs	541
2029	WF ≥6,800 lbs	457
2030	WF ≥5,500 lbs	374
2031	WF ≥5,500 lbs	333
2032	WF ≥5,500 lbs	292

The MDV target GHG standards are compared to the previous Heavy-duty (HD) Phase 2 gasoline standards in Figure 10. For MY 2027, we are finalizing a revision to the HD Phase 2 standards under which gasoline MDVs are subject to fuel-neutral standards identical to the HD Phase 2 diesel standards. MY 2027 standards for diesel MDV remain identical to HD Phase 2. EPA believes the revised MY 2027 MDV standard for gasoline MDV is reasonable given the significant advances in clean vehicle technology since our assessment at the time of the HD Phase 2 rule in 2016. In our assessment conducted during the development of HD Phase 2, we found only one manufacturer had certified HD BEVs through MY 2016, and we projected limited adoption of electric vehicles into the market for MYs 2021 through 2027. However, as discussed in section IV.C.1 of this preamble and RIA Chapter 3.1, there are now a wider range of feasible technology options for manufacturers to apply to the MDV fleet. In addition to ICE-based technologies, manufacturers are actively increasing their PHEV and BEV vehicle offerings in the MDV

[561] Note: There is no 22,000-pound GCWR cap within the WF equation.

segment, which are supported through the IRA tax credits, and we expect this growth to continue through the remaining timeframe for the HD GHG Phase 2 program and into the timeframe of this program. Based on this new information, we believe the revised gasoline MDV standard for MY 2027 is feasible, considering costs and lead time.

We further believe that the revised MY 2027 standard is feasible on a fuel neutral basis, compared to the prior standards under the HD Phase 2 program that established separate standards for gasoline and diesel MDVs, with diesel MDVs subject to a more stringent standard than gasoline. This is consistent with the approach that we have taken within the LD program, where GHG standards are fuel neutral and include BEVs. Improvements in ICE technology, in particular HEV and PHEV technology and the use of dedicated hybrid engines in those applications, have narrowed the differences between gasoline and diesel GHG for both MDV and LD. This fuel-neutral approach also extends to our treatment of MDV BEVs. We anticipate that manufacturers will comply with MDV GHG standards in part through increased averaging of BEV MDV as their sales increase over the timeframe of our rule.

We are finalizing standards in MY 2032 comparable to what was proposed except with the previously noted differences in calculating work factor and CO_2 targets. We are also finalizing standards that are less stringent than the proposal for model years 2028 through 2031 to allow additional manufacturer lead time. Note that all of the standards in Figure 10 continue beyond the data markers shown. The range of WF shown within the figure reflect the approximate transition from light-duty trucks to MDVs at a WF of approximately 3,000 pounds. Also note that a GCWR of 22,000 pounds corresponds with a work factor of approximately 5,500 pounds, above which the GHG standards flatten for MY 2030 and later. We consider these standards feasible taking into consideration the opportunities for increasing penetration of advanced technologies, within both the van and MD pickup segments, as discussed further in section IV.C.1 of the preamble.

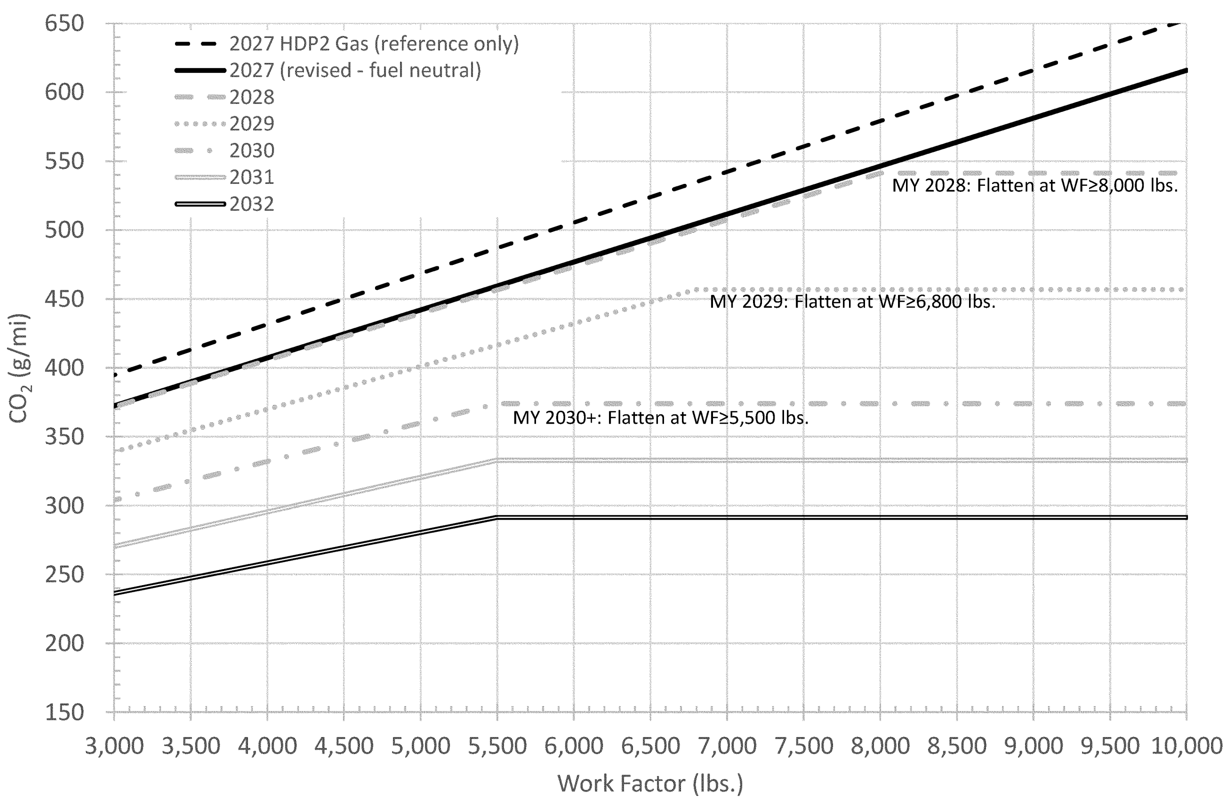

Figure 10: Final GHG Standards for Medium-Duty Vehicles

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

Table 26 shows overall fleet average target levels for both medium-duty vans and pickup trucks that are projected for the standards. A more detailed break-down of the projected CO_2 targets and achieved levels is provided in RIA Chapter 12. The actual fleet-wide average g/mile level that would be achieved in any year for medium-duty vans and pickup trucks will depend on the actual production of vehicles for that year, as well as the use of the credit averaging, banking, and trading provisions.

TABLE 26—PROJECTED TARGETS FOR FINAL MEDIUM-DUTY GHG STANDARDS, BY BODY STYLE

Model year	Vans CO_2 (g/mile)	Pickups CO_2 (g/mile)	Total fleet CO_2 (g/mile)
2027	392	497	461

TABLE 26—PROJECTED TARGETS FOR FINAL MEDIUM-DUTY GHG STANDARDS, BY BODY STYLE—Continued

Model year	Vans CO_2 (g/mile)	Pickups CO_2 (g/mile)	Total fleet CO_2 (g/mile)
2028	391	486	453
2029	355	437	408
2030	317	371	353
2031	281	331	314
2032 and later	245	290	274

iii. MDV Incentive Multipliers

For the Heavy-duty (HD) GHG Phase 2 rule, EPA adopted credit multipliers through MY 2027 for vehicles that qualified as ''advanced technology'' (*i.e.,* PHEV, BEV and FCEV) based on the administrative record at that time. In the proposal for this rule (88 FR at 29243), we described the HD GHG Phase 2 advanced technology credit multipliers as representing a tradeoff between incentivizing new advanced technologies that could have significant emissions benefits and providing credits that could allow higher emissions from credit-using engines and vehicles. At the time we finalized the HD GHG Phase 2 program in 2016, we estimated that there would be very little market penetration of PHEV, BEV, and FCEV in the heavy-duty market in the MY 2021 to MY 2027 timeframe when the advanced technology credit multipliers would be in effect. Additionally, the technology packages in our technical basis of the feasibility of the HD GHG Phase 2 standards did not include any of these advanced technologies.

TABLE 27—ADVANCED TECHNOLOGY MULTIPLIERS IN HD GHG PHASE 2—THE 2016 FINAL RULE APPLIED THESE MULTIPLIERS TO MYS 2021 THROUGH 2027

Technology	Multiplier
Plug-in hybrid electric vehicles	3.5
All-electric vehicles	4.5
Fuel cell electric vehicles	5.5

In our assessment conducted during the development of HD GHG Phase 2, we found only one manufacturer had certified HD BEVs through MY 2016, and we projected ''limited adoption of all-electric vehicles into the market'' for MYs 2021 through 2027.[562] At low adoption levels, the benefits of encouraging additional utilization of these technologies outweighed negative emissions impacts of multipliers. However, as discussed in section IV of the preamble, manufacturers are now actively increasing their use of PHEV and BEV technologies in the medium-duty segment with further support through the IRA and other actions, and we expect this growth to continue through the remaining timeframe for the HD GHG Phase 2 program and into the timeframe for this medium-duty program.

While we did anticipate that some growth in development of these technologies would occur due to the credit incentives in the HD GHG Phase 2 final rule, we did not expect the level of innovation observed since we finalized the rule in 2016, the IRA or BIL incentives, or that California would adopt the Advanced Clean Trucks (ACT) rule at the same time these advanced technology multipliers were in effect. We therefore proposed phasing out multipliers for PHEV, BEV and FCEV technologies one year earlier than provided in the Phase 2 rule such that the multipliers would be eliminated in MY 2027.

EPA received comments both in support of and in opposition to its proposal to eliminate MDV multiplier incentives for MY 2027 vehicles. Some auto industry commenters opposed the elimination of the multipliers for MY 2027 as they believed the multipliers are important to address market uncertainties and that changes in the multipliers could be disruptive to manufacturers' planning and development cycles already underway. Other commenters supported EPA's proposal to remove multipliers for MY 2027 believing that multipliers are no longer necessary given the rapid advancement of BEVs in the MDV market and given their concern that multipliers erode the emissions benefits of the program and could result in emissions backsliding.

EPA has considered these comments (as discussed further in section 3.1.8 of the RTC). We believe that, if left as is, the MY 2027 MDV multiplier credits may allow for backsliding of emission reductions expected from non-advanced technology vehicles for some manufacturers in the near term (*i.e.,* the generation of excess credits which could delay the introduction of technology in the near or mid-term) as sales of advanced technology MDVs that can generate the incentive credit continue to increase. In light of the current existence of, and expected continued rapid increase in, adoption of advanced technologies (including zero-emission technologies) in the MDV market, EPA is, as proposed, removing the BEV, PHEV, and FCEV multipliers for MY 2027.

In the proposal, EPA also requested comment on phasing down the MDV multipliers for MYs 2025 and 2026. Upon considering public comments, we have decided not to make any changes to the multiplier levels for MYs 2025–2026. While one auto manufacturer supported a phase-down of the MY 2025–2026 multipliers, another manufacturer raised the concern that changes to the multipliers in MY 2025–2026 would not provide sufficient lead time for manufacturers who have been planning to utilize the multipliers in their compliance plans for those model years. Given that MY 2025 has already begun and that MY 2026 begins as early as nine months from this final rule, EPA believes it would not be appropriate to change the MY 2025 or 2026 multipliers. Therefore, the MDV MY 2025–2026 multipliers will remain in effect as established under the Phase 2 rule.

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

Averaging, banking, and trading (ABT) is an important compliance flexibility that has long been built into various highway engine and vehicle programs (and nonroad engine and equipment programs) to support emissions standards that, through the introduction and application of new technologies, result in reductions in air pollution. EPA is explaining the ABT provisions of the GHG program as background information, as we did not reopen the existing provisions in 40 CFR 86.1865–12.

EPA's first mobile source program to feature averaging was issued in 1983

[562] 81 FR 73818 (October 25, 2016).

and included averaging for diesel light-duty vehicles to provide flexibility in meeting new PM standards.[563] EPA introduced NO_X and PM averaging for highway heavy-duty vehicles in 1985.[564] EPA introduced credit banking and trading in 1990 with new more stringent highway heavy-duty NO_X and PM standards to provide additional compliance flexibility for manufacturers.[565] Since those early rules, EPA has included ABT in many programs across a wide range of mobile sources.[566] For light-duty vehicles, EPA has included ABT in several criteria pollutant emissions standards rules including in the National Low Emissions Vehicle (NLEV) program,[567] the Tier 2 standards,[568] and the Tier 3 standards.[569] ABT has also been a key feature of all GHG rules for both light-duty and heavy-duty vehicles.[570]

ABT can help to address issues of technological feasibility and lead time, as well as considerations of cost. In many cases, ABT supports the ability of automakers to comply with standards in a manner that is more economically efficient and possibly with less lead time. This provides important environmental benefits and at the same time it increases flexibility and reduces costs for the regulated industry. Furthermore, by encouraging automakers to exceed minimum requirements where possible, the ABT program encourages technological innovation, which makes further reductions in fleetwide emissions possible. The light-duty ABT program for GHG standards includes existing provisions initially established in the 2010 rule for how credits may be generated and used within the program. The ABT provisions of 40 CFR 86.1865–12 include credit carry-forward, credit carry-back (also called deficit carry-forward), credit transfers (within a manufacturer), and credit trading (across manufacturers). The MDV GHG program includes similar ABT provisions. EPA received comments from vehicle manufacturers and environmental organizations generally supporting the continuation of the ABT provisions to allow a wide array of vehicles to be produced providing that no particular technologies are forced.

Credit carry-forward refers to banking (saving) credits for future use, after satisfying any needs to offset prior MY debits within a vehicle category (car fleet or truck fleet). Credit carry-back refers to using credits to offset any deficit in meeting the fleet average standards that had accrued in a prior MY. The regulation at 40 CFR 86.1865–12 allows a manufacturer to have a deficit at the end of a MY (after averaging across its fleet using credit transfers between cars and trucks)—that is, a manufacturer's fleet average emissions level may fail to meet the manufacturer's required fleet average standard for the MY, for a limited number of model years. The CAA does not specify or limit the duration of such credit provisions. In previous rules, EPA chose to generally adopt 5-year credit carry-forward and 3-year credit carry-back provisions[571] as a reasonable approach that maintained consistency between EPA's GHG and NHTSA CAFE regulatory provisions.[572] These provisions continue to apply during the timeframe for compliance with this rule, and as noted above, EPA did not reopen the GHG ABT program.

Transferring credits in the GHG program under 40 CFR 86.1865–12 refers to exchanging credits between the two averaging sets—passenger cars and light trucks—within a manufacturer. For example, credits accrued by overcompliance with a manufacturer's car fleet average standard can be used to offset debits accrued due to that manufacturer not meeting the truck fleet average standard in a given model year.[573] Except as described in section III.D.2.v of the preamble, MDVs are a separate averaging set and credits are not allowed to be transferred between vehicles meeting the light- and medium-duty GHG standards due to the very different standards structure, vehicle testing differences (*e.g.,* MDVs are tested at an adjusted loaded vehicle weight of vehicle curb weight plus half payload whereas light-duty vehicles are tested at an estimated test weight of curb weight plus 300 pounds) and marketplace competitiveness issues. This prohibition includes traded credits such that, once traded, credits may not be transferred between the light- and medium-duty fleets. Finally, 40 CFR 86.1865–12 allows accumulated credits to be traded to another manufacturer. Credit trading has occurred on a regular basis in EPA's light-duty vehicle program.[574] Manufacturers acquiring credits may offset credit shortfalls and bank credits for use toward future compliance within the carry-forward constraints of the program.

The ABT provisions are an integral part of the vehicle GHG program, and the agency expects that manufacturers will continue to utilize these provisions into the future, as they give manufacturers an important tool to resolve any potential lead time and cost issues. EPA's annual Automotive Trends Report provides details on the use of these provisions in the GHG program.[575] EPA did not reopen the GHG program ABT provisions in this rulemaking.

5. Vehicle Air Conditioning System Related Provisions

Vehicle air conditioning (A/C) contributes to vehicle emissions in two ways. The first is indirect emissions of GHG exhaust emissions resulting from the increase in fuel consumption needed to operate an AC system. The second is direct emissions of hydrofluorocarbon (HFC) greenhouse gases of refrigerant via leakage from the A/C system. EPA has addressed the first mechanism through the use of credits to encourage manufacturers to make efficiency improvements to their A/C systems to reduce fuel consumption and the associated GHG emissions. EPA has also addressed the second mechanism through a credit provision, providing manufacturers credits for using lower

[563] 48 FR 33456, July 21, 1983.

[564] 50 FR 30584, March 15, 1985.

[565] 55 FR 30584, July 26, 1990.

[566] We note that in upholding the first HD final rule that included averaging, the D.C. Circuit rejected petitioner's challenge that Congress meant to prohibit averaging in standards promulgated under section 202(a). *NRDC* v. *Thomas,* 805 F.2d 410, 425 (D.C. Cir. 1986). In the 1990 Clean Act Amendments, Congress, noting *NRDC* v. *Thomas,* opted to let the existing law ''remain in effect,'' reflecting that ''[t]he intention was to retain the status quo,'' *i.e.,* EPA's existing authority to allow averaging for standards under section 202(a). 136 Cong. Rec. 36,713, 1990 WL 1222468 at *1,136 Cong. Rec. 35,367, 1990 WL 1222469 at *1.

[567] 62 FR 31192, June 6, 1997.

[568] 65 FR 6698, February 10, 2000.

[569] 79 FR 23414, April 28, 2014.

[570] The **Federal Register** citations for previous vehicle GHG rules are provided in section III.A.2 of this preamble.

[571] Although the existing credit carry-forward and carry-back provisions generally remained in place for MY 2017 and later standards, EPA finalized provisions in the 2012 rule allowing all unused (banked) credits generated in MYs 2010–2015 (but not MY 2009 early credits) to be carried forward through MY 2021. See 77 FR 62788. In addition, in the 2021 rule, EPA adopted a targeted one-year extension (6 years total carry-forward) of credit carry-forward for MY 2017 and 2018 credits. See 86 FR 74453.

[572] The EPCA/EISA statutory framework for the CAFE program limits credit carry-forward to 5 years and credit carry-back to 3 years.

[573] There is a VMT factor included in the credit calculations such that light trucks generate and use more credits than passenger cars based on higher lifetime VMT projections for light trucks compared to passenger cars. The lifetime VMT used for passenger cars and light trucks are 195,264 and 225,865, respectively.

[574] EPA provides general information on credit trades annually as part of its annual Automotive Trends and GHG Compliance Report. The latest report is available at: *https://www.epa.gov/automotive-trends* and in the docket for this rulemaking.

[575] ''The 2022 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–22–029, December 2022.

global warming potential (GWP) HFC refrigerants and/or reducing the leakage of A/C systems. EPA has included air conditioning (A/C) system credits in its light-duty GHG program since the initial program adopted in the 2010 rule. Although the use of A/C credits has been voluntary, EPA in past rules has adjusted the level of the CO_2 standards downward, making them more stringent, to reflect the availability of technology to mitigate these two emission sources (and the associated availability of credits). Manufacturers opting not to adopt technologies that improve A/C efficiency or reduce refrigerant leakage emissions and earn A/C credits, meet the vehicle GHG standards through additional tailpipe CO_2 emission reductions. In this FRM, EPA is revising the A/C credits program for light-duty vehicles in two ways. First, for A/C system efficiency, as proposed, EPA is limiting the eligibility for voluntary credits for tailpipe CO_2 emissions control to ICE vehicles starting in MY 2027 (*i.e.,* BEVs would not earn A/C efficiency credits). Second, for A/C refrigerant leakage control, EPA is phasing down the credit from MYs 2027–2030 and retaining a small permanent credit for MYs 2031 and later.

i. Background on A/C Emissions in Previous Programs

As noted above, there are two mechanisms by which A/C systems contribute to the emissions of GHGs: through leakage of hydrofluorocarbon (HFC) refrigerants into the atmosphere (sometimes called ''direct emissions'') and through the consumption of fuel to provide mechanical power to the A/C system (sometimes called ''indirect emissions'').[576] Since the first GHG standards in 2010, EPA has regulated the emissions of HFCs from vehicles by identifying control strategies for reducing refrigerant leakage (and for reducing the climate impacts of GHG leakage on a CO_2e basis), offering credits for adopting those strategies, and then setting the stringency of the tailpipe emissions standards based on the feasibility of adopting technologies that mitigate emissions from air conditioning, with the final level of the standards reflecting the level of the credits a manufacturer could earn. Thus, since 2010, the tailpipe standards have been intentionally set to achieve control of HFCs. This program has been successful; since the 2010 rule, manufacturers have reduced the impacts of refrigerant leakage significantly by using systems that incorporate leak-tight components and by using refrigerants with a lower global warming potential. When EPA established the light-duty refrigerant credits in the 2010 rule, the most common refrigerant was HFC 134a which has a global warming potential of 1430. The high global warming potential of HFC–134a, means that leakage of a gram of HFC134(a) would have 1430 times the global warming potential of a gram of CO_2. Manufacturers have steadily increased their use of low GWP refrigerant HFO–1234yf which has a GWP of 1, much lower than the GWP of the HFC refrigerant it replaces. The A/C system also contributes to increased tailpipe CO_2 emissions through the additional work required to operate the compressor, fans, and blowers. This additional power demand is ultimately met by using additional fuel, which is converted into CO_2 by the engine during combustion and exhausted through the tailpipe. These emissions can be reduced by increasing the overall efficiency of an A/C system, thus reducing the additional load on the engine from A/C operation, which in turn means a reduction in fuel consumption and a commensurate reduction in CO_2 emissions.

In past rules, EPA adjusted the stringency of the light-duty CO_2 footprint curves to reflect the expected adoption of technologies that reduce A/C emissions (and the associated A/C credits) by shifting the footprint curves downward. In the 2010 rule and again in subsequent rules, EPA increased the stringency of the footprint curves for cars and trucks to reflect the expected adoption of technologies that reduce A/C emissions and the associated and relatively low-cost A/C credits earned.

For MDVs, EPA adopted a somewhat different approach to address A/C refrigerant emissions. In the Phase 1 rule, rather than indirectly regulating HFCs through offering a credit, EPA directly regulated HFCs through a refrigerant leakage standard.[577] This approach eliminated the need to adjust the CO_2 work factor-based standards to account for the availability of adoption of lower GWP refrigerants, as EPA did in setting the prior light-duty standards. EPA projected that manufacturers would meet the leakage standard either through the use of leak tight components or through the use of alternative refrigerants. In the Phase 2 rule, EPA revised the refrigerant leakage standard to be refrigerant neutral, meaning that regardless of the type of refrigerant used, the loss of refrigerant cannot exceed the standard of 11 g/year or a percentage leakage rate greater than 1.5 percent per year.[578] The MDV program does not include A/C efficiency related credits or requirements.[579]

ii. Modifications to the A/C Efficiency Credits

The previous light-duty vehicle A/C indirect emissions reduction credits in 40 CFR 86.1868–12, which EPA also commonly refers to as A/C efficiency credits, are based on a technology menu with a testing component to confirm that the technologies provide emissions reductions when installed as a system on vehicles. The menu includes credits for improved system components and air recirculation settings designed to reduce the A/C load on the IC engine.[580] The A/C efficiency credits are capped at 5.0 g/mile for passenger cars and 7.2 g/mile for light trucks. In addition, a limited amount of vehicle tailpipe testing (*i.e.,* the ''AC17'' test) is required for manufacturers claiming credits to verify anticipated emissions reductions are occurring. The credits have been effective in incentivizing A/C efficiency improvements since the program's inception, and manufacturers' use of A/C menu credits has steadily increased over time. In MY 2022, 20 of 22 manufacturers reported efficiency credits resulting in an average credit of 5.8 g/mile.[581]

EPA is finalizing its proposal that beginning with MY 2027, A/C efficiency credits are eligible only for vehicles equipped with IC engines. Thus, BEVs will no longer be eligible for A/C efficiency credits after MY 2026.

The Alliance for Automotive Innovation (AAI) and some vehicle manufacturers provided comments opposing the elimination of A/C efficiency credits for BEVs. Some of these commenters noted the importance of more efficient A/C systems for BEVs in improving overall BEV efficiency. Other commenters including NGOs supported EPA's proposal and specifically supported the decision not to apply A/C efficiency credits to BEVs

[576] 40 CFR 1867–12 and 40 CFR 86.1868–12.

[577] 76 FR 57194 and 73525.

[578] Under the Phase 2 program, loss of refrigerant from air conditioning systems may not exceed a total leakage rate of 11.0 grams per year or a percent leakage rate of 1.50 percent per year, whichever is greater. See 81 FR 73742 and 40 CFR 1037.115(e).

[579] In the previous heavy-duty GHG rules, EPA discussed but did not propose or finalize A/C efficiency credits for MDVs. For further discussion see 76 FR 57196 and 81 FR 73742.

[580] Joint Technical Support Document, Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA–420–R–12–901, August 2012.

[581] ''The 2023 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–23–033, December 2023.

given that BEVs have a zero grams per mile compliance value.

The A/C efficiency credits are based on emissions reductions from ICE vehicles. They correspond to motor vehicle emissions reductions that occur when the A/C systems on ICE vehicles are operated more efficiently, which in turn reduces their use of electricity produced by the alternator and engine, and which in turn reduces pollution emitted by the motor vehicle engine. The credits provided an incentive for manufacturers to increase the efficiency of their A/C systems and in turn reduce the pollution emitted by the vehicle engine. The amount of the credits was determined based on our technical analysis of the emissions produced by an ICE engine and how A/C efficiency improvements could reduce such emissions. In turn, while the credits were optional, EPA established the GHG standards accounting for the level of credits that manufacturers could potentially obtain.

Currently, BEVs are generating credits even though the credits are based solely on improvements to ICE vehicles, and not representative of emissions reductions for BEVs. That is, BEVs completely prevent engine emissions. Thus, improving A/C efficiency does not and is not needed to further decrease vehicle engine emissions. Moreover, the amount of the credits EPA previously determined based on ICE vehicle emissions has no real-world correlation to BEVs. Allowing BEVs to generate A/C efficiency credits is therefore not technically sound as it is unrelated to controlling emissions from the vehicle. Instead, they are receiving a windfall of credits that fails to correspond to any real-world reduction in vehicle emissions, a problem which increases in significance as the manufacturers choose to produce an increasing number of BEVs.

When EPA first established A/C efficiency credits in the 2010 rule, BEV sales were relatively small, and EPA anticipated that BEVs would be required eventually to reflect a portion of carbon emissions from upstream electricity generation in compliance results. However, as discussed in section III.C.7 of this preamble, EPA has concluded it is appropriate to measure compliance with vehicle emissions standards solely by reference to vehicle emissions and is thus removing the MY 2027 date previously specified in the regulations for including upstream emissions in compliance calculations for BEVs. In addition, the ability of BEVs to generate A/C credits has contributed to manufacturers reporting BEV emissions as less than zero, which is not representative of actual vehicle emissions and can be a source of confusion. For example, in the latest Trends report, Tesla, which sells only BEVs, reported a fleet average performance value of negative 23 g/mile including 18.2 g/mile of A/C credits.[579] Initially, when BEV sales were very low, these issues and their impacts were small, and the A/C efficiency credits in turn provided some amount of incentive for more efficient BEVs overall and resulting upstream emission reductions. However, EPA has reconsidered the appropriateness of applying A/C efficiency credits to BEVs in light of the increasing level of BEVs that we anticipate manufacturers will choose to produce in future model years and our final rule provision to indefinitely exclude upstream emissions from BEV compliance calculations. For all these reasons, EPA believes limiting eligibility for A/C efficiency credits to only ICE vehicles beginning in MY 2027 is appropriate. As described for off-cycle credits in section III.C.6.i of this preamble, the final rule also restricts the applicability of A/C efficiency credits for PHEVs to the portion of vehicle operation when the engine is running, based on the vehicle's utility factor. Similar to the preceding discussion of BEVs and A/C efficiency credits, this calculation adjustment is appropriate to associate A/C efficiency credits only with ICE operation beginning in MY 2027.

EPA notes that its approaches for A/C efficiency credits and off-cycle credits, discussed in detail in section III.C.6 of this preamble, differ even though the types of emissions the credits are designed to address (*i.e.,* emissions not considered on the 2-cycle compliance test cycles) are similar. As discussed in section III.C.6 of this preamble, while EPA is phasing out the off-cycle credits entirely after MY 2032, EPA is not phasing out A/C efficiency credits for ICE vehicles because the A/C efficiency credits program is more robust as it includes a check of vehicle emissions performance through AC17 testing. EPA established the AC17 testing requirements as part of the 2012 rule to provide an assurance that the A/C systems earning credits were providing anticipated emissions reductions. As established in the 2012 rule, the AC17 test is mandatory for MYs 2017 and later (with the exception that manufacturers are not required to test BEVs).[582] The off-cycle credits program includes no such mechanism to check performance. EPA did not reopen the existing AC17 testing provisions as part of this rule; therefore, the AC17 testing requirements of manufacturers earning A/C efficiency credits will remain in effect under the MY 2027 and later program.

EPA's MDV GHG work factor-based program does not include A/C system efficiency provisions,[583] and EPA did not reopen this issue for this rule.

iii. Phase-Down of A/C Credits for Reduced Refrigerant Leakage

The previous light-duty vehicle A/C credits program in 40 CFR 86.1867–12 that was adopted in the 2012 rule also included credits for low refrigerant leakage systems and/or the use of alternative low global warming potential (GWP) refrigerants rather than hydrofluorocarbons (HFCs). Under the prior program, the potential available A/C leakage credits are larger than the A/C efficiency credits. The prior program caps refrigerant related credits for passenger cars and light trucks, respectively, at 13.8 and 17.2 g/mile when an alternative refrigerant is used and 6.3 and 7.8 g/mile in cases where an alternative refrigerant is not used. Although the credits program has been voluntary since its inception, the standards were adjusted to reflect the anticipated use of the credits and the program has been effective in achieving its goal of increasing the use of low GWP refrigerants and low leak technologies. Since EPA established the refrigerant-based credits, low GWP refrigerant HFO–1234yf has been successfully used by many manufacturers to claim the full refrigerant replacement credits. As of MY 2022, 97 percent of new vehicles used the low GWP refrigerant.[584] EPA adopted a different approach for MDVs by including in the program a refrigerant leakage standard rather than a credit.[585]

In December 2020, the American Innovation and Manufacturing (AIM) Act (42 U.S.C. 7675) was enacted. The AIM Act, among other things, authorizes EPA to phase down production and consumption of HFCs in specific sectors and subsectors, including their use in vehicle A/C systems. The AIM Act has sent a strong signal to all vehicle manufacturers that there is no future for using high GWP refrigerants in new vehicles. In October 2023, in response to the AIM Act, EPA finalized the Technology Transitions Rule which

[582] 77 FR 62722.

[583] See 81 FR 73742, October 25, 2016.

[584] "The 2023 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975," EPA–420–R–23–033, December 2023. See Figure 5.5 in page 97.

[585] See 40 CFR 1037.115(e) and 81 FR 73726, October 25, 2016.

restricts the use of high GWP refrigerants such as HFCs in vehicle applications.[586] The new restriction on refrigerant use is effective in MY 2025 for light-duty vehicles and MY 2028 for MDVs.[587] Auto manufacturers have already successfully developed and employed HFO–1234–yf low GWP refrigerants across the large majority of the fleet and there is no reason at this time to believe that manufacturers would redesign those systems again under the AIM Act, in the absence of EPA vehicle-based credits, to develop and use systems equipped with a higher GWP refrigerant. In light of the Agency's phase out of high GWP refrigerants pursuant to the AIM Act, EPA proposed sunsetting the voluntary refrigerant-related credits in MY 2027 for light-duty vehicles. Based on significant public comments on this issue, EPA is finalizing an approach that provides a phase-down of the current A/C leakage credits from MYs 2027–2030, and establishes a small A/C leakage credit for MY 2031 and later, as described in detail below.

Some commenters, including NGOs and states, were generally supportive of the proposal to eliminate A/C leakage credits given the AIM Act's provisions on phasing out high GWP refrigerants, although some of these commenters also supported regulatory changes to support the continued use of low leak technologies. Other comments from auto manufacturers expressed concerns with the proposal to end A/C leakage credits altogether in MY 2027, as they believed this change would have a significant impact on the effective stringency of the standards. Some auto manufacturers who supported the proposal's Alternative 3 (linear ramp rate) stringency as the right direction also commented that in order to address concerns about lead time in the early years, the program should also slow the phase-down of both off-cycle and A/C leakage credits. Some auto manufacturers also recommended that EPA should retain A/C leakage credits in the program as a way to continue to incentivize the lowest GWP refrigerants below the threshold established in the EPA Technology Transitions Rule.

EPA has carefully considered these public comments and reconsidered its proposal for A/C leakage credits in the context of our updated technical analysis. We are retaining a small credit to further incentivize vehicle refrigerants below the threshold established in the EPA Technology Transitions Rule which prohibits refrigerants above a GWP of 150. Since much of the light-duty vehicle fleet is already using the HFO–1234yf refrigerant which has a GWP of 1, EPA also believes this credit will provide an incentive for manufacturers to not backslide, for example, by moving in the future to a GWP that approaches the Technology Transitions Rule threshold. In addition, EPA believes this credit will continue to incentivize low leak systems along with the use of very low GWP refrigerants. EPA has scaled back its existing A/C leakage credits to capture a credit value that represents the use of vehicle A/C refrigerants of less than 150 GWP. Specifically, for MY 2031 and beyond, manufacturers may earn A/C leakage credits of up to 1.6 g/mile for cars and 2.0 g/mile for light trucks. EPA's calculation methodology for these A/C credits can be found in RIA Chapter 3.6.

We also agree with auto industry commenters that it is important to provide additional lead time in the early years of the program. Therefore, we are finalizing a phase-down of A/C leakage credits from MY 2027–2031. Specifically, the available A/C leakage credits will phase down as shown in Table 28.

TABLE 28—A/C LEAKAGE CREDITS AVAILABLE TO MANUFACTURERS, FINAL PROGRAM

[CO_2 g/mile]

MY	Car	Truck
2026	13.8	17.2
2027	11.0	13.8
2028	8.3	10.3
2029	5.5	6.9
2030	2.8	3.4
2031	1.6	2.0
2032 and later	1.6	2.0

For MDVs, EPA had proposed to eliminate the MDV leakage standard in MY 2027. EPA received comments from some stakeholders, including the California Air Resources Board, that the MDV leakage standard should be retained as it provides additional GHG reductions. While recognizing that the Agency's Technology Transitions Rule will provide significant climate benefits by phasing out refrigerants above a GWP of 150, CARB pointed out that there are still benefits that the MDV leakage standard can achieve to ensure low leak systems regardless of the refrigerant used. In response to these comments, and for the reasons described above on the importance of a continued role for preventing emissions from A/C equipment in the vehicle program (recognizing that both LD and HD vehicles are subject to regulations to control leaks), EPA is retaining the existing MDV refrigerant leakage standard that was established under the Phase 2 program. The current MDV leakage standard requires that loss of refrigerant from A/C systems may not exceed a total leakage rate of 11.0 grams per year or a percent leakage rate of 1.50 percent per year, whichever is greater. This leakage standard applies regardless of the refrigerant used in the A/C system. (See 81 FR 73742, October 25, 2016 and 40 CFR 86.1819–14(h)).

6. Off-Cycle Credits Program

i. Background on the Off-Cycle Credits Program

Starting with MY 2008, EPA started employing a "five-cycle" test methodology to measure fuel economy for purposes of new car window stickers (labels) to give consumers better information on the fuel economy they could more reasonably expect under real-world driving conditions.[588] However, for GHG compliance, EPA continues to use the established "two-cycle" (city and highway test cycles, also known as the FTP and HFET) test methodology.[589] As learned through development of the "five-cycle" methodology and prior rulemakings, there are technologies that provide real-world GHG emissions improvements, but whose improvements are not fully reflected on the "two-cycle" test. EPA established the off-cycle credit program in 40 CFR 86.1869–12 to provide an appropriate level of CO_2 credit for technologies that achieve CO_2 reductions but may not otherwise be chosen as a GHG control strategy, as their GHG benefits are not measured on the specified 2-cycle test. For example, high efficiency lighting is not measured on EPA's 2-cycle tests because lighting is not turned on as part of the test procedure, but this technology reduces CO_2 emissions by decreasing the electrical load on the alternator and engine. Both light-duty and medium-

[586] 88 FR 73098, October 24, 2023.

[587] EPA did not reopen the refrigerant-based credits for MYs 2025–2026. In EPA's judgment, such an action (which we did not take) would appropriately be accompanied by a proposal to revise the stringency of the footprint curves for those model years, established in the 2021 rule, to account for the absence of the availability of refrigerant-based credits. EPA did not revisit the standards it established for MYs 2023–2026.

[588] *https://www.epa.gov/vehicle-and-fuel-emissions-testing/dynamometer-drive-schedules.* See also 75 FR 25439 for a discussion of 5-cycle testing.

[589] The city and highway test cycles, commonly referred to together as the "2-cycle tests" are laboratory compliance tests that are effectively required by law for CAFE, and also used for determining compliance with the GHG standards. 49 U.S.C. 32904(c).

duty vehicles may generate off-cycle credits, but the program is much more limited in the medium-duty work factor-based program.

Under EPA's regulations through MY 2026, there are three pathways by which a manufacturer may accrue light-duty vehicle off-cycle technology credits.[590] The first pathway is a predetermined list or ''menu'' of credit values for specific off-cycle technologies that has been effective since MY 2014.[591] This pathway allows manufacturers to use credit values established by EPA for a wide range of off-cycle technologies, with minimal or no data submittal or testing requirements. The menu includes a fleetwide cap on credits to address the uncertainty of a one-size-fits-all credit level for all vehicles and the limitations of the data and analysis used as the basis of the menu credits. The menu cap is 10 g/mile except for a temporary increased cap of 15 g/mile available only for MYs 2023–2026, adopted by EPA in the 2021 rule.[592] The existing menu technologies and associated credits are summarized in Table 29 and Table 30.[593]

TABLE 29—EXISTING OFF-CYCLE TECHNOLOGIES AND CREDITS FOR CARS AND LIGHT TRUCKS

Technology	Credit for cars (g/mile)	Credit for light trucks (g/mile)
High Efficiency Alternator (at 73%; scalable)	1.0	1.0
High Efficiency Exterior Lighting (at 100W)	1.0	1.0
Waste Heat Recovery (at 100W; scalable)	0.7	0.7
Solar Roof Panels (for 75W, battery charging only)	3.3	3.3
Solar Roof Panels (for 75W, active cabin ventilation plus battery charging)	2.5	2.5
Active Aerodynamic Improvements (scalable)	0.6	1.0
Engine Idle Start-Stop with 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

TABLE 30—EXISTING OFF-CYCLE TECHNOLOGIES AND CREDITS FOR SOLAR/THERMAL CONTROL TECHNOLOGIES FOR CARS AND LIGHT TRUCKS

Thermal control technology	Car credit (g/mile)	Truck credit (g/mile)
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

A second pathway allows manufacturers of light-duty vehicles to use 5-cycle testing to demonstrate and justify off-cycle CO_2 credits.[594] The additional emissions tests allow emission benefits to be demonstrated over some elements of real-world driving not captured by the GHG compliance tests, including high speeds, rapid accelerations, and cold temperatures. Under this pathway, manufacturers submit test data to EPA, and EPA determines whether there is sufficient technical basis to approve the off-cycle credits. The third pathway allows manufacturers to seek EPA approval, through a notice and comment process, to use an alternative methodology other than the menu or 5-cycle methodology for determining the off-cycle technology CO_2 credits.[595] This option is only available if the benefit of the technology cannot be adequately demonstrated using the 5-cycle methodology. For MDVs, the manufacturers may use the public process or 5-cycle pathways for generating credits.[596] There is no off-cycle credits menu for MDVs.

EPA designed the off-cycle program to provide an incentive for new and innovative technologies that reduce real world CO_2 emissions primarily outside of the 2-cycle test procedures (*i.e.,* off-cycle) such that most of the emissions reductions are not reflected or ''captured'' during certification testing. The program also provides flexibility to manufacturers since off-cycle credits may be used to meet their emissions reduction obligations.

Since MY 2012, the program has successfully encouraged the introduction and use of a variety of off-cycle technologies, especially menu technologies under the light-duty program. The use of several menu technologies has steadily increased over time, including engine stop-start, active aerodynamics, high efficiency alternators, high efficiency lighting, and thermal controls that reduce A/C energy demand. The program has allowed manufacturers to reduce emissions by applying off-cycle technologies, at lower overall costs, compared to the technologies that would have otherwise been used to provide reductions over the 2-cycle test, consistent with the intent of the program. Since MY 2012, the quantity of off-cycle credits generated by manufacturers steadily increased over time. In MY 2022, the industry averaged 9.2 g/mile of credits with more than 95 percent of those

[590] ''The 2023 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–23–033, December 2023, for information regarding the use of each pathway by manufacturers.

[591] See 40 CFR 86.1869–12(b).

[592] See 86 FR 74465.

[593] See 40 CFR 86.1869–12(b). See also ''Joint Technical Support Document: Final Rulemaking for 2017–2025 Light-duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for the Final Rule,'' EPA–420–R–12–901, August 2012, for further information on the definitions and derivation of the credit values.

[594] See 40 CFR 86.1869–12(c).

[595] See 40 CFR 86.1869–12(d).

[596] See 40 CFR 86.1819–14(d)(13).

credits based on the menu.[597] Seven manufacturers (BMW, Ford, GM, Honda, Jaguar Land Rover, Stellantis, and VW) claimed the maximum menu credit available of 10 g/mile.[579] Most manufacturers used at least some off-cycle technologies on 60–100 percent of vehicles.[598]

The program has had mixed results for 5-cycle and public process pathways. There have been few 5-cycle credit demonstrations, and the public process pathway has been challenging due to the complexity of demonstrating real-world emissions reductions for technologies not listed on the menu. The public process pathway was used successfully by several manufacturers for high efficiency alternators, resulting in EPA adding this technology to the off-cycle menu beginning in MY 2021.[599] The program has resulted in a number of concepts for potential off-cycle technologies over the years, but few have been implemented, at least partly due to the difficulty in demonstrating the quantifiable real-world emissions reductions associated with using the technology. Many credits sought by manufacturers have been relatively small (less than 1 g/mile). Over the past several years, manufacturers have commented that the process takes too long, but the length of time is often associated with the need for additional data and information or issues regarding whether a technology is eligible for credits.

ii. Phase Out of Off-Cycle Credits

EPA proposed a phase-out of the off-cycle program for light-duty vehicles as follows: (1) by setting a declining menu cap starting with the 10 g/mile cap currently in place for MY 2027 and then phasing down to 8.0/6.0/3.0/0.0 g/mile over MYs 2028–2031 such that MY 2030 would be the last year manufacturers could generate credits; (2) by eliminating the 5-cycle and public process pathways starting in MY 2027; and (3) by limiting eligibility for off-cycle credits to vehicles with tailpipe emissions greater than zero (*i.e.,* vehicles equipped with IC engines) starting in MY 2027.

EPA received a range of comments on the off-cycle program proposal. Comments received from environmental NGOs, consumer groups, and many states were generally supportive of the proposed phase-out of the off-cycle credits program, and many of these commenters expressed concerns that the off-cycle credits are not achieving the real-world reductions reflected by the current menu values. Comments received from auto manufacturers expressed concern about the phase-out of the off-cycle credit program as they believe the off-cycle program provides an important additional pathway for vehicle technologies that they believe reflect real-world CO_2 emissions reductions. Different auto manufacturers provided various suggestions on how the off-cycle program should be retained, and many suggested that any phase-out of the menu credits should be slowed down and extended for additional model years. Specifically, several auto manufacturers believed that, at a minimum, any phase-down of the off-cycle credits program, like the A/C leakage credits program, should be slowed down in the early years of the program as an additional means of providing necessary lead time for the revised standards. Manufacturers stated that they view the off-cycle credits as a potential tool for addressing uncertainties in meeting the level of stringency of the standards especially in the early years of the program, as the credits provide an additional means to ensure the emissions targets are met. Auto industry commenters also noted that manufacturers have made investments in off-cycle technologies which are included as part of their compliance plans and noted that off-cycle technologies are among the lowest cost means to reduce emissions.

Upon considering this range of public comments, EPA is finalizing a phase-out of off-cycle menu credits over the MY 2030–2033 timeframe as a reasonable way to bring the program to an end. Specifically, EPA is extending the phase-out of off-cycle menu credits, compared to our proposal, to provide a longer transition period. As discussed in the proposal (section III.B.6 of the draft preamble) and above, the off-cycle credit program was originally designed both to give an incentive for new and innovative technologies, and to provide additional flexibility for manufacturers in meeting the standards. Moreover, as with AC credits, the level of the standards was determined in light of the availability of these credits.

EPA now finds that the off-cycle program has achieved its goal of incentivizing the adoption of innovative technologies for ICE-based vehicles to reduce emissions that might otherwise not have been adopted. EPA also recognizes that, as some commenters argue, the credit values for implementing specific technologies are outdated and may no longer be reflective of the real-world emissions impact of the off-cycle technologies. These concerns are only heightened by the increase of BEVs in the market and the increased stringency of the standards (which makes off-cycle credits a greater proportion of compliance). For these reasons, and as explained further below, EPA finds it appropriate to phase out the off-cycle program, including finalizing its proposal to eliminate the 5-cycle and the public process pathways for off-cycle credits beginning in MY 2027 for both light-duty and medium-duty vehicles.

At the same time, EPA recognizes that there will be a substantial number of ICE-based vehicles sold under these standards which would benefit from off-cycle technologies that reduce emissions and we recognize that manufacturers may have made substantial use of off-cycle credits in their planned compliance strategies, a concern which is heightened by the increase in stringency of the standards. For these reasons, and consistent with our past practice of taking the availability of credits into account in determining the appropriate level of the standards, we judge that it is appropriate to adopt a slower phase-out of the off-cycle credits to provide a smoother transition and reduce concerns about lead time for the early years of the program. Specifically, instead of the proposed menu cap phase-out of 10/8/6/3/0 g/mile in MYs 2027–2031, EPA is finalizing provisions that retain the 10 g/mile menu cap through MY 2030, with a phase-out of 8/6/0 g/mile in MYs 2031–2033. The final phase-out of the menu cap is shown in Table 31.

TABLE 31—OFF-CYCLE MENU CREDIT CAP PHASE DOWN, FINAL PROGRAM, EXPRESSED IN CO_2 G/MILE

MY	Off-cycle menu credit cap (CO_2 g/mile)
2027	10
2028	10
2029	10
2030	10
2031	8.0
2032	6.0
2033 and later	0.0

EPA is also finalizing its proposal to limit eligibility of off-cycle credits to vehicles equipped with an IC engine beginning in MY 2027; thus, BEVs will no longer be eligible for off-cycle credits beginning in MY 2027. The off-cycle menu credits were established based on

[597] The 2023 EPA Automotive Trends Report (EPA–420–R–23–033), December 2023. See Tables 5.3 and 5.4.

[598] *Ibid.* Figure 5.8.

[599] 85 FR 25236.

potential emissions reductions from ICE vehicles and are not representative of emissions reductions from BEVs. As with A/C efficiency credits, there is no technical basis for providing BEVs with off-cycle credits to reflect technologies that decrease vehicle engine emissions because BEVs completely prevent engine emissions.

Previously, the cap was applied to individual manufacturers by dividing the credits generated by a manufacturer's entire vehicle production to determine an average credit level for the model year. As was proposed, EPA is finalizing that starting in MY 2027, the denominator will include only eligible vehicles (*i.e.,* vehicles equipped with an IC engine) rather than all vehicles produced by the manufacturer.

Also, as discussed in detail in section III.C.8 of this preamble, EPA is revising the utility factor for PHEVs. While PHEVs will remain eligible for off-cycle credits under EPA's eligibility criteria, EPA is finalizing, as a reasonable approach for addressing off-cycle credits for PHEVs, to scale the calculated credit value for PHEVs based on the vehicle's assigned utility factor. For example, if a PHEV has a utility factor of 0.3, meaning the vehicle is estimated to operate as an ICE vehicle 70 percent of the vehicle's VMT, the PHEV will earn an off-cycle credit that is 70 percent of the full value to properly account for the value of the off-cycle credit corresponding to expected engine operation. This calculation methodology corrects errors in the way we described how to apply a utility factor correction for PHEV off-cycle credits in the proposed rule. As was the case in the previous program, individual vehicles can generate more credits than the fleetwide cap value but the fleet average credits must remain at or below the applicable menu cap.

EPA believes that phasing out the off-cycle program is generally consistent with EPA's standards and the direction it appears the industry is headed in changing their vehicle mix toward vehicle electrification technologies. EPA originally created the off-cycle program both to provide flexibility to manufacturers and to encourage the development of new and innovative technologies that might not otherwise be used because their benefits were not captured on the 2-cycle test. EPA believes the off-cycle credits program has successfully served these purposes. However, the credits were based on estimated emissions improvements for ICE vehicles which at the time accounted for the vast majority of vehicles produced. Now with the industry focusing most R&D resources on vehicle electrification technology development and increasing production, as discussed in auto industry comments (see RTC section 3.3) and sections I.A.2 and IV.C.1 of this preamble,[600] [601] [602] the development of additional technologies that might potentially generate off-cycle credits is not likely to be a key area of focus for manufacturers. In addition, EPA believes that it is not likely that manufacturers would invest resources on off-cycle technology in the future for their ICE vehicle fleet that is likely to become a smaller part of their overall vehicle mix over the next several years. For example, in MY 2021, credits per technology generated under the public process pathways were all well below 1 g/mile[603] and there is little reason to expect the program to drive significant new innovation in the future. The public process pathway has been in place since the 2010 rule and manufacturers have had ample opportunity to consider potential off-cycle technologies. The 5-cycle process pathway has been seldom utilized; this pathway has been used by only one manufacturer and for only one technology applied to several vehicles through MY 2017.[604] Also, since most manufacturers have stated their future product plans will focus on electrifications, manufacturers would be recouping any investment in off-cycle technologies, with relatively small emission reductions, over a decreasing number of ICE vehicles in their fleets.

In addition, the off-cycle credits were initially small relative to the average fleet emissions and standards. For example, in the 2012 rule, EPA established menu credits of up to 10 g/mile, a relatively small value compared to a projected fleet-wide average compliance value of about 243 g/mile in MY 2016 phasing down to 163 g/mile in MY 2025.[605] Across the MY 2016–2025 program, therefore, EPA projected menu credits would be about 4 percent to 6 percent of the standard. Now, EPA is finalizing standards that will reduce fleet average emissions to a projected 85 g/mile and therefore off-cycle credits would become an outsized portion (*e.g.,* up to 12 percent) of the program if they were retained in their current form. One concern is that there is not currently a mechanism to check that off-cycle technologies provide emissions reductions in use commensurate with the level of the credits the menu provides. This is becoming more of a concern as vehicles become less polluting overall. The menu credits are based on MY 2008 vintage engine and vehicle baseline technologies (assessed during the 2012 rule) and therefore the credit levels are potentially becoming less representative of the emissions reductions provided by the off-cycle technologies as vehicle emissions are reduced. Some stakeholders have also become increasingly concerned that the emissions reductions reflected in the off-cycle credits may not be being achieved, as also expressed by some stakeholders in the public comments on the proposal.[606] Also, details such as the synergistic effects and overlap among off-cycle technologies take on more importance as the credits represent a larger portion of the emissions reductions. During the 2021 rulemaking to revise the MY 2023–2026 standards, EPA received comments that due to the potential for loss of GHG emissions reductions, the off-cycle program should be further constrained, or discontinued, or that a significantly more robust mechanism be implemented for verifying purported emissions reductions of off-cycle technologies. The potential for a loss of GHG emissions reductions could become further exacerbated as the standards become more stringent.[604]

Initially, EPA addressed the uncertainty surrounding the precise emissions reductions from equipping vehicle models with off-cycle technologies by making the initial credit values conservative, but the values may no longer be conservative, and may even provide more credits than appropriate for later MY vehicles. Because off-cycle credits effectively displace two-cycle emissions reductions, EPA has long strived to ensure that off-cycle credits are based on real-world reductions and do not result in a loss of emissions reductions overall. EPA received

[600] Reuters, ''A Reuters analysis of 37 global automakers found that they plan to invest nearly $1.2 trillion in electric vehicles and batteries through 2030,'' October 21, 2022. Accessed on November 4, 2022 at *https://graphics.reuters.com/AUTOS-INVESTMENT/ELECTRIC/akpeqgzqypr/.*

[601] Reuters, ''Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030,'' October 25, 2022. Accessed on November 4, 2022 at *https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/.*

[602] Center for Automotive Research, ''Automakers Invest Billions in North American EV and Battery Manufacturing Facilities,'' July 21, 2022. Retrieved on November 10, 2022 at *https://www.cargroup.org/automakers-invest-billions-in-north-american-ev-and-battery-manufacturing-facilities/.*

[603] ''The 2023 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–23–033, December 2023. Table 5.4.

[604] *Ibid.* Section 5.B, page 107.

[605] 77 FR 62641.

[606] ''Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emission Standards: Response to Comments,'' Chapter 8, EPA–420–R–21–027, December 2021.

comments in past rules that it should revise the program to better ensure real-world emissions reductions.[604] However, EPA has learned through its experience with the program to date that such demonstrations can be exceedingly challenging. At this time, EPA has not identified a single robust methodology that can provide sufficient assurance across potential off-cycle technologies due to the wide variety of off-cycle real world conditions over which a potential technology may reduce emissions. EPA does not have a methodology that would provide such assurance across a range of technologies, nor did commenters provide suggestions on such a methodology. Finally, while the off-cycle program provides an incentive for off-cycle emissions reduction technologies, it does not include full accounting of off-cycle emissions. Vehicle equipment such as remote start and even roof racks added at the dealership may well increase off-cycle emissions. For all of these reasons, EPA's final rule de-emphasizes the role of off-cycle credits in the future and the credits will be phased out over time, with the program ending altogether in MY 2033 as described above.

7. Treatment of PEVs and FCEVs in the Fleet Average

In the 2010 rule, for MYs 2012–2016, EPA measured compliance based on tailpipe emissions for the electric-only portion of operation of BEVs/PHEVs/FCEVs up to a per-company cumulative production cap.[607] As originally envisioned in the 2012 rule, starting with MY 2022, the compliance value for BEVs, FCEVs, and the electric portion of PHEVs in excess of individual automaker cumulative production caps would be based in part on net upstream emissions accounting (*i.e.,* EPA would attribute a pro rata share of national CO_2 emissions from electricity generation to each mile driven under electric power minus a pro rata share of upstream emissions associated with from gasoline production). The 2012 rule would have required net upstream emissions accounting for all MY 2022 and later electrified vehicles. However, in the 2020 rule, prior to upstream accounting taking effect for any automaker, EPA revised its regulations to extend the practice of basing compliance on tailpipe emissions for all vehicle and fuel types through MY 2026 with no production cap.

In this rule, EPA is making the current treatment of PEVs and FCEVs through MY 2026 permanent, as proposed. EPA is including only emissions measured directly from the vehicle in the vehicle GHG program for MYs 2027 and later, consistent with the treatment of all other vehicles. For purposes of measuring compliance with tailpipe emissions standards, emissions from electric vehicle operation will be measured based on tailpipe emissions. Vehicles with no IC engine (*i.e.,* BEVs and FCEVs) will be counted as 0 g/mile in compliance calculations, while PHEVs will apply the 0 g/mile factor to electric-only vehicle operation (see also section III.C.8 of the preamble for EPA's treatment of PHEVs).[608] The program has now been in place for a decade, since MY 2012, with no upstream adjustments to tailpipe compliance calculations. EPA originally proposed using upstream emissions in PEV compliance calculations at a time when there was little if any regulation of stationary sources for GHGs, and noted at the time this was a departure from its usual practice of relying on stationary source programs to address pollution risks from stationary sources.[609] In the 2020 rule, EPA extended 0 g/mile in part because power sector emissions were declining and the trend was projected to continue and stated ''EPA agrees that, at this time, manufacturers should not account for upstream utility emissions.'' [610] As noted elsewhere, power sector emissions are expected to decline significantly in the future. EPA continues to believe that it is appropriate for any vehicle which has zero tailpipe emissions to use 0 g/mile as its compliance value.[611] This approach of looking only at vehicle emissions and letting stationary source GHG emissions be addressed by separate stationary source programs is consistent with how the compliance value for every other motor vehicle is calculated. EPA notes that emissions from stationary sources under CAA title I are regulated under an entirely different statutory scheme than mobile sources under CAA title II and the upstream adjustment EPA originally adopted would make the compliance test results of BEVs depend in part on factors entirely beyond the control of BEV manufacturers (*i.e.,* the carbon emissions and transmission efficiency of the electricity grid, as compared to emissions of the refinery sector). Moreover, if EPA deviated from this tailpipe emissions approach by including upstream accounting, it is unclear why it would be appropriate to do so for BEV but not for all vehicles, including gasoline-fueled vehicles. Put more concretely, EPA does not think it is appropriate to subject vehicle manufacturers to a compliance scheme that effectively requires them to account for emissions arising from factors as diverse as the extraction of coal, natural gas, and crude oil; crude oil refining; electricity generation; electricity transmission; and wholesale and retail distribution of gasoline. These factors reinforce EPA's conclusion that the appropriate basis for measuring compliance with engine and vehicle standards promulgated under CAA 202 are emissions from vehicles and engines. EPA notes that while upstream emissions are not included in vehicle compliance determinations, which are based on direct vehicle emissions, upstream emissions impacts from fuel production at refineries and electricity generating units are considered in EPA's analysis of overall estimated emissions impacts and projected benefits, as detailed in section VIII of this preamble.

8. PHEV Utility Factor

i. Final Fleet Utility Factor

A fleet utility factor provides a means of accounting for a PHEV's operation using electricity, known as the charge depleting mode, with respect to the total mileage that a PHEV travels. The distance traveled by a PHEV driver in charge depleting mode is dependent on two significant factors. The first is the size or capacity of the battery. Typically, a PHEV with a larger battery will have greater charge depleting range, all other vehicle attributes equal. The second important factor is the driver's propensity to charge the battery. SAE J2841 states explicitly that the UF represented in the SAE standard assumes that a PHEV is fully charged at least once per day. Recent data and literature have identified that the current utility factor curves overestimate the fraction of driving that occurs in charge depleting operation. Vehicle operators are not charging their

[607] 75 FR 25234 (May 7, 2010). As discussed elsewhere in this preamble, in addition to measuring tailpipe emissions for compliance, EPA has adopted credit programs for ''off-cycle'' and A/C, which reflect emissions that are not captured on the compliance test cycles.

[608] EPA notes that in our regulations governing the emissions testing of light-duty vehicles there is a statement that manufacturers of BEVs need not submit test data, and ''[t]ailpipe emissions of regulated pollutants from vehicles powered solely by electricity are deemed to be zero.'' 40 CFR 86.1829–15(f). EPA adopted this provision in recognition of the fact that requiring BEV manufacturers to undertake emissions testing of their vehicles would be an unreasonable burden, precisely because it is well-established that every BEV will have zero tailpipe emissions.

[609] 75 FR 25434.

[610] 85 FR 25208.

[611] See Section IV.C.3 of this preamble for a full discussion of power sector emissions projections.

vehicles often enough, and/or are operating them in a manner that results in substantially less charge depleting operation and greater CO_2 emissions as compared to the current PHEV compliance procedure. This literature also concludes that vehicles with lower charge depleting ranges have even greater discrepancy between the compliance procedure and actual CO_2 emissions.

EPA is finalizing its proposed change to the light-duty vehicle PHEV Fleet Utility Factor (FUF) curve used in CO_2 compliance calculations for PHEVs but delaying its implementation in recognition of the benefits of providing additional lead time for manufacturers to adjust to this change. The current SAE J2841 FUF curve and the finalized FUF curve are shown in Figure 11.

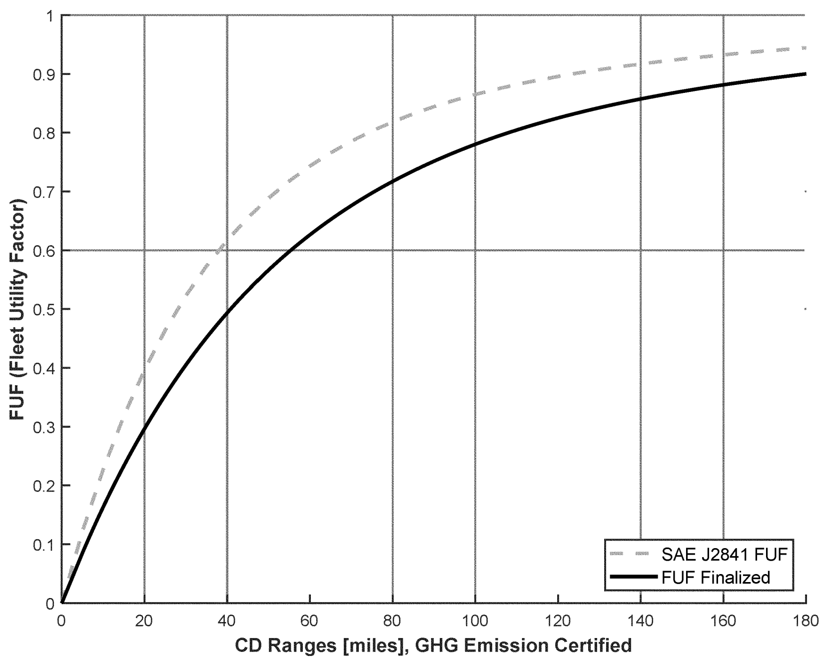

Figure 11: SAE J2841 FUF and Finalized FUF (Fleet Utility Factor) for PHEV Compliance

EPA received many comments regarding the proposed change to the PHEV fleet utility factor (FUF). Many NGOs and state air organizations supported a change to the fleet utility factor based on the available data, third party analyses, and EPA's analysis. These commenters noted that the current SAE J2841-based utility factor provides too much credit because actual CO_2 emissions from PHEVs are much higher than estimated in the current compliance calculation. The NGOs also believe that the continued application of the SAE UF could result in inaccurate and lower accounting of CO_2 emissions for PHEVs than in-use data indicates, thereby allowing manufacturers to delay application of additional CO_2-reducing technologies. These commenters also noted that the current PHEV data supports a utility factor much lower than that proposed. Several NGOs and the California Air Resources Board recommended that EPA adopt a lower utility factor than the one proposed, based on the available data.

In contrast, the Alliance for Automotive Innovation (AAI) and several of its member companies recommended that EPA retain the current SAE J2841-based utility factor. The comments from industry noted the importance of PHEVs as a bridge technology to BEVs. These commenters hypothesized that future PHEVs would be operated in a manner better reflected by the SAE-based UF, based on their projections that future PHEVs will have increased range and power, as the result of the CARB's ACC II requirements, and that future expansions of charging infrastructure and increasing consumer familiarity with PHEVs will lead to consumers charging PHEVs more frequently. In addition, AAI and some of the vehicle manufacturers commented on the quality of the data used to support the proposed PHEV FUF, the California Bureau of Automotive Repair (BAR) data, and the analytical methods that EPA applied, for example, stating the data set was not statistically significant and not a valid representation of current or future PHEV activity. Industry and academic commenters also commented that the data set was skewed towards vehicles that had recently relocated to the state of California that had potentially been operated over long distances without charging. Several commenters also believed that the proposed FUF was not a better representation of the PHEV FUF as compared to the SAE J2841-based FUF and should therefore not be finalized. Finally, AAI, vehicle manufacturers and an academic coalition recommend that if a new FUF is appropriate, then instead of finalizing a revised FUF in this rule, EPA should work collaboratively with the Department of Transportation, Department of Energy, Society of Automotive Engineers, and vehicle manufacturers to develop an alternative.

EPA carefully considered all the comments we received in response to the proposed revised FUF. In addition, and as noted below, we have received an updated set of data from BAR representing an additional year of PHEV activity. Also, in response to comments received, we duplicated and expanded the statistical analysis of all the available data to address the technical analysis concerns raised in comments.

EPA agrees with commenters on the importance of PHEVs as a technology that might be best suited to meet the needs of some consumers, particularly over the timeframe of this rulemaking. PHEVs have the potential to reduce vehicle GHG emissions, but the degree to which that potential is realized depends on whether they are charged and operating on electricity. EPA's goal is to apply a fleet utility factor which accurately accounts for PHEV greenhouse gas emissions. SAE J2841 states explicitly that the UF represented in SAE standard assumes that a PHEV is fully charged at least once per day. Recent literature [612] and data have identified that the current utility factor curves overestimate the fraction of driving that occurs in charge depleting operation. This literature also concludes that vehicles with lower charge depleting ranges have even greater discrepancy in CO_2 emissions.

While EPA used BAR data from October 2022 [613] for the NPRM, an additional year of data was available to inform this FRM. In November 2023 [614] OBD datasets were made available for EPA to analyze. EPA found that the expanded data set confirms that, on average, there are more charge sustaining miles traveled and more gasoline miles traveled than are predicted by the current SAE J2841 FUF (Fleet Utility Factor) curves.[615] The BAR OBD data enables the evaluation of real-world PHEV distances traveled in various operational modes; these include charge-depleting engine-off distance, charge-depleting engine-on distance, charge-sustaining engine-on distance, total distance traveled, odometer readings, total fuel consumed, and total grid energy inputs and outputs of the battery pack. These fields allow us to filter the BAR OBD data and calculate real-world driving FUFs (ratios of charge depleting distance to total distance) and to then compare to the existing SAE J2841 FUFs as calculated and applied in EPA's GHG emissions certification using the 2-cycle charge depleting range values.[616] Although we have reached a similar conclusion to other studies that have been conducted to evaluate PHEV utility, the BAR data has allowed EPA to analyze PHEV utility specifically on distance traveled in each mode as recorded by the vehicle itself, using recording strategies required by CARB and implemented by the vehicle manufacturers. In addition, the integrity of the data recorded by the vehicles is subject to CARB's regulatory enforcement. Other studies [617] [618] regarding PHEV utility have attempted to calculate distance traveled in each mode using energy and fuel consumption or the labeled values. Because energy and fuel consumption can vary greatly based on operating and environmental conditions distance calculations can also vary, EPA did not rely on these types of analyses to inform this final rule.

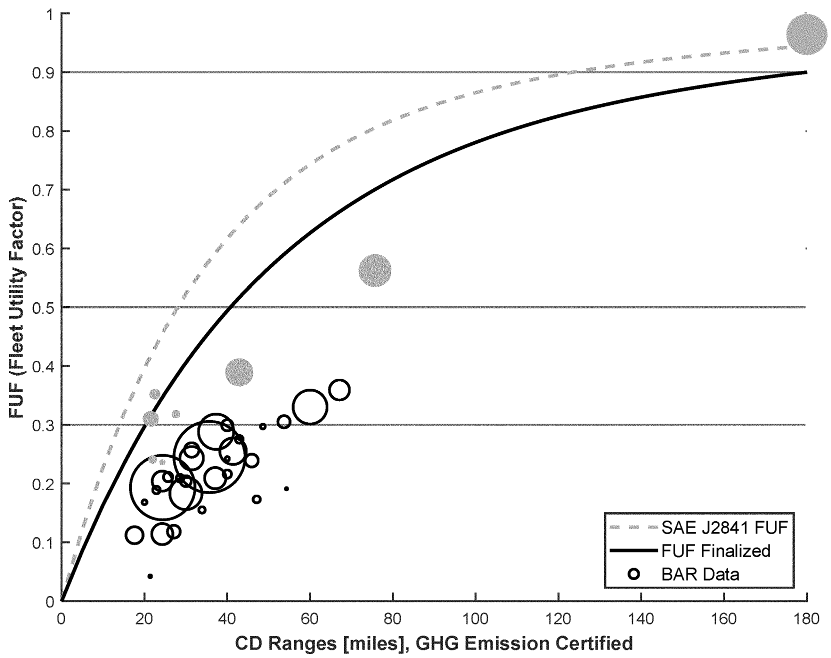

Figure 12: FUF Finalized, and SAE J2841 FUF Curves on 2-Cycle Combined GHG Emission-Certified CD Range

Figure 12 shows an overlay of points from the BAR data, representing individual vehicle models, together with the current and final FUF curves from Figure 11, labeled "SAE J2841 FUF" and "FUF finalized", respectively. The finalized FUF curve represents a modest change of about 11 percent from SAE J2841 FUF curve.

EPA's assessment of the updated BAR data, consistent with our analysis of the BAR data used for the NPRM, is that the current FUF based on SAE J2841 lies above the vast majority of charge depleting operation of current PHEV models and associated activity. While it may be that an even lower curve than we are finalizing might more appropriately reflect current real-world usage, based on our updated analysis and comments received, EPA is

[612] Aaron Isenstadt, Zifei Yang, Stephanie Searle, John German. 2022. "Real world usage of plug-in hybrid vehicles in the United States," *https://theicct.org/publication/real-world-phev-us-dec22/*, ICCT.

[613] California Air Resource Board [OBD data records]. 2022. October. *https://www.bar.ca.gov/records-requests.*

[614] California Air Resource Board [OBD data records]. 2023. November. *https://www.bar.ca.gov/records-requests.*

[615] EPA finds that the additional data provides confirmation that the current UF is overstating CD miles.

[616] The existing regulatory FUFs are separate city and highway curves, and the charge depleting ranges that are used with the city and highway FUF curves are 2-cycle range.

[617] Patrick Plötz et al, "From lab-to-road: real-world fuel consumption and CO2 emissions of plug-in hybrid electric vehicles," 2021 Environ. Res. Lett. 16 054078.

[618] Patrick Plötz et al 2023, "Corrigendum: From lab-to-road: real-world fuel consumption and CO2 emissions of plug-in hybrid electric vehicles (2021 Environ. Res. Lett.16054078)," Environ. Res. Lett. 18 099502.

finalizing the proposed curve to reflect anticipated usage patterns in future model years. Our updated analysis, summary of the comments received, and how EPA considered those comments is outlined below.

First, the agency determined that a curve shape with a generally increasing slope and which asymptotically approaches its upper limit is appropriate. Specifically, the BAR data clearly supports EPA's, and SAE's, conclusion that the potential for greater charge depleting operation increases as a function of a PHEV's estimated charge depleting range. At the same time, it is reasonable to conclude that increases in FUF should diminish continuously as range increases in value (*i.e.* approaches an upper asymptote), since any other assumption would result in FUF values eventually exceeding the physical limit of FUF equal to 1. For these reasons, EPA has chosen to maintain the basic form of the SAE J2841 equation to define the final FUF curve.

Second, having determined the appropriate shape of the curve, EPA has chosen a position of the curve (along the FUF-axis, vertically) that appropriately balances the evidence from the typical use of PHEV's today with the consideration of factors that are expected to increase charge depleting operation in the future. Several vehicle manufacturers and the Alliance for Automotive Innovation (AAI) asserted that ''growth in charging infrastructure coupled with higher capability PHEVs means that the current utility factor will be representative for future PHEVs and should remain unchanged.'' [619] In addition, AAI noted that ''EPA's proposed PHEV cold start requirement encourages more all-electric operation. Further CARB requires a minimum 70-mile combined city and highway and 40-mile US06 all-electric range starting in MY 2029. These requirements force all new PHEVs under development to be highly capable.'' [620] While EPA disagrees that there is any compelling evidence that typical PHEVs in the future will reach the SAE J2841 level of charge depleting operation, we do see evidence in the BAR data where PHEVs with higher charge depleting driving capability and power tend to have higher FUF than typical PHEVs in use today. EPA observed that vehicles with higher demonstrated charge depleting operation in the BAR data tended to also have higher electric drive capability. The shaded points in Figure 12 represent vehicles that are more likely typical of future PHEV designs and strongly influenced EPA's determination of the position of the final curve. As noted below, this conclusion is supported by comments received.

EPA also recognizes that charging infrastructure is expected to become more widely available, and vehicle manufacturers can have a significant influence on PHEV operation through increased customer understanding of PHEV technology, supportive infrastructure, such as assistance in home charging installation and manufacturer provided charging cables, advertising which focuses on PHEV technology and internet resources, such as instructional videos and FAQ's, that help their customers maximize their vehicle's all electric operation and reduce GHG emissions. Because the current SAE utility factor assumes that PHEVs are fully charged once per day, manufacturers may have had less motivation to ensure that their customers were completely familiar with PHEV technology or that the customers had access to the appropriate infrastructure. While the data on current PHEV activity could support further revisions to the fleet utility factor, EPA is setting a FUF for future model years based on our expectations about charging and PHEV performance that will occur in those future years. We are also taking into consideration the views of automakers that the improvements they anticipate in product design (such as range), consumer education and awareness, and charging convenience with expanded infrastructure will result in PHEV activity that is similar to the finalized FUF. In light of manufacturer plans to improve PHEV technology and the potential for improved customer knowledge and infrastructure, EPA is finalizing the PHEV fleet utility factor as proposed.

At the same time, EPA is committed to an ongoing evaluation of future PHEV FUF data to assess whether the revised FUF is in fact adequately representative of future PHEV operation, as a result of future PHEV designs and consumer charging behavior, or if there is merit in further adjusting the FUF. EPA will take a multipronged approach to monitor, assess and, if warranted, potentially adjust the FUF through a future rulemaking action. First, EPA will continue to gather and monitor publicly available data such as that made available by California BAR. EPA will also collect, and monitor data extracted from available in-use PHEV testing and may further supplement the data set through other data gathering mechanisms, such as work done by the Department of Energy or independent contractors and researchers. Although vehicle manufacturers chose not to submit data as part of their public comments, EPA believes that with additional time it is reasonable to project that vehicle manufacturers can gather the same type of data, and in greater quantities, on their own PHEV models than available to EPA through the California BAR; we encourage auto manufacturers to share such data with EPA to inform this future assessment. Thus, second, EPA encourages researchers and other stakeholders, including manufacturers, to supplement the publicly available data by providing data directly to EPA for inclusion in an updated analysis. These first and second steps will form the basis for an assessment of how well future PHEV activity is represented by the FUF established in this final rule, and whether there is merit for proposing adjustments through a future rulemaking. Finally, EPA will engage with stakeholders to share results of our assessments, and to hear from stakeholders who may have their own data and analysis to share, for example, through public forums. If EPA determines that changes to the FUF are warranted, we will engage with stakeholders on technical details such as the shape of the FUF curve and the appropriate timing for its implementation. Stakeholders will also be encouraged to independently assess the publicly available data and provide individual conclusions. This process could also be an opportunity for stakeholders to provide input on changes to additional future program elements (for example, the possibility for manufacturers to submit data directly to EPA as part of the compliance process to a inform model level specific FUF). If such evaluation were to support a proposed revision to the FUF, EPA could initiate a future rulemaking to revise the FUF for MY 2031.

Furthermore, at the time of this final rule, MY 2025 vehicle production has already commenced. This means that manufacturers have approximately two years of lead time to address the revised standards and provisions finalized in this final rule. While lead time is addressed in many ways throughout this rulemaking, such as the year over year change in emission standard stringency and extensions of the phase-down of off-cycle and air conditioning leakage

[619] Comments of Alliance for Automotive Innovation at 107 (Docket ID EPA–HQ–OAR–2022–0829–0701).

[620] California Air Resource Board, ''Advanced Clean Cars II,'' Accessed on February 16, 2024 at *https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/advanced-clean-cars-ii.*

credits, we recognize that a fundamental change to the compliance methodology for any single technology in as little as two years could be significantly disruptive to some vehicle manufacturers' current compliance plans. Several auto manufacturers commented that the proposed revised PHEV utility factor would impact product planning and the overall emission reductions projected for their fleets to meet the standards. We also understand that several vehicle manufacturers have already made significant investments in PHEV technology and are relying on PHEVs as an important portion of their GHG compliance strategy. Without adequate time to adjust their product plans to the revised compliance values for PHEVs under the revised utility factor, and to plan for additional GHG-reducing technologies to ensure adequate additional emissions reductions to meet the standards, the revised FUF may disproportionately impact those manufacturers planning large volumes of PHEVs as compared to manufacturers who are not relying as heavily on PHEV technology. To mitigate such a potential impact and to address concerns about adequacy of lead time for the early years of the program, we are delaying the application of the revised FUF until MY 2031. EPA believes that the revising the FUF in MY 2031 will provide vehicle manufacturers adequate lead time for product development and product plan adjustments, given that the average vehicle redesign cycle is approximately five years.

ii. Consideration of CARB ACC II PHEV Provisions

CARB recently set minimum performance requirements for PHEVs in their ACC II program. These requirements include performance over the US06 test cycle and a minimum range and are meant to set qualifications for PHEVs to be included in a manufacturer's ZEV compliance. EPA received comments that it should adopt ACC II for PHEVs. ACC II is a suite of emissions standards that includes a ZEV mandate and other tools EPA is not using in this rule and it would not be appropriate to take only the PHEV portions of ACC II. EPA is not adopting the range and US06 performance requirements or fleet penetration limits that are included in the CARB ACC II ZEV provisions. EPA agrees that PHEVs meeting the performance provisions required by CARB in ACC II have the potential to provide greater environmental benefits as compared to other PHEVs that are less capable. However, unlike the ACC II program, the GHG program in this rulemaking is performance-based and not a ZEV mandate. In that regard, EPA believes that it is appropriate to have a robust GHG compliance program for PHEVs that properly accounts for their GHG emissions independent of a PHEV's range or capability over the US06 test cycle. We are addressing the issue of ensuring appropriate GHG compliance values for PHEVs through the revised PHEV fleet utility factor as described in section III.C.8 of this preamble; EPA is not adopting design requirements for PHEVs, that is, we are not adopting minimum range requirements or specifying minimum capability over any prescribed test cycles.

9. Small Volume Manufacturer GHG Standards

EPA's prior light-duty GHG program included unique provisions for small volume manufacturers (SVMs), defined as manufacturers with annual U.S. sales of less than 5,000 vehicles per year. In the 2012 rule, EPA adopted regulations allowing SVMs to petition EPA for alternative standards, recognizing the unique challenges SVMs could face in meeting the primary program standards in the timeframe of the MY 2017–2025 standards. There are currently four SVMs who have applied for, and been approved, less stringent, alternative standards: Aston Martin, Ferrari, Lotus, and McLaren.[621]

EPA believes it is appropriate to transition away from unique SVM standards and bring SVMs into the primary program. Although in the 2012 rule EPA provided SVMs with the opportunity to comply with manufacturer-specific standards which are substantially less stringent than the primary program, in EPA's judgment, developments in both the vehicles market and the market for credits warrants a transition for these manufacturers to the primary compliance program. When EPA established the SVM alternative standards option in the 2012 rule, certain legacy ICE technologies were the primary CO_2 control technologies and there was limited access to more advanced control technologies, particularly for luxury, high-performance, and certain other lower production volume vehicles. As discussed in the proposal, the landscape has fundamentally changed. Today, many larger manufacturers are already implementing more advanced technologies, including electrification technologies, across many vehicle types including both luxury and high-performance vehicles by larger manufacturers, and EPA expects this trend to continue. EPA believes that meeting the CO_2 standards is becoming less a feasibility issue and more a lead time issue for SVMs. Also, the credit trading market has become more robust since we initially established the SVM unique standards provisions. Now that it has, we would expect SVMs to be able to seek credit purchases as a compliance strategy option should they elect to do so.[622] As electrification technologies become more widespread and commonly used, EPA believes there is no reason SVMs cannot adopt similar technological approaches with enough lead time (or purchase credits or technology from other OEMs).[623]

As a reasonable way to transition SVMs into the primary program, EPA is finalizing a phase-in schedule over MYs 2027 to 2031 that will require SVMs to comply with primary program standards, but with additional years of lead time compared to larger volume manufacturers and compared to the proposed schedule for SVMs.[624] After this phase-in schedule, for MYs 2032 and later, SVMs will meet the primary program standards—that is, the same standards that apply to larger volume OEMs. EPA had proposed to have the phase-in to the primary program standards start with MY 2025, with the MY 2023 primary program standard applying for MYs 2025 and 2026. SVMs commented expressing concerns that beginning the phase-in to primary program standards in MYs 2025–2026 did not provide sufficient lead time. EPA acknowledges that MY 2025 may have already begun, and that MY 2026 may begin as early as January 2, 2025, approximately 9 months from the date of this final rule. In response to these comments, EPA believes it is appropriate to extend the SVM alternative standards established in MY 2021 through MY 2026, instead of through MY 2024 as proposed. Specifically, EPA is finalizing that SVM alternative standards established for MY 2021 will apply through MY 2026 to provide the requested stability for SVMs so that SVMs have an opportunity to reduce their GHG emissions in future years. This schedule provides a total of an additional five years of stability for the SVMs to transition from their

[621] See 85 FR 39561, July 1, 2020.

[622] ''The 2022 EPA Automotive Trends Report, Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975,'' EPA–420–R–22–029, December 2022.

[623] *https://ir.lucidmotors.com/news-releases/news-release-details/lucids-world-leading-electric-powertrain-technology-propels.*

[624] See 40 CFR 86.1818–12(h) for the primary program standards through MY 2026.

existing MY 2021 standards into delayed primary program standards after MY 2026. Starting in MY 2027, SVMs will meet primary program standards albeit with additional lead-time. As shown in Table 32, EPA is finalizing that SVMs will meet the primary program standards for MY 2025 in MY 2027, providing an additional two years of lead time as compared to larger volume manufacturers. EPA is also establishing a period of stability (keeping the standards at MY 2021 levels for MY 2021 through MY 2026) rather than year-over-year incremental reductions in the standards levels for SVMs which was 3 percent per year in their previous individual standards for MY 2017 to MY 2021. SVMs have fewer vehicle models over which to average, and EPA believes a staggered phase down in standards with a period of stability, and the opportunity to generate additional credits, between the steps is reasonable. As shown in Table 32, EPA is establishing a delayed schedule for SVMs to meet the primary program standards, until SVMs are required to meet the final MY 2032 standards in MY 2032. EPA did not reopen the eligibility requirements for the SVM standards currently in the regulations for SVM alternative standards and SVMs will need to remain eligible to use these provisions.[625]

TABLE 32—ADDITIONAL LEAD TIME FOR SVM STANDARDS UNDER THE PRIMARY PROGRAM

Model year	Primary program standards that apply	Years of additional lead time
2027	2025	2
2028	2025	3
2029	2027	2
2030	2028	2
2031	2030	1
2032 and later	2032	0

This additional lead time approach is similar to the approach EPA used in the 2012 rule to provide additional lead time to intermediate volume manufacturers.[626] As with the intermediate volume manufacturer temporary lead time flexibility, EPA believes that the additional lead time for SVMs will be sufficient to ease the transition to more stringent standards in the early years of the program that could otherwise present a difficult hurdle for them to overcome. The alternative phase-in will provide additional lead time for SVMs to better plan and implement the incorporation of CO_2 reducing technologies and/or provide time needed to seek and secure credits from other manufacturers, if they so choose, to bring them into compliance with the primary standards.

Importantly, SVMs will continue to remain eligible to use the ABT 5-year credit carry-forward provisions, allowing SVMs to bank credits in these intermediate years to further help smooth the transition from one step change in the standards to the next. EPA is, however, prohibiting any SVM opting to use the additional lead time allowance from trading credits generated under the additional lead time standards to another manufacturer. These credit provisions are already in place as part of the current SVM alternative standards, and EPA did not reopen them in this rulemaking. EPA believes that credit banking along with the staggered phase down of the standards will help SVMs meet the standards, recognizing that they have limited product lines. As with the SVM alternative standards, SVMs will have the option of following the additional lead time pathway with credit trading restrictions or opt into the primary program with no such restrictions. Once opted into the primary program, however, manufacturers will no longer be eligible for the alternative standards.

Environmental and public health organizations commented in support of our approach for phasing the SVMs into the primary program. They agreed with EPA's conclusions that transitioning SVMs into the primary program is consistent with the recent announcements and developments in the business models of the SVMs who have previously been approved less stringent standards.

EPA received comments from the SVMs opposing changes to the alternative standards approach, based on what they view as challenges in their ability to average across limited product lines, access to technology, limited volumes, and their position in the market compared to larger OEMs. EPA has carefully considered these comments and has concluded that it is appropriate to provide SVMs an extended phase in before meeting the standards of the primary program.

SVMs commented that they would not be able to comply without the purchase of credits and that they felt there was uncertainty in purchasing credits and that it was unfair to have a standard that, in their view, required the purchase of credits. EPA notes that it has modeled reasonable compliance paths for the SVMs. EPA has also modeled a ''no credit trading'' scenario which identifies a reasonable compliance path for the SVMs even if no automaker is willing to sell credits, a situation which we consider very unlikely to occur (especially in light of the surplus credits generated by EV-only manufacturers). EPA views these modeling results as confirmatory of, but not necessary to, our judgment that the standards are feasible and appropriate for SVMs, and we also note that these compliance paths were modeled under the conservative assumption that SVMs must meet the final standards without any additional lead time allowance. EPA also notes that the current regulatory structure offers SVMs substantial compliance flexibilities. SVMs have alternative standards for MY 2021 of between 308 and 377 g/mile, well above the primary program standards.[627] In addition, EPA is maintaining the MY 2021 alternative standards for 5 years to enable SVMs to bank credits. EPA notes the increasing market for luxury and high-performance vehicles with more advanced control technologies, including the electrified technologies already applied by some manufacturers, and judges that that the final standards are feasible and appropriate for SVMs in light of the combination of additional lead time, the

[625] See 40 CFR 86.1818–12(g).

[626] 77 FR 62795.

[627] See 85 FR 39561, July 1, 2020. For comparison, the maximum footprint target for any passenger car in MY 2021 under the primary program is 215 g/mile.

opportunity to bank additional credits as compared to the alternative standards and, if necessary, the opportunity to purchase credits. History has shown that SVMs can purchase credits when needed, as EPA's compliance data confirms that such transactions have occurred. As discussed elsewhere in this preamble, GHG credit trading is also currently happening between large OEMs, and the existence of BEV-only manufacturers, with anticipated increased future BEV volumes, provides further assurance that the market is available, if needed.

D. Criteria Pollutant Emissions Standards

EPA anticipates that internal combustion engine (ICE) vehicles will be a significant part of new vehicle sales for years to come. As the vehicle fleet ages, ICE-based vehicles will remain in-use throughout the analysis period for this final rule with an estimated 84 percent of the light- and medium-duty fleet continuing to burn fossil fuel in calendar year 2032 (see Chapter 8.2 of the RIA). EPA intends for its criteria pollutant emissions standards program to continue to obtain feasible and significant reductions in criteria pollutant [628] emissions and mobile source air toxics, while also ensuring that vehicles do not backslide on existing emissions control achievements.

EPA is finalizing changes to criteria pollutant emissions standards for both light-duty vehicles and medium-duty vehicles [629] (MDV). These criteria pollutant standards are referred to as Tier 4 standards below. The light-duty vehicle standards apply to LDV, light-duty trucks (LDT), and medium-duty passenger vehicles (MDPV) [630], while the MDV standards apply to class 2b and 3 vehicles. For both light-duty vehicles and MDV, NMOG+NO_X bin structure, −7°C NMOG+NO_X, PM, CO, formaldehyde (HCHO), −7°C CO, and NMOG+NO_X provisions aligned with the CARB Advanced Clean Cars II program phase-in over a period of time. The phase-in structure is described in section III.D.1 of this preamble.

For light-duty vehicles, EPA is finalizing more protective NMOG+NO_X standards in the form of a MY 2027–2032 declining fleet average for LDV and LDT1–2, the same declining fleet average for LDT3–4 and MPDV in the ''early'' compliance program, or alternatively, a single step down in MY 2030 for LDT3–4 and MPV in the ''default'' program. The revisions also include the elimination of higher certification bins, a requirement for the same fleet average emissions standard to be met across four test cycles (25°C FTP, HFET, US06, SC03), a change from a fleet average NMHC standard to a fleet average NMOG+NO_X standard in the −7°C FTP test, and three NMOG+NO_X provisions aligned with the CARB Advanced Clean Cars II program. Details are discussed in sections III.D.2 and III.D.7 of this preamble.

NMOG+NO_X changes for MDV include a fleet average that steps down in MY 2031 in the default program or declines from MYs 2027–2033 in the early compliance program, the elimination of higher certification bins, a requirement for the same fleet average emissions standard to be met across four test cycles (25°C FTP, HFET, US06, SC03), and a new fleet average NMOG+NO_X standard in the −7°C FTP. EPA is also finalizing in-use standards for spark ignition and compression ignition MDV with GCWR above 22,000 pounds that are consistent with MY 2031 and later California chassis-certified MDV in-use emissions standards.[631] NMOG+NO_X standards and other related provisions are discussed in sections III.D.2 and III.D.5 of this preamble.

EPA is finalizing a PM standard of 0.5 mg/mile for light-duty vehicles and MDV that must be met across three test cycles (−7°C FTP, 25°C FTP, US06), a requirement for PM certification tests at the test group level, and a requirement that every in-use vehicle program (IUVP) test vehicle is tested for PM. The 0.5 mg/mile standard is a per-vehicle cap, not a fleet average. (Note that EPA discusses later in this section the background and history of per-vehicle cap standards and fleet-average standards). There are some differences in the final program from what was originally proposed, including the provision of additional lead time through a more gradual phase-in. Details are provided in section III.D.3 of this preamble.

EPA is finalizing CO and HCHO emissions requirement changes for light-duty vehicles and MDVs including transitioning to emissions caps (as opposed to bin-specific standards), a requirement that CO emissions caps be met across four test cycles (25°C FTP, HFET, US06, SC03), and a CO emissions cap for the −7°C FTP that is the same for all light-duty vehicles and MDVs. There are changes to the requirements from what was proposed. Details are provided in section III.D.4 of this preamble.

The Agency received significant comments on proposed programmatic elements related to high GCWR MDVs. Significant changes were made in response to comments. The Agency is finalizing proposed Alternative 2 in order to address emissions from high GCWR MDVs. Please refer to section III.D.5 of the preamble for a summary of comments, summary of the proposed alternatives, and a detailed description of the final program.

EPA is finalizing a refueling standards change to require incomplete MDVs to have the same on-board refueling vapor recovery standards as complete MDVs. See section III.E.6 of this preamble.

EPA is not finalizing new requirements for the control of enrichment on gasoline vehicles. The agency will continue to gather data on the circumstances under which vehicles use enrichment in the real world, as well as estimates of the impact on emissions inventories due to command enrichment. In addition, we will continue to review AECD applications to ensure that the AECD process is being used appropriately. EPA may revisit additional enrichment controls in a future rulemaking. Additional discussion is found in section III.E.8 of this preamble.

The final standards allow light-duty vehicle 25°C FTP NMOG+NO_X credits and −7°C FTP NMHC credits (converting to NMOG+NO_X credits) to be carried into the new program. It only allows MDV 25°C FTP NMOG+NO_X credits to be carried into the new program if a manufacturer selects the early compliance pathway. New credits may be generated, banked and traded within the new program to provide manufacturers with flexibilities in developing compliance strategies. Details are shown in section III.D.2.v of the preamble.

[628] In this notice, EPA is using ''criteria pollutants'' to refer generally to criteria pollutants and their precursors, including tailpipe NMOG, NO_X, PM, and CO, as well as evaporative and refueling HC.

[629] Although we have established light-duty and medium-duty vehicle programs, according to size, weight and function of vehicles, we recognize that all vehicles with weight over 6,000 lb are considered ''heavy-duty vehicles'' for purposes of section 202(a)(3), and we have revised the criteria pollutant standards for these vehicles consistent with that provision.

[630] MDPV have GVWR of MDV (8501 to 14,000 pounds) but are designed primarily for the transportation of people and follow light-duty vehicle standards. See Section III.E of the preamble for the Tier 4 definition of MDPV.

[631] California Environmental Protection Agency, Air Resources Board. Part 1, Section I.4. California Provisions: Certification and In-Use testing requirements for chassis certified Medium-Duty Vehicles (MDV) with a Gross Combination Weight Rating (GCWR) greater than 14,000 pounds, using the Moving Average Window (MAW). ''California 2026 and Subsequent Model Year Criteria Pollutant Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.'' August 25, 2022.

EPA is finalizing the same criteria pollutant emissions standards for small volume manufacturers (SVM) as for large manufacturers but with a delayed phase-in to provide additional lead time to implement the standards. See section III.E.10 of this preamble for details.

Useful life standards for light-duty vehicles and MDV are described in 40 CFR 86.1805–17.

EPA's initial emission standards were established as per vehicle (''cap'') standards, with new standards often phased in as an increasing percentage of the fleet over time, to allow for gradual deployment of new technologies. Over the last two decades, EPA has found that fleetwide average standards can also be an effective approach for reducing emissions. Fleetwide average standards enable and encourage manufacturers to develop and deploy a variety of new technologies which may be more appropriate for specific segments of their fleet. As with ABT generally, fleetwide averaging allows greater flexibility and can incentivize overcompliance in some segments, which can benefit manufacturers, consumers and the environment (as new technologies are developed and deployed). However, fleetwide average standards may require additional testing requirements, since the specific level of emissions is important, not merely the meeting of a per vehicle standard. EPA has historically used cap standards for PM and CO, while it has historically used fleet average standards for NMOG+NO_X and GHG.[632] EPA is continuing this approach because it will be less disruptive to manufacturer's compliance planning and because EPA finds that the fleet average approach is more appropriate for NMOG+NO_X and GHG because those standards offer more useful opportunities for varying the deployment of compliance strategies across a manufacturer's product lines, whereas the additional testing burden to establish precise emissions levels is less warranted for PM and CO emissions.[633]

EPA received a wide range of comments from a broad spectrum of stakeholders regarding the scope and stringency of the proposed criteria pollutant standards. NGOs, states, public health organizations, suppliers and a supplier trade association were strongly supportive of EPA finalizing the most protective criteria pollutant standards possible while vehicle manufacturers and their trade association, the Alliance for Automotive Innovation (AAI), voiced concerns regarding the stringency of the standards, the lack of need for additional emissions reductions, lack of alignment with CARB ACC II, phase-in timing and feasibility. Support for the revised standards included references to the significant public health impacts stemming from vehicle emissions, especially in communities with environmental justice concerns, and references to the need for assistance in attaining the NAAQS. Vehicle manufacturers stated that more stringent criteria pollutant standards would be a distraction from their efforts to electrify the light- and medium-duty fleets. Vehicle manufacturers also commented that they had extensive collaboration with the California Air Resources Board (CARB) during the development of CARB's recently finalized Advanced Clean Car II (ACC II) standards and industry broadly recommended that EPA adopt the ACC II program in lieu of our proposed standards.

1. Phase-In of Criteria Pollutant Standards

i. Light-Duty Vehicle Phase-In

The phase-in of the revised criteria pollutant standards is an important facet of our program. EPA received comments from many states, NGOs, and suppliers to finalize the most stringent standards at the earliest opportunity, while auto manufacturers generally commented that additional lead time was necessary. EPA addressed these comments for the final program as described below.

The criteria pollutant phase-in for light-duty vehicles applies to the NMOG+NO_X bin structure, PM, -7°C NMOG+NO_X, CO, HCHO, -7°C CO, and three provisions aligned with CARB ACC II (PHEV high power cold starts, early driveaway, intermediate soak mid-temperature starts). We are finalizing an extended phase-in for small volume manufacturers to provide additional lead time, as described below. The light-duty vehicle NMOG+NO_X declining fleet average has its own timeline described in section III.D.2 of the preamble.

Light-duty vehicle criteria pollutant phase-in schedules are shown in Table 33. Manufacturers comply with phase-in scenarios based on the projected number of vehicles sold or produced for sale in the United States in a given model year. LDV and LDT1–2 (GVWR ≤ 6000 lb) vehicles follow a 20, 40, 60, 100 percent phase-in schedule. LDT3–4 (GVWR 6001–8500 lb) and MDPV may follow either a default phase-in that steps to 100 percent in MY 2030 that provides a full four years of lead time as required by CAA section 202(a)(3)(C), or they may choose to follow an early phase-in schedule that ramps from 20 percent to 100 percent from MY 2027 to 2030. If a manufacturer chooses the early phase-in schedule, its LDV, LDT1–2, LDT3–4, and MDPV fleets are averaged together as one group. This scenario could be advantageous for a manufacturer as it allows lower emitting vehicles from one category to help with compliance in another. Credits from Tier 3 and new credits earned in Tier 4 are described in section III.D.2.v of the preamble.

TABLE 33—TIER 4 LIGHT-DUTY VEHICLE CRITERIA POLLUTANT PHASE-IN SCHEDULES

Model year	LDV, LDT1–2 (GVWR ≤ 6000 lb) (%)	LDT3–4 (GVWR 6001–8500 lb), MDPV	
		default (%)	early (%)
2027	20	0	20
2028	40	0	40
2029	60	0	60
2030	100	100	100

[632] NMOG standards were fleet average standards under the NLEV program, while NO_X standards were fleet average standards beginning with Tier 2. In Tier 3, EPA adopted NMOG+NO_X standards as fleet average standards. GHG standards have been fleet average standards since they were adopted in 2010, in part to harmonize with the NHTSA fuel economy program.

[633] For example, if EPA were to adopt fleet averaging for PM, the variability of PM measurements would become increasingly important. While EPA finds that there is strong technical basis to measure and certify PM below 0.5 *mg/mile,* we conclude it is appropriate to gain additional experience with measuring PM at these levels before requiring the use of new measurement procedures for averaging purposes.

Vehicles that are not part of the phase-in percentages are considered interim vehicles, which must continue to demonstrate compliance with all Tier 3 regulations with the exception that all vehicles (interim and those that are part of the phase-in percentages) contribute to the Tier 4 light-duty vehicle $NMOG+NO_X$ declining fleet average described in section III.D.2 of the preamble.

For small vehicle manufacturers (SVM),[634] we are establishing a schedule that provides additional lead time in meeting the light-duty vehicle criteria pollutant standards. The SVMs schedule steps from 0 percent to 100 percent in MY 2032 and is shown in Table 34. Before MY 2032, SVMs must comply with all Tier 3 standards and all Tier 3 bins remain available to them.

TABLE 34—TIER 4 LIGHT-DUTY VEHICLE CRITERIA POLLUTANT PHASE-IN SCHEDULES FOR SMALL VOLUME MANUFACTURERS

Model year	LDV, LDT1–2 (GVWR ≤ 6000 lb) (%)	LDT3–4 (GVWR 6001–8500 lb), MDPV (%)
2027	0	0
2028	0	0
2029	0	0
2030	0	0
2031	0	0
2032	100	100

EPA received comments from the Alliance for Automotive Innovation (AAI) as well as some of its members regarding the proposed phase-in. AAI noted that had EPA adopted the CARB ACC II program, the proposed phase-in would have been more acceptable, however, because EPA had proposed new standards and test procedures the risk to a manufacturer's compliance planning is higher. AAI and manufacturers also commented that the agency should provide more time to meet the new standards.

EPA continues to believe that the proposed criteria pollutant program is feasible and appropriate and has chosen not to adopt the CARB ACC II criteria pollutant program. With respect to phase-in, we have provided an additional year of phase-in in response to manufacturer concerns. As we elaborate further below in our discussion of specific requirements and in the RTC, we have separately assessed the reasonableness of this phase-in schedules for each of the requirements subject to it and found the schedule to be reasonable. For example, most vehicle manufacturers have considerable experience with additional PM controls, and some are already installing GPFs in the United States for sale outside of the country. Regarding alignment or full-scale adoption of the ACC II criteria pollutant program, although the goals of CARB's ACC II program are generally similar to the goals of EPA's $NMOG+NO_X$ program, the requirements in the CARB ACC II criteria pollutant program are uniquely structured to fit within the broader ACC II framework and would not be an appropriate solution in the context of EPA's performance-based criteria pollutant program. Under the CARB ACC II program, criteria pollutant emissions are guaranteed to be reduced with increasing ZEV penetrations and the remaining ICE-based vehicles are held at the current LEV III standards to prevent backsliding. EPA's performance-based standards, for both GHG and criteria pollutant emissions, provide the manufacturers with the ability to comply with a variety of technology pathways. This requires provisions in this final rule which are different from the CARB ACC II program to achieve similar emissions reductions, independent of the technology choices manufactures make and to prevent backsliding on ICE-based powertrains for manufacturers with high BEV penetrations. In addition to providing an additional year of phase-in, EPA has been responsive to comments concerned about lead time for the revised standards by continuing to allow manufacturers to carry over Tier 3 credits for vehicles less than 8,500 pounds GVWR.

ii. Medium-Duty Vehicle Phase-In

The MDV phase-in for criteria pollutant standards, including the $NMOG+NO_X$ bin structure, PM, −7°C $NMOG+NO_X$, CO, HCHO, −7°C CO standards, and standards for MDV with GCWR above 22,000 pounds is described in this section.

Default compliance phase in is required in a single step in MY 2031 for these final criteria pollutant standards. Under default compliance, MDV may not carry forward Tier 3 $NMOG+NO_X$ credits (as allowed by the early phase-in schedule). An optional early compliance phase-in for MDV is shown in Table 35. Only manufacturers opting for the early compliance phase-in may carry forward Tier 3 credits into this program. Any MDVs that are not part of the phase-in percentages are considered Interim Tier 4 vehicles, which must continue to demonstrate compliance with all Tier 3 regulations with the exception that all vehicles (interim and those that are part of the phase-in percentages) contribute to the Tier 4 MDV $NMOG+NO_X$ declining fleet average, which has its own separate timeline (see section III.E.2.iv of the preamble).

Finalized refueling standards for incomplete vehicles phase in on a different schedule as described in section III.D.6 of this preamble. The in-use standards for high GCWR MDV begin in MY 2031 regardless of whether or not a manufacturer opts for early compliance.

[634] Small vehicle manufacturers (SVM) are defined in 40 CFR 86.1838–01(a).

TABLE 35—TIER 4 MDV CRITERIA POLLUTANT PHASE-IN SCHEDULES

Model year	MDV	
	default (%)	early (%)
2027	0	20
2028	0	40
2029	0	60
2030	0	80
2031	100	100

2. NMOG+NO_X Standards

EPA is finalizing new NMOG+NO_X standards for MY 2027 and later. The standards are structured to account for the potential for significant emission reductions as the result of improving emissions control technologies for new light-duty vehicles and MDVs that is projected to occur over the next decade. Notably, while in our central case we project that these standards can be achieved by manufacturers choosing to increase electrification of their vehicle fleets, EPA projects that the standards are also feasible with the deployment of technologies to reduce emissions from ICE-based vehicles. Furthermore, absent the revised standards, we are concerned that the market shift towards greater electrification in the fleet could result in manufacturers deciding to increase the emissions relative to the status quo from their ICE vehicles to reduce cost.[635] At the same time, as we explain below, manufacturers have considerable choice in how they meet the NMOG+NO_X standards, including through the application of a range of technologies, such as electrification and improved ICE engine and exhaust aftertreatment designs.

The previous Tier 3 fleet average NMOG+NO_X emissions standards were fully phased-in for light-duty vehicles (LDV, LDT, and MDPV) in MY 2025 to a 30 mg/mile fleet average standard and were fully phased-in for MDV (Class 2b and 3) in MY 2022 at 178 and 247 mg/mile, respectively.

EPA is finalizing light-duty vehicle and MDV fleet average NMOG+NO_X standards which are more stringent than Tier 3, based on our consideration of all available vehicle and engine technologies, including ICE-based, hybrid, and zero emission vehicles, in a manufacturer's compliance pathway. This approach is consistent with Tier 3 NMOG+NO_X standards. Given the cost-effectiveness of BEVs for compliance with both criteria pollutant and GHG standards, EPA anticipates that many automakers will choose to include BEVs in their compliance strategies to minimize costs. However, the final NMOG+NO_X standards continue to be performance-based fleet average standards with multiple feasible paths to compliance, depending on choices manufacturers make about deployment of emissions control technologies for ICE as well as electrification and credit trading.

For instance, the final NMOG+NO_X standards could be met by producing (A) a larger number of additional BEVs together with a smaller number of ICE-based vehicles with higher NMOG+NO_X than final Tier 3 allowed, (B) a mix of BEVs together with ICE-based vehicles with NMOG+NO_X similar to what final Tier 3 allowed, or (C) no BEVs and solely ICE-based vehicles with improved emissions controls relative to what was required by final Tier 3. BEVs, as well as these improved ICE-based emissions control technologies are available today. EPA notes that many ICE-based light-duty vehicles including hybrids and PHEVs are being certified below 15 mg/mile today, as shown in Chapter 3.2.5 of the RIA. Specific technologies available to reduce light-duty ICE-based emissions to below 15 mg/mile and to reduce MDV ICE-based emissions to below 75 mg/mile are described in Chapter 3.2.5.1 if the RIA.

i. NMOG+ NO_X Bin Structure for Light-Duty Vehicles and Medium-Duty Vehicles

The final bin structure for light-duty vehicles and MDVs set in this rule is shown in Table 36. The upper six bins (Bin 75 to Bin 170) are only available to MDV. For light-duty vehicles, the final bin structure removes the two highest Tier 3 bins (Bin 160 and Bin 125) and adds new bins such that the bins increase in 5 mg/mile increments from Bin 0 to Bin 70. The highest two bins are removed to remove the dirtiest vehicles from the future fleet and including bins from 0 to 70 in increments of 5 mg/mile offers manufacturers more resolution in meeting the fleet-average standard. For MDV, the final bin structure also moves away from separate bins for Class 2b and Class 3 vehicles, adopting light-duty vehicle bins along with higher bins only available to MDV. In part due to comments received from MDV manufacturers, the final MDV-only bins have been harmonized with bins used for compliance with California chassis-certified MDV standards with the exception of elimination of any bins higher than Bin 170. The highest bin was also changed from Bin 160 to Bin 170 to better align with the California ACC II program and to serve as a cap on MDV emissions.

Bins are used to meet in the NMOG+NO_X fleet average standards described in section III.D.2.iii-iv of the preamble and the NMOG+NO_X provisions aligned with the CARB ACC II program described in section III.D.7 of the preamble.

Vehicles that are not part of the phase-in percentages described in section III.D.1 of the preamble are considered Interim Tier 4 vehicles and may only use Tier 3 bins, or in the case of MDV, may also use Tier 3 bins and transitional Tier 4 MDV bins defined in 40 CFR 86.1816–18 (bin 175 and 150 for Class 3 vehicles, and bin 125, 100, 85, 75 for all medium-duty vehicles). Note that transitional Tier 4 MDV bins apply only to Interim Tier 4 vehicles in model years 2027 through 2030, and not to fully phased in Tier 4 vehicles.

TABLE 36—LIGHT-DUTY VEHICLE AND MDV NMOG+NO_X BIN STRUCTURE

Bin	NMOG+ NO_X (mg/mi)
Bin 170 [a]	170
Bin 150[a]	150
Bin 125 [a]	125

[635] Tier 3 standards include a Bin 0, which allows zero emissions vehicles to be averaged with ICE-based vehicles. In the absence of the final NMOG+NO_X standards, as sales of ZEVs increase, there would be an opportunity for the ICE portions of the light-duty and MDV fleets to reduce emission control system content and cost and comply with less stringent NMOG+NO_X bins under Tier 3, typically referred to as ''backsliding''. If this were to occur, it would have the effect of increasing NMOG+NO_X emissions from the ICE portion of the light-duty vehicle and MDV fleet and delay the overall fleet emission reductions of NMOG+NO_X that would have otherwise occurred.

TABLE 36—LIGHT-DUTY VEHICLE AND MDV NMOG+NO$_X$ BIN STRUCTURE—Continued

Bin	NMOG+ NO$_X$ (mg/mi)
Bin 100 [a]	100
Bin 85 [a]	85
Bin 75 [a]	75
Bin 70	70
Bin 65	65
Bin 60	60
Bin 55	55
Bin 50	50
Bin 45	45
Bin 40	40
Bin 35	35
Bin 30	30
Bin 25	25
Bin 20	20
Bin 15	15
Bin 10	10
Bin 5	5
Bin 0	0

[a] MDV only.

EPA received comments on bin structure. The Alliance for Automotive Innovation (AAI) and GM commented that EPA should align its bin structure with CARB's ACC II program. AAI also recommended adding bins 35, 45 and 90. Small volume manufacturers requested that Bin 125 remain available to them until MY 2035.

In response to these comments EPA is finalizing a bin structure that adopts a full suite of bins from 0 to 70 for light-duty vehicles and MDV, and bins 75, 85, 100, 125, 150, and 170 for MDV. EPA's response to the bin-related SVMs comments can be found in section III.D.10 of the preamble.

ii. Smog Scores for the Fuel Economy and Environment Label

EPA is updating the smog scores used on the Fuel Economy and Environment Label [636] (see 40 CFR 600.311–12(g)), to work with the new Tier 4 bin structure, shown in Table 37. We sought comment on fitting the new Tier 4 bins and California LEV IV bins [637] into the existing MY 2025 Tier 3 smog score structure for the Tier 4 phase-in period (MY 2027–2029), as the Tier 4 program is phased in, and we also sought comment on a new Tier 4 and LEV IV smog score structure for MY 2030 and later. For both ratings schedules, it is important to avoid having any bin assigned to a higher score in a newer model year than it was assigned in an older model year (no ''backsliding'' for smog score ratings).

We received no comments on the proposal for smog scores, and we are finalizing structures that are consistent with the proposal but also reflect the fact that we are finalizing almost twice as many Tier 4 NMOG+NO$_X$ bins as were in the proposal.

For MY 2027–2029, EPA is finalizing a smog score schedule that aligns with the Tier 3 smog score schedule starting with MY 2025. This will allow the Tier 3 and Tier 4 bin structures to work together during the Tier 4 phase-in period, during which there will be a mix of Tier 3 and interim Tier 4 vehicles. Table 37 shows the MY 2025 and forward Tier 3 Smog Scores and Tier 3/LEV III bins in the first two columns, and the MY 2027–2029 Tier 4 Smog Scores and Tier 4/LEV IV bins are shown in the last two columns.

For MY 2030 and later, we are maintaining the smog ratings from MY 2027–2029 for bin 40/ULEV 40 and lower bins and distributing the higher bins evenly through a smog score of 2. The interim LEV IV Bin 125 will be assigned a smog score of 1. Table 38 shows the smog score rating schedule for MY 2030 and later.

We selected MY 2030 as the time to shift the smog scores because that is the final year for phasing in the Tier 4 criteria standards in 40 CFR 86.1811–27 for vehicles subject to fuel economy labeling requirements. An exception applies for small volume manufacturers, which may continue to meet Tier 3 standards through model year 2031. This leaves the possibility that small volume manufacturers will certify their vehicles to bin standards that are higher than the bin standards specified for MY 2030 and later. As described in 40 CFR 600.311(g), manufacturers that certify vehicles to bin standards that are higher than any values we specify automatically apply a smog score of 1 for those vehicles. As a result, small volume manufacturers certifying their vehicles to Bin 125 or Bin 160 in model years 2030 and 2031 will apply a smog score of 1 for those vehicles. If they certify their vehicles to any other bins, the smog scores apply as described in Table 38. Note as an example that all manufacturers certifying to Bin 70 standards in MY 2030 and 2031 would use a smog score of 2, whether they are meeting Tier 3 Bin 70 standards or Tier 4 Bin 70 standards, and all manufacturers certifying to Bin 50 standards in MY 2030 and 2031 would use a smog score of 4, whether they are meeting Tier 3 Bin 50 standards or Tier 4 Bin 50 standards.

TABLE 37—MY 2025—MY 2029 SMOG SCORES

Smog scores	Tier 3 and tier 4 bins	LEV III and LEV IV bins
1	Bin 160	LEV 160.
2	Bin 125	ULEV 125.
4	Bin 55 through Bin 70	ULEV 60 or ULEV 70.
5	Bin 35 through Bin 50	ULEV 40 or ULEV 50.
6	Bin 25 or Bin 30	SULEV 25 or SULEV 30.
7	Bin 15 or Bin 20	SULEV 15 or SULEV 20.
8	Bin 10.	
9	Bin 5.	
10	Bin 0	ZEV

TABLE 38—MY 2030+ SMOG SCORES

MY 2030+ smog scores	EPA and CARB bins
1	ULEV 125.
2	Bin 65, Bin 70/ULEV 70.

[636] The Fuel Economy and Environment label provisions apply to ''automobiles'' (passenger automobiles and light trucks) and medium-duty passenger vehicles as described in 40 CFR 600.001 and 600.002.

[637] See Section 1961.4, Title 13, California Code of Regulations. Final Regulation Order. Exhaust Emission Standards and Test Procedures—2026 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

TABLE 38—MY 2030+ SMOG SCORES—Continued

MY 2030+ smog scores	EPA and CARB bins
3	Bin 55, Bin 60/ULEV 60.
4	Bin 45, Bin 50/ULEV 50.
5	Bin 35, Bin 40/ULEV 40.
6	Bin 25, Bin 30/SULEV 25, SULEV 30.
7	Bin 15, Bin 20/SULEV 15, SULEV 20.
8	Bin 10.
9	Bin 5.
10	Bin 0/ZEV.

iii. NMOG+NO_X Standards and Test Cycles for Light-Duty Vehicles

EPA is establishing NMOG+NO_X standards for light-duty vehicles with GVWR at or below 6,000 lb pursuant to its authority in section 202(a)(1)–(2), which directs EPA to set standards to take effect with sufficient lead time ''to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance within such period.'' For light-duty vehicles above GVWR 6,000 lb, EPA is further governed in setting standards for NMOG+NO_X by section 202(a)(3), which mandates ''standards which reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology'' and also meets specific lead time and stability requirements. As discussed in section V of the preamble, EPA finds that the standards in this final rule satisfy the requirement for ''greatest degree of emission reduction achievable'' for vehicles above 6,000 lb GVWR, and has adopted a default compliance schedule to ensure adequate lead time and stability for these vehicles, as well as an optional compliance schedule. Section III.D.2.iv of the preamble describes how we meet these same statutory requirements for medium-duty vehicles.

The final NMOG+NO_X fleet average standards for MY 2027 and later light-duty vehicles are shown in Table 39. EPA is finalizing our proposal that the same bin-specific numerical standard be met across four test cycles: 25°C FTP,[638] HFET,[639] US06[640] and SC03.[641] This means that a manufacturer certifying a vehicle to comply with Bin 30 NMOG+NO_X standards will be required to meet the Bin 30 emissions standards for all four test cycles. Meeting the same NMOG+NO_X standards across four cycles is an increase in stringency from Tier 3, which had one standard for the higher of FTP and HFET, and a less stringent composite based standard for the SFTP (weighted average of 0.35×FTP + 0.28×US06 + 0.37×SC03). Present-day engine, transmission, and exhaust aftertreatment control technologies allow closed-loop air-to-fuel (A/F) ratio control and good exhaust catalyst performance throughout the US06 and SC03 cycles. As a result, higher emissions standards for NMOG+NO_X over these cycles are no longer necessary. Approximately 60 percent of the test group/vehicle model certifications from MY 2021 have higher NMOG+NO_X emissions over the FTP cycle as compared to the US06 cycle, supporting the conclusion that the US06 cycle does not require a higher standard than the FTP cycle does.

For LDV and LDT1–2 (GVWR ≤6,000 lb), the NMOG+NO_X standard is a declining fleet average that brings the Tier 3 standard of 30 mg/mile down to 15 mg/mile in 2032 (as shown on the left side of Table 39). The declining fleet average reflects EPA's judgment about feasible further reductions in NMOG+NO_X as a result of the application of technologies (whether the manufacturer chooses, for instance, further electrification, further improvements in internal combustion engine design and controls, or further improvements in exhaust aftertreatment). EPA judges that the standards could be met by a mix of these technologies, such as additional PHEVs with additional improvements in exhaust aftertreatment. For example, if the industry introduces BEVs into these vehicle classes at the rate projected by our central case modeling and if ICE vehicles remain at 30 mg/mile (Tier 3), the declining fleet average standard provides approximately 30 percent additional compliance headroom for emissions of NMOG+NO_X from these vehicles in 2032. With BEV penetrations as low as 35 percent (*e.g.,* as projected in our No Additional BEVs sensitivity) and considering many existing ICE vehicles already emit below 30 mg/mile, manufacturers would comply with the NMOG+NO_X standard with minimal aftertreatment improvements for their remaining ICE vehicles. The additional compliance headroom provided by the final 15 mg/mile standard ensures the standards are feasible under a wide range of compliance paths (*e.g.,* if manufacturers produce significantly fewer BEVs than is expected). Manufacturers with Tier 3 NMOG+NO_X credits may carry their credits into Tier 4 when Tier 3 is closed out, up to the end of the Tier 3 five-year credit life.

For LDT3–4 (GVWR 6001–8500 lb) and MDPV, the NMOG+ standard offers manufacturers two alternative schedules shown on the right side of Table 39. The default schedule steps down from 30 mg/mile to 15 mg/mile in 2030 and provides 4 years of lead time and 3 years of standards stability, as required by the Clean Air Act (CAA) for heavy-duty vehicles. For lead time and standards stability, LDT3–4 and MDPV (as well as MDV) are considered heavy-duty vehicles. As with LDV, the final standards reflect EPA's judgment that about the feasibility of significant further reductions of NMOG+NO_X through deployment of a range of emissions control technologies, taking into consideration the lead time available between now and 2030.

The second alternative is an optional ''early'' schedule that declines from 30 mg/mile in 2026 (Tier 3) to 15 mg/mile in 2032, matching the schedule required for LDV and LDT1–2. The declining fleet average reflects the likelihood of increased electrification in the fleet over that time period. For example, if the industry introduces BEVs into these vehicle classes at the rate projected by our central case modeling and if ICE vehicles remain at 30 mg/mile (Tier 3), the declining fleet average standard provides approximately 10 percent additional compliance margin for emissions of NMOG+NO_X from these vehicles in 2032. Manufacturers that choose the early phase-in schedule

[638] 40 CFR 1066.801(c)(1)(i) and 1066.815.

[639] 40 CFR 1066.840.

[640] 40 CFR 1066.831.

[641] 40 CFR 1066.835.

average together their LDV, LDT1–2, LDT3–4, and MDPV vehicles. This scenario may be advantageous for manufacturers as it allows lower emitting vehicles from one category to help with compliance in another. Manufacturers with Tier 3 $NMOG+NO_X$ credits may carry their credits into Tier 4 when Tier 3 is closed out, up to the end of the Tier 3 five-year credit life, regardless of whether the default or early schedule is selected.

Vehicles that are not part of the phase-in percentages described in section III.D.1 of the preamble are considered interim vehicles, which must continue to demonstrate compliance with all Tier 3 regulations with the exception that all vehicles (interim and those that are part of the phase-in percentages) contribute to the Tier 4 light-duty vehicle $NMOG+NO_X$ declining fleet average described shown in Table 39.

There are two incentives for choosing the early schedule: The first incentive is that the manufacturer has until 2032 to reach 15 mg/mile instead of 2030. The second incentive is that $NMOG+NO_X$ emissions from LDV, LDT and MDPV are calculated as one group, allowing lower emitting sales in one sub-group shown in Table 39 to help meet the manufacturers overall NMOG+ standard. From a public health and environmental perspective, these incentives are justified by the early adoption of more stringent standards.

TABLE 39—LDV, LDT, AND MDPV FLEET AVERAGE $NMOG+NO_X$ STANDARDS FOR 25 °C FTP, HFET, US06 AND SC03

Model year	LDV, LDT1–2 (GVWR ≤6000 lb) $NMOG+NO_X$ (mg/mi)	LDT3–4 (GVWR 6001–8500 lb) and MDPV $NMOG+NO_X$ (mg/mi)	
		default	early
2026 [a]	[a] 30	[a] 30	[a] 30
2027	25	[a] 30	25
2028	23	[a] 30	23
2029	21	[a] 30	21
2030	19	15	19
2031	17	15	17
2032 and later	15	15	15

[a] Tier 3 standards provided for reference.

For small vehicle manufacturers (SVM), we are finalizing an $NMOG+NO_X$ declining fleet average that provides additional lead time in meeting light-duty vehicle standards as shown in Table 40. The SVMs light-duty vehicle $NMOG+NO_X$ declining fleet average steps down from 51 mg/mile to 30 mg/mile in 2028, concurrent with Tier 3 requirements for SVMs and representing no change for SVMs. The SVMs light-duty vehicle $NMOG+NO_X$ declining fleet average then steps down from 30 mg/mile to 15 mg/mile in 2032, matching the requirements for the larger manufacturers.

TABLE 40—LIGHT-DUTY VEHICLE FLEET AVERAGE $NMOG+NO_X$ STANDARDS FOR 25 °C FTP, HFET, US06, AND SC03 FOR SMALL VEHICLE MANUFACTURERS (SVM) CRITERIA

Model year	LDV, LDT1–2 (GVWR ≤6000 lb) $NMOG+NO_X$ (mg/mi)	LDT3–4 (GVWR 6001–8500 lb) and MDPV $NMOG+NO_X$ (mg/mi)
2026 [a]	[a] 51	[a] 51
2027	51	51
2028	30	30
2029	30	30
2030	30	30
2031	30	30
2032 and later	15	15

[a] Tier 3 standards provided for reference.

EPA received comments from many stakeholders with a wide range of inputs including supportive comments for the proposed standards and recommendations for program modifications for the final rule. NGOs such as the Environmental Defense Fund (EDF), American Lung Association and others provided strong support for the proposed $NMOG+NO_X$ standards as well as replacing the SFTP with a standard that applies across four test cycles (FTP, HFET, US06, SC03). The NGOs commented on the need to reduce emissions that contribute to poor air quality and negatively impact human health. The Alliance for Automotive Innovation (AAI) reiterated their recommendation to adopt CARB's ACC II program in lieu of the proposed $NMOG+NO_X$ declining fleet average that comingles ZEVs and ICE vehicles and instead set an ICE-only fleet average equal to the final Tier 3 fleet average of 30 mg/mile. AAI stated that the lack of certainty in BEV penetrations could result in compliance difficulties for some manufacturers. AAI also recommended that if EPA were to finalize the proposed approach, the final fleet average should not be overly reliant on BEV volumes. AAI also recommended that PHEV criteria pollutant emissions should be discounted based on their all-electric range and utility factor, similar to how PHEV GHG compliance values are calculated. Stellantis also commented that the ''structure of the fleet average $NMOG+NO_X$ standard [is] acting like a de facto ZEV mandate.''

EPA has responded to these comments by setting a higher (less stringent) final fleet average. The higher fleet average is informed by several factors, including the adoption of somewhat less stringent GHG standards as compared to the proposal, the inclusion of PHEVs in the projected compliance GHG pathway, and the potential for vehicle manufacturers to make improvements to their ICE powertrains in addition to electrification. EPA has decided to not discount PHEV emissions based on their estimated all electric range. While the determination of the utility factor for PHEVs is covered in section III.C.8 of the preamble, it is clear to EPA that there is considerably more engine on operation in charge depleting mode in the real world for current PHEVs than is captured on-cycle. In other words, as the result of vehicle design, operating conditions and/or environmental conditions, many current PHEVs demonstrate engine operation that is not captured in PHEV UF. While the utility factor may be appropriate for crediting a PHEV for GHG compliance, we have concluded it is not appropriate for PHEVs for several reasons. First, we know that criteria pollutants emission levels are influenced by more factors that GHG emissions, depending not only on whether the engine is on or off, but also the operating and environmental conditions under which the engine starts and runs. The existing and proposed PHEV UF does not adequately capture or reflect the specific operating conditions under which the engine starts or the environmental conditions, both of which have significant impact on criteria pollutant emissions. In addition, we note that criteria pollutant standards are orders of magnitude more stringent than GHG standards and as a result accuracy in the utility factor down to the milligram per mile becomes important. It may be possible in the future to have sufficiently accurate information about PHEV operation to adjust criteria pollutant emissions performance to reflect CD operation, and PHEV operation may change in the future as more PHEVs become ACC II compliant, but at this time EPA has decided not to discount emissions based on utility factor, although as noted we have adopted a less stringent final fleet average standard in part due to including PHEVs as a potential compliance pathway.

Since technologies are available to further reduce $NMOG+NO_X$ emissions from internal combustion engines and vehicles relative to the current fleet, and since more than 20 percent of MY 2021 Bin 30 vehicle certifications already had an FTP certification value under 15 mg/mile $NMOG+NO_X$, achieving reduced $NMOG+NO_X$ emissions through improved ICE technologies is feasible and reasonable. Regardless of the compliance strategy chosen, whether through electrification or cleaner ICE vehicles, overall, the fleet will become significantly cleaner.

The final $NMOG+NO_X$ standards for the 25 °C FTP, HFET, US06, SC03 and the associated declining fleet average, achieve significant reductions in $NMOG+NO_X$. Our compliance modeling for the central case shows that these reductions can be achieved by deployment of BEV technology at levels consistent with the projected penetrations rates discussed for the GHG requirements. At the same time, this final rule continues to apply performance-based standards for both GHG and criteria pollutant emissions, and manufacturers are free to adopt any mix of technologies for different vehicles that achieve the levels of the final standards. EPA has reassessed the proposed standards in light of public comments and additional data and concluded that adjustments are warranted to the final $NMOG+NO_X$ fleet average standard to allow additional lead time for deploying advanced control technologies, whether BEVs, PHEVs, or further improvements to ICE vehicles. While EPA does not agree with commenters who suggested setting an ICE-only fleet average standard for $NMOG+NO_X$, we continue to believe that the availability of clean ICE vehicles, as demonstrated by their current performance, as well as BEVs, support the feasibility of the final 15 mg/mile $NMOG+NO_X$ fleet average. Additional discussion on the feasibility of the final standards can be found in RIA Chapter 3.2.5.

The final 25 °C FTP $NMOG+NO_X$ standard applies equally at high-altitude conditions (1520–1720 meters) as at low-altitude conditions (0–549 meters). Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions. The requirement that the same standard applies equally at high-altitude and low-altitude conditions extends to 25 °C FTP $NMOG+NO_X$, 25 °C FTP PM, 25 °C FTP CO, 25 °C FTP HCHO, and −7 °C FTP CO standards.

EPA is finalizing a requirement that manufacturers submit an engineering evaluation indicating that common calibration approaches are utilized at high and low altitudes for −7 °C FTP $NMOG+NO_X$. The same engineering evaluation requirement also applies to the −7 °C FTP PM standard.

EPA is replacing the existing −7 °C FTP NMHC fleet average standard of 300 mg/mile for gasoline-fueled LDV and LDT1, and 500 mg/mile fleet average standard for LDT2–4 and MDPV, with a single $NMOG+NO_X$ fleet average standard of 300 mg/mile for gasoline-fueled LDV, LDT1–4 and MDPV to harmonize with the combined $NMOG+NO_X$ approach adopted in Tier 3 for all other cycles. NMOG should be determined as explained in 40 CFR 1066.635. EPA has historically not included BEVs in the calculation of fleet average −7 °C FTP NMHC emissions and EPA is taking the same approach for the calculation of fleet average −7 °C FTP $NMOG+NO_X$. EPA emissions testing at −7 °C FTP showed that a 300 mg/mile standard is feasible with a large compliance margin for $NMOG+NO_X$. Diesel-fueled LDV, LDT1–4, and MDPV are exempt from the −7 °C FTP $NMOG+NO_X$ standard but EPA is requiring manufacturers to report results from this test cycle in their certifications.

Since −7 °C FTP and 25 °C FTP are both cold soak tests that include TWC operation during light-off and hot running operating, EPA is finalizing the application of Tier 3 25 °C FTP $NMOG+NO_X$ useful life to −7 °C FTP $NMOG+NO_X$ standards.

EPA is finalizing that −7 °C FTP $NMOG+NO_X$ emissions be certified with at least one Emissions Data Vehicle (EDV) per test group for light-duty vehicles certifying to the 300 mg/mile standard instead of one EDV per durability group as in Tier 3.

iv. $NMOG+NO_X$ Standards and Test Cycles for Medium-Duty Vehicles

The final MDV $NMOG+NO_X$ standards are shown in Table 41 for optional early compliance and in Table 42 for default compliance. The CAA requires 4 years of lead time and 3 years of standards stability for heavy-duty vehicles when establishing emissions standards for certain pollutants, including NO_X and hydrocarbons. MDV fall under the CAA definition for heavy-duty vehicles with respect to standards stability and lead time. Under default compliance, MDVs will continue to meet Tier 3 standards through the end of MY 2030 and then MDVs will proceed to meeting a 75 mg/mile NMOG+NO_X standard in a single step in MY 2031 (Table 42). This compliance schedule complies with CAA provisions for lead time and stability. Under default compliance, MDV may not carry forward Tier 3 NMOG+NO_X credits into the Tier 4 program. The optional early compliance path has declining NMOG+NO_X standards that gradually phase-in from MY 2027 through MY 2033. MDV manufacturers opting for early compliance may carry forward Tier 3 NMOG+NO_X credits into the Tier 4 program when Tier 3 is closed out, up to the end of the Tier 3 five-year credit life (Table 41).

Note that the phase-in percentages from section III.D.1.ii of this preamble also apply. MDV that are not part of the phase-in percentages summarized in section III.D.1.ii of the preamble are considered interim vehicles, which must continue to demonstrate compliance with all Tier 3 standards and regulations with the exception that all vehicles (interim and those that are part of the phase-in percentages) contribute to the Tier 4 MDV NMOG+NO_X declining fleet average.

Certification data show that for MY 2022–2023, 75 percent of sales-weighted Class 2b/3 gasoline vehicle certifications were below 120 mg/mile in FTP and US06 tests (see RIA Chapter 3.2.5). Diesel-powered MDVs designed for high towing capability (*i.e.,* GCWR above 22,000 pounds) had higher emissions; however 75 percent were still below 180 mg/mile NMOG+ NO_X. The year-over-year fleet average FTP standards for MDV are presented below. The rationale for the manufacturer's choice of early compliance and default compliance pathways is described in section III.D.1.ii of this preamble. For further discussion of MDV NMOG+NO_X feasibility, please refer to Chapter 3.2.5 of the RIA.

The final MDV NMOG+NO_X standards are based on EPA's judgment as to the greatest degree of emissions reduction that is feasible applying existing light-duty vehicle technologies, including ICE and advanced ICE technologies and electrification, to MDV.[642] As with the light-duty vehicle categories, EPA anticipates that there will be multiple compliance pathways, such as increased electrification of vans together with achieving 120 mg/mile NMOG+NO_X for ICE-power MDV. Present-day MDV engine and aftertreatment technology allows fast catalyst light-off after cold-start followed by closed-loop A/F control and excellent exhaust catalyst emission control on MDV, even at the adjusted loaded vehicle weight, ALVW [(curb + GVWR)/2] test weight, which is higher than loaded vehicle weight, LVW (curb + 300 pounds) used for testing light-duty vehicles. Diesel MDV are adopting more advanced SCR systems for NO_X emissions control that incorporate dual-injection systems for urea-based reductant similar to SCR systems that have been developed to meet more stringent NO_X standards for MY 2024 and later heavy-duty engine standards in California and federal MY 2027 and later heavy-duty engine standards.[643] [644] Under the default compliance pathway, the final MDV standards begin to take effect beginning in MY 2031. While the originally proposed date of 2030 for default compliance was fully consistent with the CAA section 202(a)(3)(C) lead time requirement for these vehicles, EPA delayed implementation in the final rule to provide additional lead time based in part on comments received from auto manufacturers concerning the need for additional lead time for compliance. Similarly, the early compliance pathway was delayed by one year relative to our proposal.

TABLE 41—MDV FLEET AVERAGE NMOG+NO_X STANDARDS UNDER THE EARLY COMPLIANCE PATHWAY [A]

Model year	NMOG+ NO_X (mg/mi)	
	Class 2b	Class 3
2026	[b] 178	[b] 247
2027	175	
2028	160	
2029	140	
2030	120	
2031 [c]	100	
2032 [c]	80	
2033 and later [c]	75	

[a] Please refer to section III.D.1 of the preamble for further discussion of the early compliance and default compliance pathways.
[b] Tier 3 FTP fleet average standards provided for reference.
[c] MDV with a GCWR greater than 22,000 pounds must also comply with additional moving average window (MAW) in-use testing requirements.

TABLE 42—MDV FLEET AVERAGE NMOG+NO_X STANDARDS UNDER THE DEFAULT COMPLIANCE PATHWAY [A]

Model year	MDV NMOG+ NO_X (mg/mi)	
	Class 2b	Class 3
2026	[b] 178	[b] 247
2027	[b] 178	[b] 247
2028	[b] 178	[b] 247
2029	[b] 178	[b] 247
2030	[b] 178	[b] 247
2031 [c]	[a] 75	
2032 [c]	[a] 75	
2033 and later	[a] 75	

[a] Please refer to section III.D.1 of the preamble for further discussion of the early compliance and default compliance pathways.
[b] Tier 3 FTP fleet average standards provided for reference.
[c] MDV with a GCWR greater than 22,000 pounds must also comply with additional moving average window (MAW) in-use testing requirements.

EPA is not finalizing SVM MDV standards that differ from large manufacturer MDV standards.

If a manufacturer has a fleet mix with relatively high sales of MDV BEV, that will ease compliance with MDV NMOG+NO_X fleet average standards for MDV ICE-powered vehicles. We have also finalized an interim provision allowing credits generated by MY 2027 through 2032 BEVs qualifying as MDPV to be used for complying with the Tier 4 MDV fleet average NMOG+NO_X standards in order to help manufacturers transition to meeting the Tier 4 MDV NMOG+NO_X fleet average standards (see section III.D.2.iv). An option also remains for manufacturers of high GCWR MDV to choose engine-certification as a light-heavy-duty engine as an additional compliance flexibility. This would allow some manufacturers to choose the option of moving vehicles with the highest towing capability out of the fleet-average chassis-certified standards and into the heavy-duty engine program. If a manufacturer has a fleet mix with relatively low BEV sales, then improvements in NMOG+NO_X emissions control for ICE-powered vehicles would be required to meet the fleet average standards and/or more capable high GCWR MDV could be moved into the heavy-duty engine program and/or credits could be used from qualifying MDPV BEVs. Improvements to NMOG+NO_X emissions from ICE-powered vehicles are feasible with available engine, aftertreatment, and sensor technology, and has been shown within an analysis of MY 2022–2023 MDV certification

[642] Further discussion of the statutory factors of costs of compliance is found in Section IV of the preamble. Discussion of safety, and energy is found in VIII.

[643] California Air Resources Board. Heavy-duty Omnibus Regulation. *https://ww2.arb.ca.gov/rulemaking/2020/hdomnibuslowno.*

[644] 88 FR 4296. Control of Air Pollution From New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards. January 24, 2023.

data (see RIA Chapter 3.2.5). Under the final standards, fleet average $NMOG+NO_X$ will continue to decline to well below the final Tier 3 $NMOG+NO_X$ standards of 178 mg/mile and 247 mg/mile for Class 2b and 3 vehicles, respectively.

The final standards require the same MDV numerical standards be met across all four test cycles, the 25 °C FTP, HFET, US06 and SC03, consistent with the approach for light-duty vehicles described in section III.D.2.iii of the preamble. This would mean that a manufacturer certifying a vehicle to bin 75 would be required to meet the bin 75 emissions standards for all four cycles.

Meeting the same $NMOG+NO_X$ standard across four cycles is an increase in stringency from Tier 3, which had one standard over the FTP and less stringent bin standards for the HD–SFTP (weighted average of 0.35×FTP + 0.28×HDSIM + 0.37×SC03, where HDSIM is the driving schedule specified in 40 CFR 86.1816–18(b)(1)(ii)). Existing MDV control technologies allow closed-loop A/F control and high exhaust catalyst emissions conversion throughout the US06 and SC03 cycles, so compliance with higher numerical emissions standards over these cycles is no longer needed. Manufacturer submitted certification data and EPA testing show that Tier 3 MDV typically have similar $NMOG+NO_X$ emissions in US06 and 25 °C FTP cycles, and $NMOG+NO_X$ from the HFET and SC03 are typically much lower. Testing of a 2022 F250 7.3L at EPA showed average $NMOG+NO_X$ emissions of 56 mg/mile in the 25 °C FTP and 48 mg/mile in the US06. Manufacturer-submitted certifications show that MY 2021+2022 gasoline Class 2b trucks achieved, on average, 69 mg/mile in the FTP, 75 mg/mile in the US06, and 18 mg/mile in the SC03. MY 2021+2022 gasoline Class 3 trucks achieved, on average, 87 mg/mile in the FTP and 25 mg/mile in the SC03.

Several Tier 3 provisions will end with the elimination of the HD–SFTP and the combining of bins for Class 2b and class 3 vehicles. First, Class 2b vehicles with power-to-weight ratios at or below 0.024 hp/pound may no longer replace the full US06 component of the SFTP with the second of three sampling bags from the US06. Second, Class 3 vehicles may no longer use the LA–92 cycle in the HD–SFTP calculation but will instead have to meet the $NMOG+NO_X$ standard in each of four test cycles (25 °C FTP, HFET, US06 and SC03). Third, the SC03 may no longer be replaced with the FTP in the SFTP calculation.

The final MDV 25 °C FTP $NMOG+NO_X$ standard applies equally at high altitude conditions (1520–1720 m) as at low-altitude conditions (0–549 m), rather than continuing compliance relief provisions from Tier 3 for certification at high altitude conditions. Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions.

EPA is also setting a new −7 °C FTP $NMOG+NO_X$ fleet average standard of 300 mg/mile for gasoline-fueled MDV. NMOG should be determined as explained in 40 CFR 1066.635. EPA testing has demonstrated the feasibility of a single fleet average −7 °C FTP $NMOG+NO_X$ standard of 300 mg/mile across light-duty vehicles and MDV. Consistent with the proposal, our technical assessment for the standards, and the approach in Tier 3 to assessing compliance with the −7 °C FTP NMHC standards, BEVs and other zero emission vehicles are not included and not averaged into the fleet average −7 °C FTP $NMOG+NO_X$ standards. Diesel-fueled MDV are exempt from the −7 °C FTP $NMOG+NO_X$ standard but EPA is requiring manufacturers to report results from this test cycle in their certifications.

For Tier 3 certification of −7 °C FTP NMHC, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high and low altitudes. For Tier 4 certification, this requirement continues for −7 °C FTP $NMOG+NO_X$.

Since −7 °C FTP and 25 °C FTP are both cold soak tests that include TWC operation during light-off and hot running operating, EPA is finalizing the application of Tier 3 25 °C FTP $NMOG+NO_X$ useful life to −7 °C FTP and $NMOG+NO_X$ standards.

EPA is finalizing that −7 °C FTP $NMOG+NO_X$ emissions be certified with at least one Emissions Data Vehicle (EDV) per test group for MDV certifying to the 300 mg/mile standard instead of one EDV per durability group as in Tier 3.

Additional discussion on the feasibility of the proposed standards can be found in RIA Chapter 3.2.

v. Averaging, Banking, and Trading Provisions

Similar to the existing criteria pollutant program, $NMOG+NO_X$ credits may be generated, banked, and traded within the Tier 4 program to provide manufacturers with flexibilities in developing compliance strategies. EPA did not reopen or solicit comment on the ABT program for criteria pollutants,[645] with the sole exceptions of discrete changes relating to the transition between Tier 3 and Tier 4 for certain $NMOG+NO_X$ credits and expanding the credit program for −7 °C FTP testing to apply for $NMOG+NO_X$ emissions for light-duty and medium-duty vehicles (rather than only NMHC emissions for light-duty vehicles). We proposed and are finalizing these discrete changes, which we describe below.

EPA is allowing light-duty vehicle (LDV, LDT, MDPV) 25 °C FTP $NMOG+NO_X$ credits to be transferred into the Tier 4 program when Tier 3 is closed out (*i.e.,* when all of a manufacturers' test groups within a certification category are Tier 4 compliant), up to the end of the Tier 3 five-year credit life.[646] In the separate program for light-duty vehicle −7 °C FTP testing, NMHC credits may be transferred into the Tier 4 program on a 1:1 basis for −7 °C FTP $NMOG+NO_X$ credits when Tier 3 is closed out, up to the end of the five-year credit life.

EPA is allowing MDV (Class 2b and 3 vehicles) 25 °C FTP $NMOG+NO_X$ credits to be transferred into the Tier 4 program only if a manufacturer selects the early compliance phase-in for MDV. If the MDV early compliance phase-in is selected, MDV credits may be transferred into Tier 4 when Tier 3 is closed out, up to the end of the Tier 3 five-year credit life. There were no −7 °C FTP NMHC or −7 °C $NMOG+NO_X$ standards for MDV before the Tier 4 standards adopted in this rule so there are no MDV −7 °C FTP credits to transfer.

As noted in section III.E of this preamble, EPA is broadening the definition of MDPV to include passenger vehicles that could potentially fall outside the prior definition, especially as a result of increased weight from electrification. We have concluded that the newly designated MDPVs should be included in the light-duty program considering their size and function, but we recognize that this recategorization may reduce the number of electric vehicles that would otherwise have been available to factor into each manufacturer's strategy for meeting MDV standards. To help manufacturers transition to meeting the Tier 4 MDV

[645] ABT credit provisions for the GHG program are described in Section III.C.4 of the preamble. As noted in that section, EPA did not reopen any GHG ABT provisions.

[646] We mention the length of the credit life here for informational purposes but note that EPA did not reopen the provisions governing the five-year length of the credit life.

$NMOG+NO_X$ standards for 25 °C testing, we are adopting an interim provision allowing credits generated by MY 2027 through 2032 battery electric (BEV) and fuel cell vehicles (FCEV) qualifying as MDPV to be used for complying with the Tier 4 MDV fleet average $NMOG+NO_X$ standard for 25 °C testing. See 40 CFR 86.1861–17(b)(6). Manufacturers may use these credits starting in MY 2031 under the default phase-in, and starting in MY 2027 under the early compliance phase-in. Since this interim provision is addressing a potential issue arising from changes in an individual manufacturer's fleet mix of MDPV and MDV, we are not including an option to buy or sell these credits for a different company to use for certifying its MDV. Except as described here, all the other provisions for calculating and using credits apply as specified in 40 CFR part 86, subpart S. Note that this interim provision does not apply for $NMOG+NO_X$ standards for −7 °C testing because electric vehicles are not subject to those standards.

3. PM Standard

i. PM Standard and Test Cycles for Light-Duty and Medium-Duty Vehicles

EPA is finalizing changes to the current Tier 3 p.m. standards and requirements. These changes include a more protective standard for the 25 °C FTP and US06 test cycles, and the addition of a cold PM standard for the existing cold temperature test (−7 °C FTP) presently used for CO and NMHC (40 CFR 1066.710). As proposed, the same numerical standard of 0.5 mg/mile and the same certification test cycles are being finalized for light-duty vehicles (LDV, LDT, and MDPV) and MDV, as shown in Table 43 for light-duty vehicles and Table 44 for MDV. The standard for −7 °C testing applies only to gasoline-fueled and diesel-fueled vehicles.[647] Comparisons to current Tier 3 p.m. standards are provided for reference. EPA is finalizing that the same Tier 3 25 °C FTP useful life standard applies to all three PM test cycles.

TABLE 43—LIGHT-DUTY VEHICLE (LDV, LDT, MDPV) PM STANDARDS

Test cycle	Tier 3 standards (mg/mi)	Final PM standard (mg/mi)
25 °C FTP	3	0.5
US06	6	0.5
−7 °C FTP	Not applicable	0.5

TABLE 44—MDV (CLASS 2B AND 3) PM STANDARDS

Test cycle	Tier 3 standards (mg/mi)	Final PM standard (mg/mi)
25 °C FTP	8/10 for 2b/3 vehicles	0.5
US06	10/7 for 2b/3 vehicle on SFTP	0.5
−7 °C FTP	Not applicable	0.5

As with $NMOG+NO_X$, EPA notes that the Administrator is setting standards for vehicles under 6,000 lb GVWR pursuant to CAA section 202(a)(1)–(2), and is subject to the requirements of CAA 202(a)(3) for heavier vehicles, including the requirement that standards reflect the greatest degree of emissions reduction achievable, giving appropriate consideration to cost, energy and safety and requirements for lead time and stability. As discussed in section V of the preamble, EPA finds these standards are appropriate and consistent with these requirements, and will reduce PM emissions over the broadest range of vehicle operating and environmental conditions. Specifically, we find that the final PM standards are feasible and appropriate under section 202(a)(1)–(2) for LDV and LDT1–2 for each model year between MY 2027–32 and take effect after such period as the Administrator finds necessary to permit the development and application of the requisite technology to control PM emissions, giving appropriate consideration to the cost of compliance within such period. For LDT3–4 and MDV, we find that the final PM standards, as required by section 202(a)(3)(A), reflect the greatest degree of emission reduction achievable through the application of technology to control PM emissions which the Administrator determined will be available for each model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors associated with the application of such technology. We discuss feasibility, lead time, and costs, of the technology for controlling PM emissions in various subsections in this section III.D.3 of the preamble and in Chapter 3.2.6 of the RIA. Discussion of energy (as reflected in impact on CO_2 emissions), safety, and other factors we considered in establishing the PM standards are found in RIA Chapter 3.2.6. The complete rationale for the PM standard is presented in sections II, III.D.3, V, VII of the preamble and Chapter 3.2.6 of the RIA.

The current Tier 3 p.m. standards capture only a portion of vehicle operation and a narrow and benign set of environmental conditions. EPA has observed that PM emissions increase dramatically during cold temperature cold-starts and high engine power conditions not captured by Tier 3 p.m. test cycles. While several vehicles in the current fleet demonstrate emissions performance that could comply with the standards at 25 °C, EPA projects that to meet the −7 °C PM standard manufacturers will choose to adopt a combination of Gasoline Particulate Filters (GPF) and BEVs as the most practical and cost-effective means to control PM emissions.

GPF is a mature and cost-effective technology and current GPF designs (*e.g.,* MY 2022 GPFs) have high filtration efficiency even without ash or soot loading. GPFs are being widely used in Europe and China and at least six vehicle manufacturers are

[647] See 40 CFR 1066.710(d)(2) for −7 °C FTP gasoline and diesel test fuel specifications.

assembling GPF-equipped vehicles in the United States for export and sale in other countries.

In support of the final PM standards, EPA conducted robust and detailed characterizations of GPF performance. EPA quantified PM, elemental carbon (EC) and polyaromatic hydrocarbon (PAH) emissions, with and without the GPF installed, and assessed GPF impact on GHG emissions and vehicle performance. EPA demonstrated no measurable GPF influence on GHG emissions and only slight impact on vehicle performance with a properly sized GPF. PM emissions were typically reduced by over 95 percent, EC emissions were typically reduced by over 98 percent, and filter-collected PAH emissions were typically reduced by over 99 percent. The detailed characterization of GPF benefits is discussed Chapter 3.2.6.2 of the RIA.

The final numerical standard (0.5 mg/mi) and the three applicable test cycles (25 °C FTP, US06, −7 °C FTP) are the same as proposed in the NPRM. The phase-in of the standard, however, is more gradual, as discussed in the section III.D.1 of the preamble.

Commenters expressed opposing views on the stringency, feasibility and need of the proposed PM standard. NGOs, EJ groups, and states urged the strongest possible standards given the significant health benefits, especially important for near-roadway exposures and in communities overburdened by air pollution, and the need for reductions to attain the PM NAAQS. A 2023 remote sensing study by ICCT shows that while gaseous emissions decreased, per-vehicle PM emissions decreased and then increased from 2005 to 2022, likely due to more vehicles using GDI (gasoline direct injection) technology in recent years. Automotive suppliers provided strong support for the proposal, noting the maturity of GPF technology and the current manufacturing of GPF-equipped vehicles in the U.S. for export to meet strict PM standards in Europe and China. Suppliers attested to having sufficient production capacity. The United Steelworkers commented that GPFs can easily and affordably be applied to light-duty vehicles and MDV in the U.S. and supported requiring this technology. An analysis from the Manufacturers of Emissions Control Association (MECA), a supplier trade association, shows that a regulatory control strategy that includes a combination of electric vehicle penetration and best available exhaust controls for PM (*i.e.,* GPF) on the remaining ICE vehicles results in approximately double the $PM_{2.5}$ reduction achievable than electrification alone, during the period from 2025 to 2060.

The Alliance for Automotive Innovation (AAI) and several vehicle manufacturers argued that the proposed PM standard would divert investments from electrification and urged adoption of a less stringent standard, specifically CARB's ACC II LEV IV standard of 1 mg/mile. Vehicle manufacturers commented that they had worked closely with CARB in the development of the 1 mg/mile standard and that EPA had not appropriately justified why a lower standard than that adopted by CARB is required. However, a few major OEMs supported the standard but asked for more lead time for application of GPFs across various models considering the level of effort needed to meet the collective sets of standards of this multipollutant rulemaking. Several OEMs raised concerns about measuring tailpipe PM emissions below 0.5 mg/mile, especially at −7 °C.

As we outlined in section II of the preamble, we are setting more stringent PM standards because of the health and environmental effects associated with exposure to $PM_{2.5}$. Several commenters noted that the $PM_{2.5}$ reductions from the proposal were needed for them to attain the $PM_{2.5}$ NAAQS.[648] In addition, other key factors informed the Agency's decision to finalize the 0.5 mg/mile PM standard. First, cost effective technology that is already being applied by most, if not all manufacturers already exists and demonstrates a potential to reduce harmful PM emissions by over 95 percent in virtually all operating and environmental conditions. GPFs are a feasible, safe, mature, and prolific technology with tens of millions of filters already installed on light-duty vehicles in operation worldwide. Secondly, over 100 million new ICE vehicles will likely be produced over the coming decades and these ICE vehicles will be used on roadways for 20 or more years after their manufacture. EPA has an obligation under the Clean Air Act to establish standards that protect public health and welfare based on feasible technologies that will be available considering costs and lead time. For vehicles over 6,000 lb EPA is obligated, as required by CAA section 202(a)(3), to set standards that reflect the greatest degree of emission reduction achievable through the application of available technology (considering costs, energy, and safety). Finally, EPA recognizes that GPFs are not a drop-in technology and that vehicle manufacturers will require lead time to adopt the technology for U.S. applications. OEMs' lead time concerns are addressed by lengthening the phase-in schedule described in section III.D.3.ii and more generally in section III.D.1 of the preamble.

EPA considered industry comments recommending adoption of CARB's 1 mg/mile standard instead of our proposed 0.5 mg/mile standard. CARB adopted the 1 mg/mile standard as part of their 2013 LEV III program and set a phase-in starting in MY 2025. The 1 mg/mile PM standard was confirmed as part of CARB's recently finalized LEV IV program. In the time since the original 1 mg/mile standard was adopted by CARB there have been several important developments. The first is the development and proliferation of GPFs. At the time LEV III was finalized, GPFs were not in installed in significant numbers of vehicles and the technology was in relative infancy. Since that time, it is estimated that nearly 100 million GPFs have been installed in vehicles as the result of stringent PM standards in other countries. The feasibility of meeting more stringent PM standards has increased significantly since CARB originally adopted their 1 mg/mile standard. At the same time that CARB confirmed their PM standard for MY 2025 and beyond, they also established a ZEV mandate which will result in additional significant and guaranteed PM reductions. EPA is maintaining performance based GHG standards, and as such, cannot expect the same national PM reductions expected by California from the whole of its ACC II program absent a more stringent federal PM program.

Several commenters recommended that EPA adopt additional fuel controls in lieu of setting more stringent PM standards. The commenters noted that a change in fuel properties could provide PM emissions reductions from the entire gasoline vehicle in-use fleet. EPA agrees that adjusted fuel properties can provide widespread and important PM reductions and for this reason solicited comment on a possible additional future approach for reducing PM through new fuel controls (see section IX of the preamble in the NPRM, ''Consideration of Potential Fuels Controls for a Future Rulemaking''). However, EPA does not consider these strategies as interchangeable alternatives. As noted in the proposal and in RTC section 19, the CAA has a separate and distinct set of requirements for engaging in fuels regulations. Indeed, section 211(c)(2)(A) provides that fuel may not be regulated

[648] On February 7, 2024, EPA finalized a rule to revise the primary annual $PM_{2.5}$ standard from 12 ug/m^3 to 9 ug/m^3. *https://www.epa.gov/pm-pollution/national-ambient-air-quality-standards-naaqs-pm* accessed on March 7, 2024.

to control harmful air pollution except after ''consideration of other technologically or economically feasible means of achieving emissions standards under section [202].'' Thus, it is entirely appropriate (if not required) for the Administrator to take the technologically and economically feasible steps of this rule before undertaking further controls on fuels to address emissions reduction. Furthermore, while achieving PM emissions reduction from the in-use fleet is important, reductions through fuel properties alone would not achieve the same level of PM reductions that are possible through the use of GPFs on new vehicles.

Furthermore, EPA's authority to adopt fuel controls involves a distinct provision of the CAA with its own technical and legal requirements. As we noted in the NPRM (88 FR 29397), changes to fuel controls are beyond the scope of this rulemaking. EPA does however recognize the potential benefits of fuel property changes to reduce emissions from the in-use fleet and we will consider the information we received in response to our solicitation of comments on this topic in the context of possible future regulatory action.

ii. Phase-In for Light-Duty and Medium-Duty Vehicles

The final PM standard phases in with the finalized criteria pollutant phase-in schedule described in section III.D.1 of the preamble. The finalized phase-in is more gradual than proposed to address manufacturer lead time concerns about applying GPFs across ICE product lines, and the need to install PM sampling equipment into some cold test facilities. The finalized phase-in reaches 100 percent in 2030 for LDV and LDT1–2 vehicle categories, 2030 for LDT3–4 and MDPV, and 2031 for MDV. Section III.D.1 of the preamble provides phase-in percentages, including default and optional early phase-in schedules.

Commentors submitted opposing views on phase-in. For LDV and LDT1–2, EPA proposed a phase-in of 40/80/100 percent in 2027/2028/2029 and requested comment on accelerating the phase-in for PM relative to other criteria pollutants because of the availability of GPF technology.

Automotive suppliers urged a faster phase-in than proposed, attesting to the maturity of GPF technology, abundant manufacturing capacity, widespread use of GPF in other markets (2017 in Europe, 2020 in China, and 2023 in India), and manufacturers building GPF vehicles in the U.S. for export to other countries. MECA, Advanced Engine Systems Institute (AESI), and Alliance for Vehicle Efficiency (AVE) recommended a phase in of 60/90/100 percent in 2027/2028/2029 for LDV and LDT1/2.

Most manufacturers asked for either a longer phase-in schedule than proposed, arguing that it takes time to integrate GPFs into various product lines, or adopting CARB's 1 mg/mile standard without −7 °C testing through the ACC II phase-in. Some U.S. market trucks and SUVs do not have similar versions in other markets where GPFs are in widespread use, which would require additional engineering effort to apply GPFs to these vehicles. Also, some manufacturers noted that their cold test laboratories are not presently equipped with PM sampling equipment.

EPA is finalizing a more gradual criteria pollutant phase-in (including PM) than proposed to provide manufacturers with additional lead time, but less time than some manufacturers recommended in their comments. Although larger U.S. vehicles may not have similar versions in other countries that use GPF technology, these vehicles tend to have the most packaging space available for a GPF, somewhat mitigating the need for additional lead time. We also note that BEVs are an alternative technology for complying with the standards and in light of our projections for BEV penetration (even under the No Action scenario), some manufacturers may find that BEV technology is sufficient to satisfy the phase-in for LDV and LDT1–2, at least in 2027. Under the default phase-in scenario, manufacturers have until 2030 to comply with the final PM standard for LDT3–4 and MDPV, and until 2031 to comply with the final PM standard for MDV. EPA decided not to adopt CARB's PM standard through the ACC II phase-in because EPA is not adopting a ZEV mandate as the CARB standards use, because the 0.5 mg/mile PM standard is feasible at reasonable cost, and because controlling PM in cold temperatures and other off-cycle operation important.

iii. Feasibility of the PM Standard and Selection of Test Cycles

The PM standard that EPA is finalizing will require vehicle manufacturers to produce vehicles that emit PM at or below GPF-equipped levels of PM. The final rule does not require that GPF hardware be used on ICE vehicles, but rather reflects EPA's judgement that it is feasible and appropriate to achieve the final PM standard considering the availability of this technology. EPA projects that manufacturers will choose to employ a combination of GPF technology on ICE vehicles and BEV technology as the most practical and cost-effective pathways for meeting the standard, especially in −7 °C FTP and US06 test cycles.

To establish the level of the PM standard, EPA conducted a test program that included multiple ICE vehicle types, powertrain technologies, and GPF technologies. Much like other emissions controls, GPFs have seen considerable development since their initial introduction and have provided significantly improved effectiveness. EPA evaluated available technologies with respect to the emissions benefits, including two generations of GPF technology.

A PM test program was conducted using five chassis dynamometer test cells at EPA, Environment and Climate Change Canada (ECCC), and FEV North America Inc., and five test vehicles (2011 F150 Ecoboost, 2019 F150 5.0L, 2021 F150 Powerboost HEV, 2021 Corolla 2.0L, 2022 F250 7.3L) tested in stock and GPF configurations. These test vehicles include a passenger car, three Class 2a trucks, and one Class 2b truck. The two generations of GPFs include series production MY 2019 and series production MY 2022 models, catalyzed and bare substrates, and close-coupled and underfloor GPF installations. Details of the vehicles and test procedures are described in Chapter 3.2.6.2.1 of the RIA. Results from the test program are summarized in Figure 13. The study demonstrates that internal combustion engine-based light-duty vehicles and MDV equipped with GPFs currently in series production in Europe and China (*i.e.,* MY 2022 GPF) can easily meet the final standard of 0.5 mg/mile in all three test cycles with a large compliance margin. BEVs would of course comply as well since they do not have tailpipe emissions.

In Figure 13, tests without GPFs are shown in black, tests with MY 2019 GPFs are shown in gray, and tests performed with MY 2022 GPFs are shown in stripes. The top of each bar represents the highest measurement set mean of one vehicle in one laboratory and the bottom of each bar represents the lowest measurement set mean. The tops of the black bars are off scale in this figure, but their values are indicated with numbers above the bars.

The striped bars include PM measurements from two vehicles: A 2021 F150 Powerboost HEV (Class 2a vehicle) retrofit with a MY 2022 bare GPF in the underfloor location, and a 2022 F250 7.3L (Class 2b vehicle) retrofit with two MY 2022 bare GPFs, one for each engine bank, in the underfloor location.

Results in Figure 13 show that vehicles equipped with MY 2022 GPFs met the 0.5 mg/mile standard in all three test cycles with a very significant compliance margin. The MY 2022 GPFs showed high filtration efficiencies generally over 95 percent. The mean of test sets with MY 2022 GPF are over 95 percent lower than the mean of non-GPF test sets in each of the three test cycles. The results show some non-GPF vehicles could meet the 0.5 mg/mile standard without GPF on the 25 °C FTP and US06 cycles, but no non-GPF vehicles could meet the standard in the −7 °C FTP test cycle. All vehicles with GPF met the standard for all test cycles except the MY 2019 GPFs failed to meet the standard in the US06 because passive GPF regeneration occurred as a result of high exhaust gas temperatures (GPF inlet gas temperature greater than 600 °C) and these older generation GPFs rely on stored soot for high filtration efficiency. GPF regeneration oxidizes stored soot and reduces GPF filtration efficiency during and immediately after the regeneration, especially on the older generation GPFs. The results support the conclusion that a 0.5 mg/mile PM standard over the −7 °C FTP, 25 °C FTP, and US06 test cycles is feasible and appropriate.

The −7 °C FTP test cycle is crucial to the final PM standard because it addresses uncontrolled cold PM emissions in Tier 3 vehicles, and absent the −7 °C FTP test, vehicles would not achieve PM reductions commensurate with what GPF technology offers across a wide range of operating conditions. This is illustrated by the bottoms of the black bars in Figure 13 that show some vehicles without GPFs satisfy the 0.5 mg/mile standard in the 25 °C FTP and US06 cycles, but fail dramatically at −7 °C (an important real-world temperature), with the same being true at other important off-cycle vehicle operation. Without the −7 °C FTP test cycle, vehicles would not have low PM under all operating conditions.

The US06 cycle is a similarly crucial part of the final PM standard because it induces passive GPF regeneration in all vehicle-GPF combinations (*i.e.,* light-duty vehicles and MDV, naturally aspirated and turbocharged engines, close-coupled and underfloor GPF installations, bare and catalyzed GPFs), and GPF regeneration is an important mode of operation with respect to emissions and frequently occurs in real world use. GPF regeneration does not occur in the −7 °C FTP, 25 °C FTP, and LA–92 (used instead of the US06 for some MDV in Tier 3) across vehicle and exhaust system combinations. Including a certification test in which passive GPF regeneration occurs is important because it ensures that vehicles have good PM control during and immediately after GPF regenerations, which occur during high load operation, including road grades, towing, and driving at higher speeds.

Older GPF technology does not exhibit high PM filtration during and immediately after GPF regeneration. Older GPF technology can have filtration efficiency as low as 50 percent, as opposed to generally more than 95 percent demonstrated by the MY 2022 GPFs shown in Figure 13. Without the US06 test cycle, manufacturers could employ older GPF technology with poor PM control during high load operation. Average US06 p.m. from the MY 2019 GPFs is 15 times higher than average US06 p.m. from the MY 2022 GPFs from the data shown in Figure 13.

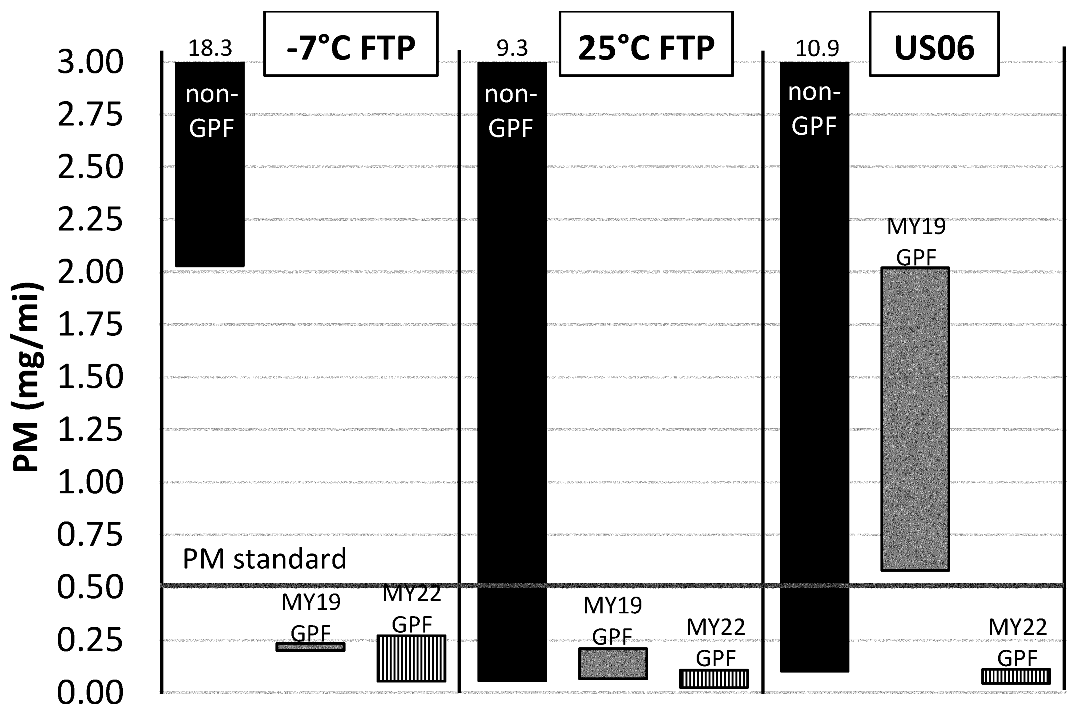

Figure 13: Results from a Five-Lab Five-Vehicle Test Program Illustrating the Effectiveness of Series Production MY 2019 GPFs and Series Production MY 2022 GPFs in Meeting the 0.5 mg/mile PM Standard in −7 °C FTP, 25 °C FTP, and US06 Test Cycles. The Top of Each Bar Represents the Highest Measurement Set Mean of One Vehicle in One Laboratory and the Bottom of Each Bar Represents the Lowest Measurement Set Mean

MDVs are certified at higher test weights and road load coefficients than light-duty vehicles, but measurements show that series production MY 2022 GPF technology enables meeting the 0.5 mg/mile standard equally well on MDV as light-duty vehicles, with compliance margins of over 100 percent. Measurements comparing PM from a Class 2b vehicle with a current technology GPF (MDV MY 2022 F250 7.3L with MY 2022 GPF) to a Class 2a vehicle with a current technology GPF (LDV MY 2021 F150 Powerboost HEV with a MY 2022 GPF) are shown in Figure 14. Further measurements support the same conclusion for Class 3 vehicles.

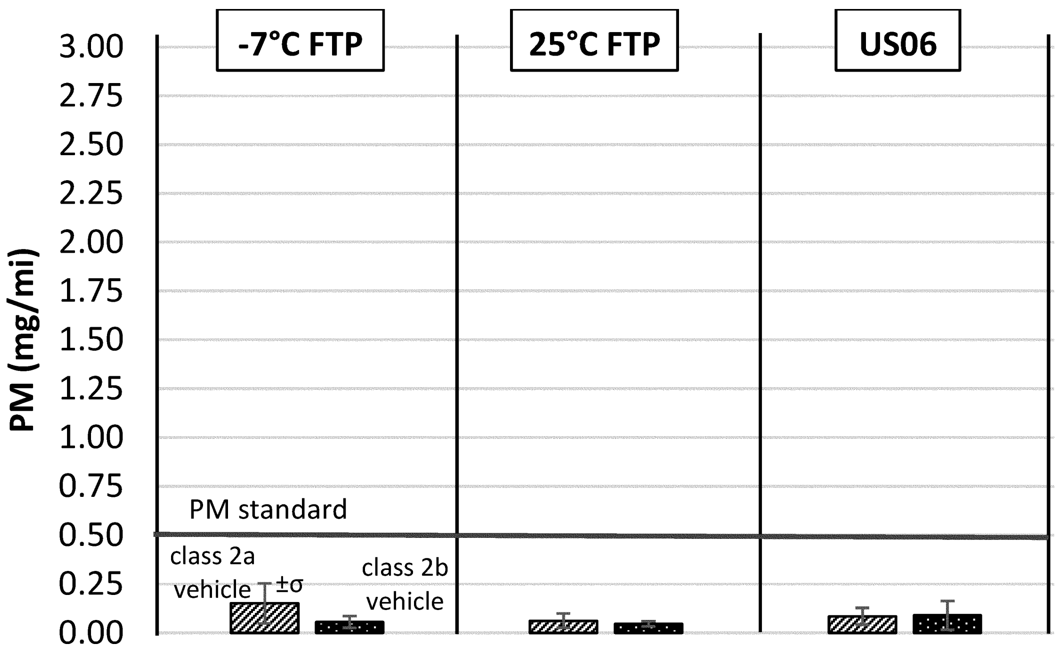

Figure 14: PM Measurements Comparing PM From a Class 2a Vehicle to a Class 2b Vehicle, Both With MY 2022 GPFs, in −7 °C FTP, 25 °C FTP, and US06 Test Cycles

As was the case for light-duty vehicles, the −7 °C FTP test cycle is crucial to the final PM standard because it addresses uncontrolled cold PM emissions in Tier 3, and absent the −7 °C FTP test, MDV would not achieve PM reductions commensurate with what MY 2022 GPF technology offers across a wide range of operating conditions. Without the −7 °C FTP test cycle, MDV would not have low PM under all operating conditions.

Furthermore, as was the case for light-duty vehicles, the US06 cycle is a similarly crucial part of the PM standard. High load operation, which is common on MDVs, induces passive GPF regeneration and GPF regeneration can cause elevated emissions if MY 2022 GPF technology is not used. The full US06 cycle results in GPF regeneration across different vehicle-GPF combinations. The LA–92 cycle, which was used instead of the US06 cycle for certification of Tier 3 Class 3 vehicles, usually does not induce GPF regeneration. Therefore, to capture high load operation and passive GPF regeneration in a test cycle, the full US06 cycle is required for all light-duty vehicles and MDV in the final PM standard.

GPF inlet gas temperatures measured on the MY 2022 F250 7.3L during sampled US06, sampled hot LA–92, and −7 °C FTP test cycles, are shown in Figure 15. Fast soot oxidation begins in a GPF around 600 °C.[649] The US06 is the only cycle where GPF inlet gas temperature of the MY 2022 F250 exceeded 600 °C and it exceeded it for a significant amount of time (265 seconds), illustrating the importance of the US06 cycle in the finalized PM standard. Peak inlet gas temperature was 674 °C in the US06. In contrast, GPF inlet gas temperature never exceeded 600 °C in the LA–92 and only exceeded 500 °C for a limited period of time. Peak GPF inlet gas temperature in the LA–92 (566 °C) was closer to the −7 °C FTP (493 °C) than the US06 (674 °C).

Additional tests performed with the MY 2022 F250 with MY 2022 GPFs using test weight and road load coefficients from a MY 2022 F350 Class 3 vehicle show that even with the higher test weight and road load, the GPFs did not undergo substantial regeneration in the LA–92 cycle. Without requiring the US06 as a certification cycle for MDV, the GPF may not undergo GPF regeneration and as a result, low PM emissions, which new GPF technology offers, would not be ensured during high load operation,

[649] Achleitner, E., Frenzel, H., Grimm, J., Maiwald, O., Rösel, G., Senft, P., Zhang, H., ''System approach for a vehicle with gasoline direct injection and particulate filter for RDE,'' 39th International Vienna Motor Symposium, Vienna, April 26–27, 2018.

including trailer towing, road grades, or high speeds.

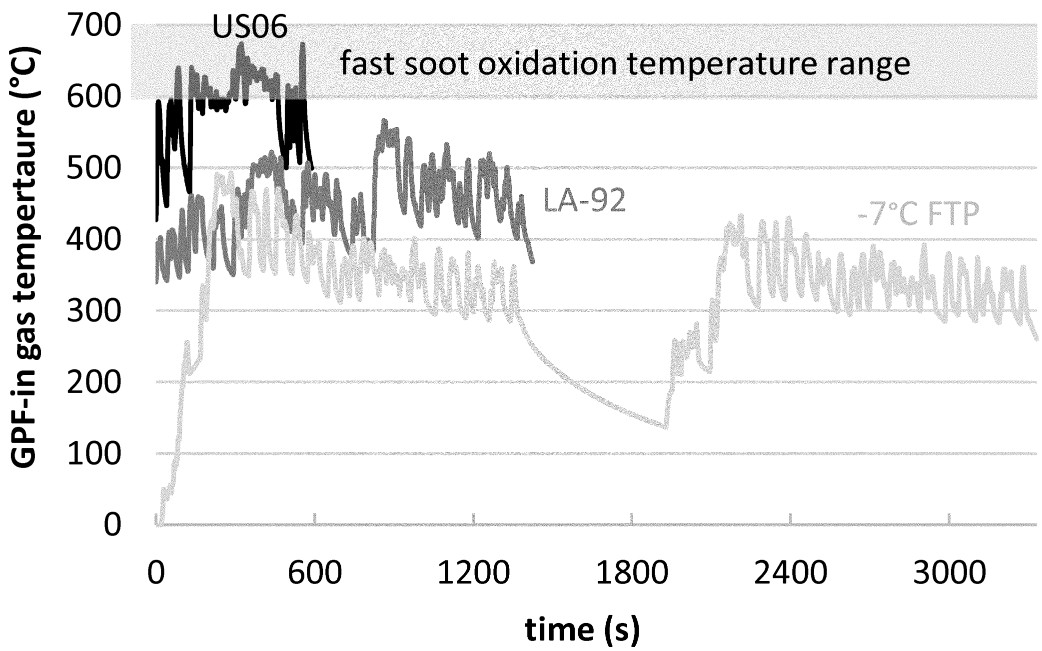

Figure 15: GPF Inlet Gas Temperatures Measured on MY 2022 F250 7.3L Left Engine Bank GPF During Sampled US06, Sampled Hot LA–92, and −7 °C FTP Test Cycles

Under the final standards, Class 2b vehicles with power-to-weight ratios at or below 0.024 hp/pound will no longer replace the full US06 component of the SFTP with the second of three phases (the highway phase) of the US06 for PM certification. Class 2b vehicles with low power-to-weight ratios will now use the full US06 test cycle, which represents high load operation in urban and highway use. If a vehicle is unable to follow the trace, it should use maximum accelerator command to follow the trace as best it can, and doing so will not result in a voided test. This procedure mimics how vehicles with low power-to-weight tend to be driven in the real world.

Also, Class 3 vehicles will not use the LA–92 for PM certification, as they did in Tier 3. Instead, Class 3 vehicles will have to meet the 0.5 mg/mile PM standard across the same three test cycles as light-duty vehicles and other MDV: −7 °C FTP, 25 °C FTP, and US06.

GPF technology is both mature and cost effective. In this rulemaking, unlike some prior vehicle emissions standards including those adopted in the Clean Air Act of 1970, the technology necessary to achieve the standards has already been demonstrated in production vehicles. It has been used in series production on all new pure gasoline direct injection (GDI) vehicle models in Europe since 2017 (WLTC and RDE test cycles) and on all pure GDI vehicles in Europe since first registration of 2019 (WLTC and RDE test cycles) to meet Europe's emissions standards. All gasoline vehicles (GDI and PFI) in China have had to meet similar standards in the WLTC since 2020, and in the WLTC and RDE starting in 2023. All pure GDI vehicles in India have also had to meet similar GPF-forcing standards starting in 2023. GPFs like the MY 2022 GPFs described by Figure 13 and Figure 14 are being used in series production by U.S., European, and Asian manufacturers, and several manufacturers currently assemble vehicles equipped with GPF in the U.S. for export to other markets. While EPA believes that the prolific application of GPFs outside of the United States supports our feasibility assessment of GPF technology, we are not adopting more stringent PM standards to mimic other countries, but rather for the well documented health and environmental benefits from reduced PM emissions. In addition, while some commenters interpreted EPA's reference to GPF technology in other countries as implying a reduced level of effort to adapt the technology to U.S. applications, once again, EPA only means to show that the technology is in widespread use in other areas of the world, which demonstrates a high degree of technical feasibility.

Further details and discussion of test vehicles, GPFs, test procedures, and results are provided in the RIA Chapter 3.2.6.

AAI and several manufacturers requested removal of the −7 °C FTP PM standard, exemption of GPF-equipped vehicles from the −7 °C FTP PM standard, or the option to attest to meeting the −7 °C FTP PM standard in lieu of test data. After consideration, EPA is not finalizing the three recommendations.

EPA is requiring the −7 °C FTP test cycle because it is a crucial part of the PM standard that addresses uncontrolled cold PM emissions in Tier 3, and absent the −7 °C FTP test, vehicles would not achieve appropriate and feasible PM reductions across a wide range of operating conditions. For example, the 2021 Corolla in the EPA test program emits 0.1 mg/mile in the 25 °C FTP and 3.5 mg/mile in the −7 °C FTP.

EPA decided against exempting GPF-equipped vehicles from the −7 °C FTP PM standard because the purpose of the standard is to require low tailpipe emissions, not to force a certain device onto vehicles. If a poor GPF design were added to a non-GPF vehicle with low PM emissions in the 25 °C FTP and US06, it could still easily fail the −7 °C FTP and other operating conditions. Poor GPF designs can have very low filtration efficiencies (*e.g.,* 50 percent) and simply not be effective. Allowing GPF-equipped vehicles to be exempt from the −7 °C FTP PM standard would be analogous to allowing three-way catalyst-equipped vehicles to be exempt from gaseous criteria pollutant standards.

The decision not to allow indefinite attestation to the −7 °C FTP PM standard was made because of the critical importance of this test in ensuring that vehicles achieve appropriate and feasible PM emissions reductions across a wide range of operating conditions. Based on manufacturer comments, however, EPA is finalizing an option for manufacturers to attest to meeting the −7 °C FTP PM standard for MY 2027 and MY 2028 vehicles. This option applies to vehicles at or below 6000 lb GVWR, early phase-in schedule vehicles between 6001–8500 lb GVWR, and early phase-in schedule vehicles between 8501–14,000 lb GVWR, and provides manufacturers with extra time to integrate PM samplers into their cold test cells if they do not already have them. Manufacturers are still responsible for ensuring that vehicles comply with the −7 °C FTP PM standard, and EPA may conduct testing to confirm whether vehicles meet the standard, so manufacturers must have confidence in their attestation.

Although EPA decided against removing the −7 °C FTP PM standard, exempting GPF-equipped vehicles from the −7 °C FTP PM standard, and allowing indefinite attestation, it is finalizing PM relief in several areas: (1) The finalized criteria pollutant phase-in is more gradual than proposed (section III.D.3.ii of the preamble); (2) manufacturers do not have to perform −7 °C FTP PM testing for IUVP, although EPA may check that vehicles meet the standard (section III.D.3.vi of the preamble); (3) all GPF OBD requirements proposed in the NPRM were dropped in favor harmonizing with the CARB approach to GPF OBD (section III.D.3.vii of the preamble); (4) temporary relief is provided on the criteria that trigger an IUCP (in-use confirmatory testing program, section III.G.4.ii of the preamble); and (5) manufacturers may attest to meeting the −7 °C FTP PM standard for MY 2027 and MY 2028 vehicles, although EPA may check that vehicles meet the standard (above paragraph, section III.D.3.iii of the preamble). We adopted these relief provisions after consideration of comments and we believe that with these provisions, the PM standard represents a feasible and appropriate means of reducing PM emissions from light-duty and medium-duty vehicles.

iv. PM Measurement Considerations

EPA did not propose and is not finalizing changes to PM test procedures because the Agency does not believe that test procedure changes are required to measure PM for the final PM standard. Current test procedures outlined in 40 CFR parts 1065 and 1066 allow robust gravimetric PM measurements well below the PM standard of 0.5 mg/mile, as demonstrated by EPA and other laboratories.

Repeat measurements in EPA laboratories at different levels of PM below 0.5 mg/mile are shown in Figure 16 for vehicles (dark bars), a spark aerosol generator (stiped bar), and tunnel blanks (light bars). The size of the error bars, which represent plus/minus one standard deviation, relative to the measurement averages at and below 0.5 mg/mile demonstrates that the current measurement methodology is sufficiently precise to support a 0.5 mg/mile standard. No changes to 40 CFR part 1065 and 1066 procedures are required, but it is important to use good engineering judgment when transitioning to measuring PM below 0.5 mg/mile. This includes consideration of filter media selection, removal of static charge from filter media, dilution factor, filter media flow rate, using a single filter for all phases of a test cycle, robotic weighing, and minimizing contamination from filter handling, filter screens and cassettes.

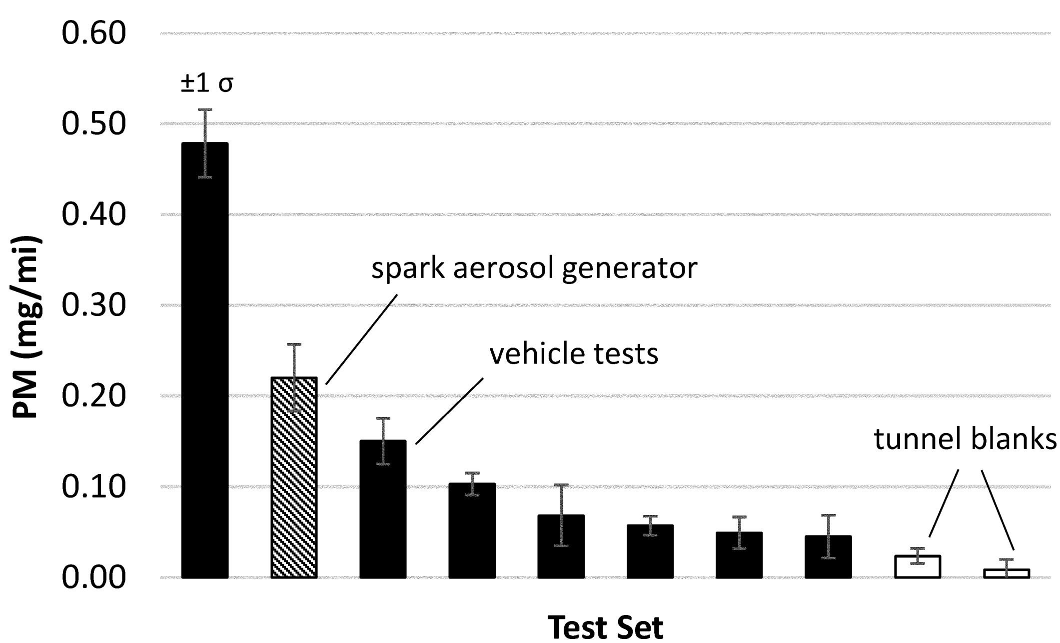

Figure 16: Example of Test-to-Test Repeatability of PM Measurements From Vehicles Without and With GPF, an Aerosol Generator, and Tunnel Blanks From Two EPA Test Cells

EPA also notes that many manufacturers have submitted, and certified the validity of, PM test data below 0.5 g/mile to date. Over 20 percent of MY 2021–2024 light-duty vehicle federal PM certification test results are below 0.5 mg/mile. We recognize that test-to-test variability may be of greater concern to manufacturers for the revised standard, but based on the round robin test results described in III.D.3.iv of the preamble and RIA Chapter 3.2.6, and the test-to-test repeatability results shown in Figure 16, we conclude that should not be a significant issue for certification.

Some manufacturers raised concerns over the ability to reliably measure PM below 0.5 mg/mile. EPA engaged with several manufacturers in technical discussions on PM measurement capability during the development of this rule and will continue to assist and advise manufacturers on best practices for measuring PM at low levels. As a result of these conversations, EPA recognizes that current manufacturer PM test capability is commensurate with the Tier 3 level of the standards, but in some labs, changes may be needed to reliably measure PM below 0.5 mg/mile. Manufacturers may want to consider using power-free gloves, avoiding clothing that sheds lint or dust, not leaning over exposed filters on workbenches, using sticky pads in clean room entranceways, wearing shoe covers to reduce dirt being tracked into the clean room, and regular clean room cleaning. Other elements may be less obvious, like grounding technicians while they handle filters, grounding work benches, etc. These practices are important not just in the PM clean room, but anywhere that filters are handled, such as when they are loaded and unloaded into PM sampling equipment.

EPA's discussions with manufacturers focused on the importance of using PTFE membrane sample filters with FEP (fluorinated ethylene propylene), PMP (polymethyl pentene) or similar support rings (40 CFR 1065.170). Such filters minimize gas-phase artifact but require good static charge removal during weighing using alpha-emitter static charge removal or other techniques with similar effectiveness (40 CFR 1065.190). Discussions with manufacturers included improving signal-to-noise ratio by using the lower half of the allowable dilution factor range (40 CFR 1066.110), elevating filter face velocity (FFV) to a velocity approaching the maximum allowable 140 cm/s, and loading one filter per test instead of one filter per phase (40 CFR 1066.815). Further elements of good measurement procedure include control of temperature, dewpoint, grounding, using HEPA-filtered dilution air, using an effective coarse particle separator (40 CFR 1065.145) and good filter handing procedures (40 CFR 1065.140 and 1065.190). Laboratories may also consider using robotic auto-handling for weighing (40 CFR 1065.190) and background correction (40 CFR 1066.110), although the tests demonstrating the ability to measure below 0.5 mg/mile in the test program summarized in section III.D.3.iii of the preamble did not use background correction and only one of three organizations used robotic auto-handling. EPA welcomes additional industry interaction as manufacturers prepare their facilities to measure PM at the final standard and will be happy to share best practices and help improve PM measurement capability. Further discussion of PM measurement below 0.5 mg/mile is detailed in Chapter 3.2.6 of the RIA.

v. Pre-Production Certification

EPA is finalizing that PM emissions be certified over −7 °C FTP, 25 °C FTP, and US06 cycles with at least one Emissions Data Vehicle (EDV) per test group for light-duty vehicles and MDV certifying to the new 0.5 mg/mile standard. As described toward the end of section III.D.3.iii of this preamble, EPA is finalizing an option for manufacturers to attest to meeting the −7 °C FTP PM standard for MY 2027 and MY 2028 vehicles. Also, since BEVs do not have tailpipe emissions, they are not subject to the tailpipe PM standard being finalized.

This level of PM certification testing matches the requirement to certify gaseous criteria emissions at the test group level and ensures that the final PM standard of 0.5 mg/mile is met across a wide range of ICE technologies. The requirement to certify PM emissions at the test group level is an increase in testing requirements relative to Tier 3, where PM emissions were certified at the durability group level.

EPA is updating the instructions to select a worst-case Tier 4 test vehicle from each test group by considering −7 °C FTP testing along with the other test cycles (40 CFR 86.1828–01). This contrasts with the Tier 3 approach where manufacturers selected worst-case test vehicles separate from −7 °C FTP testing and then selected a test vehicle for −7 °C FTP testing from those test vehicles included in the same durability group. The change in selecting a worst-case test vehicle from each test group is being made because concern for emissions from −7 °C FTP testing is on par with concern for emissions from other test cycles. As a practical matter, it becomes possible to include consideration of emissions from −7 °C FTP testing because we are amending 40 CFR 86.1829–15 to require manufacturers to submit emission data for PM and other pollutants from −7 °C FTP testing for each test group.

EPA solicited comment on whether to revert to pre-production PM certification at the durability group level in 2030 for light-duty vehicles and in 2031 for MDV after PM control technologies have been demonstrated across a range of ICE technology and AAI was supportive of this concept. After consideration, EPA decided that it would be appropriate to review PM certification relief if it were part of a comprehensive review of certification test burden for all criteria pollutants. Such a review would appropriately consider how to select worst-case vehicles for certification testing if manufacturers demonstrate compliance based on testing vehicles from every test group for some standards and testing vehicles only based on the durability group for other standards. EPA has not begun such a comprehensive review at this time but will consider whether and when such a review would be appropriate to undertake.

The final 25 °C FTP PM standard applies equally at high-altitude conditions (1520–1720 meters) as at low-altitude conditions (0–549 meters). Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions and GPF filtration of elemental carbon does not diminish at high altitude conditions.

EPA is finalizing a requirement that manufacturers submit an engineering evaluation indicating that common calibration approaches are utilized at high and low altitude conditions for −7 °C FTP PM.

Since EPA is finalizing that SVMs must meet the same criteria pollutant emissions standards as large manufacturers, although with a delayed phase-in, SVMs must provide PM test data when certifying to the Tier 4 p.m. standard.

vi. In-Use Compliance Testing

In addition to pre-production certification, the final PM standard requires in-use compliance testing as part of the in-use vehicle program (IUVP). Each test vehicle must be tested in 25 °C FTP and US06 cycles and meet the 0.5 mg/mile PM standard. This is a change from Tier 3, where only 50 percent of in-use test vehicles had to be tested for PM. The final PM standard also requires in-use vehicles to comply with the 0.5 mg/mile PM standard in the −7 °C FTP cycle but manufacturers are not required to test using this cycle as part of IUVP. However, EPA may test in-use vehicles using −7 °C FTP, 25 °C FTP, and US06 cycles to ensure compliance. IUVP test vehicles are not required to be tested in the −7 °C FTP to reduce manufacturer testing burden. This testing relief is based on the reasoning that if a vehicle demonstrates compliance across all three test cycles at pre-production and demonstrates in-use compliance in 25 °C FTP and US06 cycles, then the vehicle design can be expected to also comply with the in-use −7 °C FTP test cycle. The same in-use requirements apply to SVMs as to large manufacturers, although SVMs have a delayed phase-in.

vii. OBD Monitoring and Warranty

Since GPF technology is a key enabler for meeting the final PM standard in vehicles with an internal combustion engine, OBD monitoring of GPFs is important. If a vehicle uses a GPF, the OBD system must detect GPF-related malfunctions, store trouble codes related to detected malfunctions, and alert operators appropriately.

EPA is finalizing that manufacturers follow the latest CARB OBD requirements, which at this time are the California 2022 OBD–II requirements in Title 13, section 1968.2 of the California Code of Regulations, finalized on November 22, 2022. Following section 1968.2(e)(17), manufacturers propose GPF OBD plans and CARB reviews the manufacturer plans on a case-by-case basis. This provides flexibility relative to diesel PM trap (DPF) monitoring requirements described in section 1968.2(e)(15).

EPA had proposed GPF OBD requirements unique from those of CARB, but manufacturers commented that certain aspects of the EPA OBD requirements were difficult to achieve and that manufacturers had already certified GPF diagnostics with CARB. Harmonizing with CARB's current requirements resolves potential conflicts of having two sets of GPF OBD requirements and addresses manufacturer concerns about the difficulty of achieving the EPA-proposed diagnostics. Therefore, EPA is not finalizing our proposed GPF OBD requirements, and instead is finalizing that manufacturers follow the latest CARB GPF OBD requirements. EPA plans to continue to work with CARB on developing increasingly robust OBD for GPFs. Broader discussion of OBD system requirements is found in section III.H of this preamble.

As proposed, EPA is designating the GPF as a specified major emission control component, which brings with it a warranty period of 8 years or 80,000 miles of use (whichever first occurs), as detailed in section III.G.6 of the preamble.

viii. GPF Cost

GPF direct manufacturing cost (DMC) is estimated using an updated cost model described in RIA Chapter 3.2.6.4. The cost model estimates DMC of bare GPF(s) in their own enclosures (cans) installed downstream of the TWC(s). This configuration results in a similar or slightly higher system cost as compared to an aftertreatment system that uses catalyzed GPF(s) to replace TWC(s) in the close-coupled position just downstream of the first TWC(s). The updated GPF DMC model is used in FRM OMEGA analyses. Indirect costs including R&D and markup are calculated separately by OMEGA.

The updated GPF DMC model is based on the model used in the NPRM but uses a larger GPF swept volume ratio (GPF volume to engine displacement volume) of 0.80 instead of 0.55 in the NPRM, and uses 2022 dollars instead of 2021 dollars. The larger swept volume ratio is based on an expanded GPF/vehicle database, input from a GPF supplier, and an ICCT PM/GPF fact sheet released in November 2023.[650] Details are provided in RIA Chapter 3.2.6.4. The updated model estimates GPF DMC of $87, $131, $176 for engines with displacements of 2.0L, 4.0L, and 6.0L, respectively.

AAI and several manufacturers raised the issue of GPF cost, including the cost to re-design vehicles to accommodate GPFs. In response to these comments, the Agency updated the NPRM GPF cost model to estimate GPF cost as accurately as possible using the latest available information. The Agency is also finalizing a more gradual criteria phase-in to provide manufacturers with additional time to add GPFs to existing designs and in some cases add them together with vehicle re-design or the introduction of new models. We believe the updated GPF cost information and the more gradual phase-in supports that the final PM standard can be met at a reasonable cost.

[650] Isenstadt, A., ''What EPA's New Multi-Pollutant Emissions Proposal Means for PM Emissions and GPFs,'' ICCT Fact Sheet, November 2023. *https://www.theicct.org* accessed on March 7, 2024.

4. CO and Formaldehyde (HCHO) Standards

i. CO and HCHO Standards for Light-Duty Vehicles

EPA is finalizing the light-duty vehicle CO and formaldehyde (HCHO) per vehicle emissions standards (caps) shown in Table 45. The CO caps are 1.7 g/mile in the 25 °C FTP, HFET, and SC03 test cycles, 9.6 g/mile in the US06, and 10.0 g/mile in the −7 °C FTP. The HCHO cap is 4 mg/mile in the 25 °C FTP. EPA is finalizing that the same Tier 3 25 °C FTP useful life standard applies to all the emissions caps shown in Table 45.

The final standards contrast with Tier 3 bin-specific standards for the FTP (1.0 g/mile for Bins 20 and 30, 1.7 g/mile for Bins 50 and 70, 2.1 g/mile for Bin 125, and 4.2 g/mile for Bin 160), a 4.2 g/mile standard for the SFTP, a 10.0 g/mile −7 °C FTP CO cap for LDV and LDT1, a 12.5 g/mile −7 °C FTP CO cap for LDT2–4 and MDPV, and a 4 mg/mile FTP HCHO bin-specific standard for Bin 20 through Bin 160. In Tier 3 the −7 °C FTP CO caps applied only to gasoline-fueled vehicles, while the 10.0 g/mile cap being finalized applies to gasoline-fueled and diesel-fueled vehicles.

The majority of the CO and HCHO standards in Table 45 are the same as those EPA proposed with the exception of the level of the US06 standard, which has been increased from 1.7 g/mile to 9.6 g/mile.

TABLE 45—LIGHT-DUTY VEHICLE CO AND HCHO EMISSIONS CAPS

CO cap for 25 °C FTP, HFET, SC03 (g/mi)	1.7
CO cap for US06 (g/mi)	9.6
CO cap for −7 °C FTP (g/mi)	10.0
HCHO cap for 25 °C FTP (mg/mi)	4

The 1.7 g/mile CO cap for the 25 °C FTP is less stringent than the Tier 3 25 °C FTP bin specific standard for Bin 20 and Bin 30, but overall, the 1.7 g/mile CO cap is somewhat more stringent than Tier 3 because it applies to three cycles instead of one, and because it is more stringent than the Tier 3 25 °C FTP bin specific standard for Bin 125 and Bin 160.

The 1.7 g/mile CO cap for the 25 °C FTP, HFET, and SC03 cycles is feasible because most current production light-duty vehicles already meet the cap and existing aftertreatment technology can be applied to the remaining light-duty vehicles that do not already meet the standard during the phase-in period described in section III.D.1.i of the preamble. EPA did not receive adverse comments on the feasibility of the 1.7 g/mile standard for the 25 °C FTP, HFET, and SC03 test cycles.

The final US06 cap was increased from the proposed value of 1.7 g/mile to 9.6 g/mile for several reasons. While EPA recognizes that CO is a pollutant with significant health risks, the United States does not currently have any nonattainment areas for CO. EPA also considered the current Tier 3 SFTP CO standards. The current Tier 3 US06 CO emissions are captured as part of the Supplemental Federal Test Procedure (SFTP). The SFTP is a composite standard which is the numerically weighted result of CO emissions from the FTP, SC03 and US06 tests.[651] The current Tier 3 SFTP CO cap is 4.2 g/mile for LDVs. Because the Tier 3 US06 CO requirements are captured within the SFTP CO cap, Tier 3 allows higher US06 CO emissions with lower FTP and SC03 CO emissions. In their ACC II program, CARB also eliminated their SFTP standards and established a 9.6 g/mile stand-alone US06 CO standard as well as separate SC03 CO standards that were identical to the FTP CO standards. EPA confirmed that 9.6 g/mile on the US06 is commensurate with the Tier 3 Bin 125 CO standard and is a more stringent standard for cleaner bins, as compared to the current Tier 3 SFTP structure.[652] The implicit US06 limit under Tier 3 for a vehicle meeting 1.7 g/mile for SCO3 and FTP (as is required for all vehicles in Tier 4) would be 10.6 g/mile. Additional detail can be found in RIA Chapter 3.2.3.

In addition, several vehicle manufacturers, and the Alliance for Automotive Innovation (AAI) expressed significant concern in meeting the 1.7 g/mile standard over the US06 test cycle. Commenters noted that test-to-test variability may be higher in the US06 than in other cycles, and the proposed US06 CO standard would most likely require significant engine and aftertreatment redesign and/or substantially reduced use of enrichment. Industry commenters recommended that EPA finalize a US06 CO standard of 9.6 g/mile aligned with current Tier 3 standards and the California ACC II standard. The International Council for Clean Transportation (ICCT) noted in their comments the steady historical decline in CO emissions in the United States as the result of previous emissions standards.

With consideration of the current air quality needs, current Tier 3 standards, and the comments received, EPA has concluded that it is appropriate to eliminate the SFTP structure but adopt 25 °C FTP, HFET, SC03 standards of 1.7 g/mile, and a US06 CO standard of 9.6 g/mile. This US06 standard is less stringent than proposed but more stringent than the current implicit US06 limits under Tier 3 SFTP standards for vehicles meeting 1.7 g/mile on the FTP and SC03.

The final 25 °C FTP CO standard applies equally at high-altitude conditions (1520–1720 meters) as at low-altitude conditions (0–549 meters). Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions.

EPA is finalizing a minor increase in stringency in the −7 °C FTP CO standard in that all light-duty vehicles will have to meet a 10.0 g/mile cap instead of 10.0 g/mile for LDV and LDT1 and a 12.5 g/mile cap for LDT2–4 and MDPV. All light-duty vehicle and MDPV MYs 2022–2024 certifications already meet the finalized 10.0 g/mile cap with at least a 40 percent compliance margin, demonstrating the feasibility of this final standard. Additionally, −7 °C FTP CO testing at EPA using a MY 2019 Ford F150 5.0L and a MYs 2021 Toyota Corolla 2.0L show these vehicles also meet the final standard by large compliance margins, so there is no question about the feasibility of this standard.

The final −7 °C FTP CO standard applies equally at high-altitude conditions as at low-altitude conditions. Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions.

EPA is finalizing that −7 °C FTP CO emissions be certified with at least one Emissions Data Vehicle (EDV) per test group for light-duty vehicles certifying to the 10.0 g/mile standard instead of one EDV per durability group as in Tier 3.

EPA is finalizing a HCHO cap of 4 mg/mile in the 25 °C FTP, which has the same stringency as the Tier 3 bin-specific 4 mg/mile standard for Bin 20 through Bin 160, (*i.e.,* all current light-duty vehicles and MDPV already meet the HCHO cap being finalized).

The final 25 °C FTP HCHO standard applies equally at high-altitude conditions (1520–1720 m) as at low-altitude conditions.

ii. CO and HCHO Standards for Medium-Duty Vehicles

EPA is finalizing the MDV CO and formaldehyde (HCHO) per vehicle emissions standards (caps) shown in Table 46. The CO caps are 3.2 g/mile in the 25 °C FTP, HFET, and SC03 test cycles, 25 g/mile in the US06 (*i.e.,* identical to California MDV standards over the entire US06 cycle), and 10.0 g/mile in the −7 °C FTP. The HCHO cap is 6 mg/mile in the 25 °C FTP. EPA is finalizing that the same Tier 3 25 °C FTP useful life standard applies to all the emissions caps shown in Table 46.

This contrasts with Tier 3 bin-specific standards for the FTP (3.2–7.3 g/mile depending on bin and class), bin-specific standards for the HD–SFTP (4.0–22.0 g/mile depending on bin and class), no −7 °C FTP standard, and a 6 mg/mile FTP HCHO bin-specific standard for all bins over bin 0. The 10.0 g/mile cap at −7 °C applies to gasoline-fueled and diesel-fueled vehicles.

The majority of the final MDV standards for CO and HCHO shown in Table 46 are the same as what EPA proposed with the exception of the US06 standard, which has been increased from 3.2 g/mile to 25 g/mile.

TABLE 46—MDV CO AND HCHO EMISSIONS CAPS

CO cap for 25 °C FTP, HFET, SC03 (g/mi)	3.2
CO cap for US06 (g/mi)	25
CO cap for −7 °C FTP (g/mi)	10.0
HCHO cap for 25 °C FTP (mg/mi)	6

The 3.2 g/mile CO cap for the 25 °C FTP is equal to the stringency of some Tier 3 bins and more stringent than others. EPA did not receive adverse comments on the feasibility of the 3.2 g/mile standard for the 25 °C FTP, HFET, and SC03 test cycles.

The MDV US06 cap was increased from the proposed value of 3.2 g/mile to 25 g/mile for similar reasons identified above for light-duty vehicles. While EPA recognizes that CO is a pollutant with significant health risks, the United States does not currently have any non-attainment areas for CO. The current Tier 3 US06 CO emissions are captured as part of the Supplemental Federal Test Procedure (SFTP). The SFTP is a composite standard which is the numerically weighted result of CO emissions from the FTP, SC03 and US06 tests. The current Tier 3 SFTP CO cap is 12 g/mile. Because the Tier 3 US06

[651] SFTP (g/mi) = 0.35 × FTP + 0.28 × US06 + 0.37 × SC03.

[652] Tier 3 FTP Bin 125 has a CO standard of 2.1 g/mile. Given the Tier 3 SFTP cap of 4.2 g/mile, and assuming FTP CO = SC03 CO emissions, 4.2 g/mile = (0.35*2.1) + (0.28*2.1) + (0.37*US06) yields a US06 implicit limit of 9.6 g/mile. Substituting 1.7 g/mile CO (for Tier 3 FTP Bins 70 and 50) allows US06 CO to increase to 10.6 g/mile.

CO requirements are captured within the SFTP CO cap, Tier 3 allows higher US06 CO emissions with lower FTP and SC03 CO emissions. EPA has determined that 25 g/mile is marginally more stringent that the current Tier 3 MDV CO standard and is a lower standard for the cleaner bins (including those that are equivalent to the Tier 4 standards), as compared to the current Tier 3 SFTP structure.[653] Additional detail can be found in RIA Chapter 3.2.3.

EPA received comments from several vehicle manufacturers and AAI expressing significant concern in meeting the 3.2 g/mile standard over US06 test cycle. Commenters noted that test-to-test variability may be higher in the US06 than in other cycles, and the proposed US06 CO standard would most likely require significant engine and aftertreatment redesign and/or substantially reduced use of enrichment. Industry commenters recommended that EPA finalize a US06 CO standard of 25 g/mile to better align with current Tier 3 standards and the California ACC II standard.

With consideration of the current air quality needs, current Tier 3 standards and the comments received, EPA has concluded that it is appropriate to set a US06 CO standard that is more stringent than the current Tier 3 SFTP standards for cleaner bins, albeit, under the revised program structure of eliminating SFTP requirements.

The final 25 °C FTP CO standard applies equally at high-altitude conditions (1520–1720 meters) as at low-altitude conditions (0–549 meters). Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions.

EPA is finalizing a new 10.0 g/mile MDV CO cap for the −7 °C FTP because CO emissions increase in cold temperatures but there were no MDV cold CO standards included in Tier 3 . Testing of a 2022 F250 7.3L in the −7 °C FTP at EPA showed average CO emissions of 2.7 g/mile CO, demonstrating that a 10.0 g/mile standard is feasible for MDV. Present-day MDV gasoline engine aftertreatment technology allows fast catalyst light-off followed by closed-loop A/F control and excellent emissions conversion on Class 2b and 3 vehicles.

The final −7 °C FTP CO standard applies equally at high-altitude conditions as at low-altitude conditions. Modern engine management systems can use idle speed, engine spark timing, valve timing, and other controls to offset the effect of lower air density on exhaust catalyst performance at high altitude conditions.

EPA is finalizing that −7 °C FTP CO emissions be certified with at least one Emissions Data Vehicle (EDV) per test group for MDV certifying to the 10.0 g/mile standard instead of one EDV per durability group as in Tier 3.

EPA is finalizing a HCHO cap of 6 mg/mile in the 25 °C FTP, which has the same stringency as the Tier 3 FTP HCHO 6 mg/mile bin-specific standard for all bins over bin 0.

The final 25 °C FTP HCHO standard applies equally at high-altitude conditions (1520–1720 meters) as at low-altitude conditions (0–549 meters).

5. Requirements for Medium-Duty Vehicles With High GCWR

The Agency proposed requiring high GCWR MDVs, defined as MDV with a gross combination weight rating (GCWR) above 22,000 pounds, to be subject to heavy-duty engine certification instead of chassis-certification for criteria air pollutant standards. Within the proposed rule, the Agency asked for comment on three alternatives to engine certification of high GCWR MDV:

- MDV above 22,000 pounds GCWR would comply with the MDV chassis dynamometer standards with the introduction of additional engine-dynamometer-based standards over the Supplemental Emissions Test as finalized within the Heavy-duty 2027 and later standards;
- MDV above 22,000 pounds GCWR would comply with the MDV chassis dynamometer standards with additional in-use testing and standards comparable to those used within the California ACC II;
- Introduction of other test procedures for demonstration of effective criteria pollutant emissions control under the sustained high-load conditions encountered during operation above 22,000 pounds GCWR.

We received comments from the Alliance for Automotive Innovation supporting implementation of Alternative 2 for MDV in the final rule. Similarly, Stellantis requested that MDV comply with California ACC II provisions in lieu of engine certification. Alternative 2 fully addresses the Agency's concern that NO_X emissions controls be designed to adequately control NO_X emissions under the high load conditions encountered by high GCWR MDV, and thus the Agency is adopting Alternative 2 for the final rule. Alternative 2 includes PEMS-based moving-average-window in-use standards that are comparable to California in-use standards for chassis-certified MDV and include options that facilitate 50-state certification of high GCWR MDV. The Agency is not finalizing mandatory engine certification for compliance with criteria pollutant emissions standards for high GCWR MDV; however, there is still an option that allows manufacturers to choose compliance with light-heavy-duty engine standards for high GCWR MDV in lieu of compliance with MDV test procedures and standards.

i. Background on California ACC II/LEV IV Medium-Duty Vehicle In-Use Standards

As part of ACC II and LEV IV programs, California established in-use testing requirements for chassis certified LEV IV MDV with a GCWR greater than 14,000 pounds using PEMS-based moving average window (MAW) in-use standards.[654] California's in-use test procedures and standards for chassis-certified MDV are based upon California's MAW in-use test procedures and standards for heavy-duty engines. Under California's program, chassis-certified diesel MDV with a GCWR greater than 14,000 pounds meet NO_X, NHMC, CO, and PM in-use emissions standards over a three-bin MAW (3B–MAW) with bins representing idle operation (less than or equal to 6 percent engine load), low-load operation (above 6 percent engine load and less than or equal to 20 percent engine load) and medium-high operation (above 20 percent engine load) at up to GCWR.[655] Chassis-certified gasoline MDV with a GCWR greater than 14,000 pounds attest to meeting NO_X, NHMC, CO, and PM in-use emissions standards over a single MAW (1B–MAW) at up to GCWR.[653] Note that under these provisions,

[653] For example, given the Tier 3 SFTP cap of 12 g/mile, and assuming a vehicle is meeting 3.2 g/mile for both FTP and SC03 CO emissions (*i.e.,* Tier 4 levels), 12 g/mile = (0.35*3.2) + (0.28*3.2) + (0.37*US06) yields a US06 implicit limit of 27 g/mile.

[654] California 2026 And Subsequent Model Year Criteria Pollutant Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium-Duty Vehicles; Part 1, section I.4. ''California Provisions: Certification and In-Use testing requirements for chassis certified Medium-Duty Vehicles (MDV) with a Gross Combination Weight Rating (GCWR) greater than 14,000 pounds, using the Moving Average Window (MAW).'' August 25, 2022.

[655] California 2026 And Subsequent Model Year Criteria Pollutant Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium-Duty Vehicles; Part 1, section I.4.1 ''Test Procedures for Three Binned Moving Average Window (3B–MAW) and Moving Average Window (MAW). Applies to 2027 and subsequent model year diesel and Otto-cycle vehicles.'' August 25, 2022.

chassis certified MDV with a GCWR greater than 14,000 pounds are required to meet g/bhp-hr MAW standards instead of g/mile MAW standards and use a FTP CO_2 family certification level (FCL) calculated either from chassis dynamometer test results or engine dynamometer test results.[656] The chassis dynamometer FCL definition uses OBD torque data collection together with CO_2 emissions measurement during chassis-dynamometer testing. The California MDV in-use standards also include a conformity factor (CF) for in-use compliance that is multiplied by each emissions standard. The CF is set to 2.0 for MYs 2027 through 2029. The CF is set to 1.5 for MY 2030 and subsequent model year vehicles.

ii. Background on Federal MAW Standards and Procedures for Light-Heavy-Duty Engines and California Harmonization With Federal Standards

In January 2023, the Agency finalized MAW in-use test procedures and NO_X, PM, HC and CO in-use standards for heavy-duty diesel engines based upon a two-bin moving average window (2B–MAW) instead of California's 3B–MAW.[657] [658] The Federal 2B–MAW standards also applied a separate temperature correction to light-heavy-duty diesel engine (LHDDE) NO_X standards than the temperature correction used for medium- and heavy-heavy-duty diesel engines. The Agency established 1B–MAW test procedures for gasoline heavy-duty engines comparable to the California procedures, however the Agency did not establish 1B–MAW standards for heavy-duty gasoline engines.

The Federal 2B–MAW procedures for diesel engines are based upon two 300-second moving average window (MAW) operational bins. Bin 1 represents extended idle operation and other very low (≤6 percent) load operation where exhaust temperatures may drop below the optimal temperature for aftertreatment function. Bin 2 represents higher load operation (>6 percent). The California 3B–MAW procedures differ chiefly by dividing Bin 2 into Bin 2 and Bin 3, with Bin 2 representing operation from 6 percent to 20 percent load and Bin 3 having operation at greater than 20 percent load.

Within the Federal in-use procedures, CO_2 emissions rates normalized to the maximum CO_2 rate of the engine are used as a surrogate for engine power within the bin definitions. The maximum CO_2 rate is defined as the engine's rated maximum power multiplied by the engine's CO_2 family certification level (FCL) for the FTP certification cycle.[659]

In June 2023, a final agreement was signed by representatives of the California Air Resources Board (CARB), the Truck and Engine Manufacturers Association, Cummins, Daimler Truck, General Motors, Hino, Isuzu, Navistar, PACCAR, Stellantis, and Volvo.[660] As part of this agreement, CARB proposed adopting the Federal 2B–MAW test procedures and standards from 40 CFR part 1036 for diesel heavy-duty engines with no changes to California's 1B–MAW standards and procedures for gasoline heavy-duty engines. California has previously maintained consistent MAW standards and procedures between their in-use medium-duty chassis-certified Tier IV program and their medium-duty engine-certified program.

iii. In-Use Testing Requirements for Chassis-Certified High GCWR Medium-Duty Vehicles Using the Moving Average Window (MAW)

The agency is not finalizing the proposed provisions for requiring MY 2030 engine-certification to light-heavy-duty engine standards under 40 CFR part 1036 for high GCWR MDV (GCWR above 22,000 pounds), however the final rule retains engine certification as an option for high GCWR MDV. See section III.D.5.iv of the preamble for further description of the option to certify engines under 40 CFR part 1036. The remainder of this section describes the in-use provisions required for high-GCWR MDV chassis certification 40 CFR part 86, subpart S, and 40 CFR part 1036, subparts B, E, and F.

The agency is finalizing in-use standards for MY 2031 and later high GCWR MDVs consistent with the California provisions for certification and in-use standards for chassis certified medium-duty vehicles (MDV) based on moving average windows (*i.e.,* Alternative 2 in the proposal). The timing of the standards is simultaneous with default compliance with other criteria pollutant standards (see section III.D.1.ii of the preamble) and one year after the fully phase-in of California's in-use program. Consistent with the proposal, note that this differs from the California program with respect to applicability. The Federal in-use standards only apply for MDV with a GCWR greater than 22,000 pounds whereas the California program applies above 14,000 pounds GCWR.

The applicability and feasibility of 2B–MAW standards to high GCWR diesel MDV is based upon EPA's previous analysis of in-use 2B–MAW standards for MY 2027 and later light-heavy-duty diesel engines.[661] EPA is also allowing optional certification of high GCWR diesel MDV to 3B–MAW standards; however, this has been included solely as a flexibility to facilitate 50-state certification of high GCWR MDV. There remains a degree of uncertainty with respect to California's anticipated adoption of 2B–MAW standards for diesel chassis-certified MDV in place of California's current 3B–MAW, and thus we will allow manufacturers of high GCWR diesel MDV to choose between compliance with 2B–MAW standards or 3B–MAW standards. The levels of the 2B–MAW emissions standards for MY 2031 and later high GCWR MDV are identical to those of current 2B–MAW standards applicable to MY 2027 and later compression-ignition light heavy-duty engines. The levels of the 3B–MAW emissions standards for high GCWR MDV are consistent with MY 2030 and later California standards for chassis-certified MDV.

The final in-use test procedures and standards for high GCWR MDV are based upon Federal heavy-duty in-use test procedures and standards for light-heavy-duty engines with changes that include:

- Optionally allow FCL to be derived entirely from chassis dynamometer testing, emissions measurement and OBD data collection.
- Addition of optional 3B–MAW standards, procedures calculations for high GCWR diesel MDV. Note that Federal 3B–MAW standards incorporate California's full-phase-in CF of 1.5.
- Addition of 1B–MAW standards for high GCWR gasoline MDV.

The high GCWR gasoline MDV standards are summarized in Table 47. High GCWR diesel 3B–MAW standards and off-cycle bin definitions are summarized in Table 48 and Table 49. High GCWR diesel 2B–MAW standards and off-cycle bin definitions are

[656] California 2026 And Subsequent Model Year Criteria Pollutant Exhaust Emission Standards and Test Procedures for Passenger Cars, Light Duty Trucks, and Medium-Duty Vehicles; Part 1, section I.4.1.14. August 25, 2022.

[657] 88 FR 4296, January 24, 2023.

[658] 40 CFR 1036.104, and 1036.530 and 40 CFR part 1036, subpart E.

[659] 40 CFR 1036.530(e).

[660] Final Agreement between Carb and EMA, 6–27–2023. *https://ww2.arb.ca.gov/sites/default/files/2023-07/Final%20Agreement%20between%20CARB%20and%20EMA%202023_06_27.pdf.*

[661] U.S. EPA. Chapter 2.2—Manufacturer-Run Off-Cycle Field Testing Program for Compression-Ignition Engines. Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards—Regulatory Impact Analysis. EPA–420–R–22–035, December 2022.

summarized in Table 50 and Table 51. Note that, identical to standards for light-heavy-duty diesel engines, the 2B–MAW standards for high GCWR diesel MDV also include PEMS accuracy margins (Table 52). The 2B–MAW and 3B–MAW NO_X standards, including any applicable accuracy margins and temperature corrections, are compared in Figure 17 and Figure 18. Note that while the 2B–MAW NO_X standards are somewhat less stringent the corresponding 3B–MAW standards, the level of the 2B–MAW NO_X standards together with the accuracy margins and temperature corrections to those standards represent what we consider to be feasible with current and near-term urea SCR NO_X controls and are consistent with data previously generated in support of the MY 2027 and later heavy-duty engine standards.[662] See 40 CFR 86.1811–27 for further details regarding the finalized high GCWR MDV in-use standards and see 40 CFR 86.1845–04(h) for further details regarding the finalized high GCWR MDV in-use test procedures. These regulatory provisions include extensive references to 40 CFR part 1036.

TABLE 47—MY 2031 AND LATER SPARK-IGNITION STANDARDS FOR OFF-CYCLE TESTING OF HIGH GCWR MDV [a] [b]

NO_X mg/hp·hr	HC mg/hp·hr [c]	PM mg/hp·hr	CO g/hp·hr
30	210	7.5	21.6

[a] Standards already include a conformity factor of 1.5 and Accuracy Margins do not apply.
[b] In-use standards for spark-ignition vehicles are not divided into separate operation bins.
[c] There is no applicable temperature condition, $\bar{T}_{amb}$, for spark-ignition vehicles certifying to moving average window standards.

TABLE 48—MODEL YEAR 2031 AND LATER COMPRESSION-IGNITION STANDARDS FOR OFF-CYCLE TESTING OF HIGH GCWR MDV OVER THE 3B–MAW PROCEDURES [a] [b]

Off-cycle Bin [a] [b] [c]	NO_X [c]	HC mg/hp·hr	PM mg/hp·hr	CO g/hp·hr
Bin 1	7.5 g/hr			
Bin 2	75 mg/hp·hr	21	7.5	23.25
Bin 3	30 mg/hp·hr	21	7.5	23.25

[a] Vehicles optionally certifying to 3-bin moving average window standards.
[b] Standards already include a conformity factor of 1.5 and Accuracy Margins do not apply.
[c] There is no applicable temperature condition, $\bar{T}_{amb}$, for vehicles certifying to 3-bin moving average window standards.

TABLE 49—CRITERIA FOR 3B–MAW OFF-CYCLE BINS

Bin	Normalized CO_2 emission mass over the 300 second test interval
Bin 1	mCO_2,norm,testinterval ≤ 6.00%.
Bin 2	6.00% < mCO_2,norm,testinterval ≤ 20.00%.
Bin 3	mCO_2,norm,testinterval > 20.00%.

TABLE 50—MODEL YEAR 2031 AND LATER COMPRESSION-IGNITION STANDARDS FOR OFF-CYCLE TESTING OVER THE 2B–MAW

Off-cycle Bin [a]	NO_X [b]	Temperature adjustment [c]	HC mg/hp·hr	PM mg/hp·hr	CO g/hp·hr
Bin 1	10.0 g/hr	$(25.0-\bar{T}_{amb})\cdot 0.25$			
Bin 2	58 mg/hp·hr	$(25.0-\bar{T}_{amb})\cdot 2.2$	120	7.5	9

[a] Vehicles and engines certifying to 2-bin moving average window standards.
[b] Use Accuracy Margins from 40 CFR 1036.420(a).
[c] $\bar{T}_{amb}$ is the mean ambient temperature over a shift-day, or equivalent. Adjust the off-cycle NO_X standard for $\bar{T}_{amb}$ below 25.0 °C by adding the calculated temperature adjustment to the specified NO_X standard.

TABLE 51—CRITERIA FOR 2B–MAW OFF-CYCLE BINS

Bin	Normalized CO_2 emission mass over the 300 second test interval
Bin 1	mCO_2,norm,testinterval ≤ 6.00%.
Bin 2	mCO_2,norm,testinterval > 6.00%.

TABLE 52—ACCURACY MARGINS FOR IN-USE TESTING OVER THE 2B–MAW

	NO_X	HC	PM	CO
Bin 1	0.4 g/hr.			

[662] U.S. EPA. Chapter 2.2—Manufacturer-Run Off-Cycle Field Testing Program for Compression-Ignition Engines. Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards—Regulatory Impact Analysis. EPA–420–R–22–035, December, 2022.

TABLE 52—ACCURACY MARGINS FOR IN-USE TESTING OVER THE 2B–MAW—Continued

	NO_X	HC	PM	CO
Bin 2	5 mg/hp·hr	10 mg/hp·hr	6 mg/hp·hr	0.025 g/hp·hr.

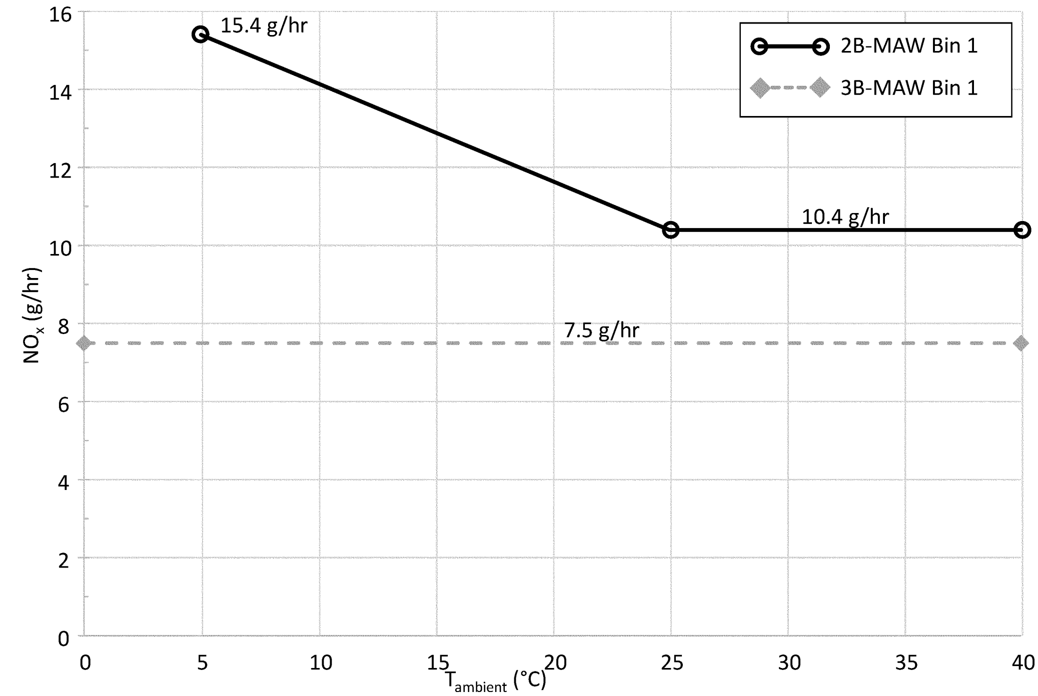

Figure 17: 2B–MAW Bin 1 In-Use NO_X Standard With Ambient Temperature Correction and PEMS Accuracy Margin Compared to 3B–MAW Bin 1 In-Use NO_X Standard

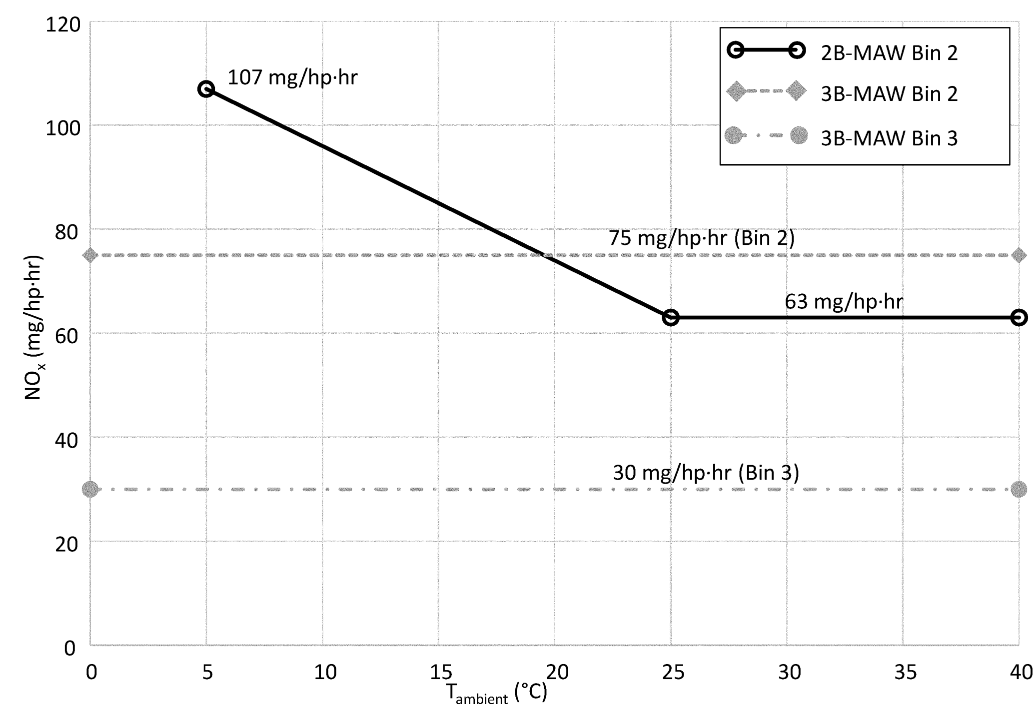

Figure 18: 2B–MAW Bin 2 In-Use NO_X Standard With Ambient Temperature Correction and PEMS Accuracy Margin Compared to 3B–MAW Bin 2 and Bin 3 In-Use NO_X Standard

iv. Optional High GCWR Medium-Duty Vehicles Engine Certification

The final rule includes the option for engine-based certification to emission standards for both spark-ignition and compression-ignition (diesel) engines, and complete and incomplete vehicles (see 40 CFR 1036.635). Engine certification would require compliance with all the same engine certification criteria pollutant requirements and standards as for MY 2027 and later engines installed in heavy-duty vehicles above 14,000 pounds GVWR, including the 2023 rule's NO_X, HC, PM, and CO standards, useful life, warranty and in-use requirements (88 FR 4296, January 24, 2023). Complete MDVs would still require chassis dynamometer testing for demonstrating compliance with GHG standards as described in section III.D.3 of the preamble and are included within the fleet average MDV GHG emissions standards along with the other MDVs. Manufacturers would have the option to certify incomplete MDVs to GHG standards under 40 CFR 86.1819 or 40 CFR parts 1036 and 1037. Note that existing regulations at 40 CFR 1037.150(l) already allow a similar dual-testing methodology, which utilizes engine dynamometer certification for demonstration of compliance with criteria pollutant emissions standards while maintaining chassis dynamometer certification for demonstration of compliance with GHG emissions standards under 40 CFR 86.1819.

6. Refueling Standards for Incomplete Spark-Ignition Vehicles

Spark-ignition medium-duty vehicles generally operate with volatile liquid fuel (such as gasoline or ethanol) or gaseous fuel (such as natural gas or liquefied petroleum gas) which have the potential to release high levels of evaporative and refueling hydrocarbon (HC) emissions. As a result, EPA has established evaporative emission standards at 40 CFR 86.1813–17 that apply to vehicles operated on these fuels. Refueling emissions are evaporative emissions that result when the pumped liquid fuel displaces the vapor in the vehicle tank. Without refueling emission controls, most of those vapors are released into the ambient air. The HCs emitted are a function of ambient temperature, fuel temperature, and fuel volatility.[663] The emission control technology that collects and stores the vapor generated during refueling events is the Onboard Refueling Vapor Recovery (ORVR) system.

Light-duty vehicles, light-duty trucks, and chassis-certified complete medium-duty vehicles at or below 14,000 pounds GVWR have been meeting evaporative and refueling requirements for many years. ORVR requirements for light-duty vehicles started phasing in as part of EPA's National Low Emission Vehicle (NLEV) and Clean Fuel Vehicle (CFV) programs in 1998.[664] In EPA's Tier 2 vehicle program, all complete vehicles with a GVWR of 8,501 to 14,000 pounds were required to phase-in ORVR requirements between 2004 and 2006 model years.[665] In the Tier 3 rulemaking, EPA adopted a more stringent standard of 0.20 grams of HC per gallon of gasoline dispensed, with implementation in model year 2022 (see 40 CFR 86.1813–17(b)).[666] The 2023 final rule to set standards for model year 2027 and later heavy-duty engines also established refueling standards for incomplete heavy-duty vehicles over 14,000 pounds GVWR (88 FR 4296, January 24, 2023). This left incomplete medium-duty spark-ignition engine powered vehicles 8,501 to 14,000 pounds GVWR as the only SI vehicles not required to meet refueling standards.

As proposed, the agency is requiring that incomplete medium-duty vehicles meet the same on-board refueling vapor recovery (ORVR) standards as complete vehicles. Incomplete medium-duty vehicles have not been required to comply with the ORVR requirements to date because of the potential complexity of their fuel systems, primarily the filler neck and fuel tank.[667] Unlike complete vehicles, which have permanent fuel system designs that are fully integrated into the vehicle structure at time of original construction by manufacturers, it was previously believed that for incomplete vehicles, manufacturers may need to change or modify some fuel system components during finishing assembly. For this reason, it was previously determined that ORVR might introduce complexity for the upfitters that is unnecessarily burdensome.

Since then, the agency has newly assessed both current ORVR-equipped vehicles and their incomplete versions. Based on our updated assessment, the agency believes that the fuel system designs are almost identical, with only the ORVR components removed for the incomplete version. The complete and incomplete vehicles appear to share the same fuel tanks, lines, and filler tubes. The original thought that extensive differences between the original manufacturer's designs and the upfitter modifications to the fuel system would be required have not been observed. Therefore, the agency believes that all incomplete vehicles can comply with the same ORVR standards as complete vehicles with the addition of the same ORVR components on the incomplete vehicles to match the complete vehicles. Commenters uniformly affirmed the appropriateness of adopting the proposed refueling standards.

We are finalizing, as proposed, a new refueling emission standard for incomplete vehicles 8,501 to 14,000 pounds GVWR, along with corresponding testing and certification procedures. The new standard is 0.20 grams HC per gallon of dispensed fuel (0.15 grams for gaseous-fueled vehicles), which is the same as the existing refueling standards for other vehicles.[668] These refueling emission standards will apply to all liquid-fueled and gaseous-fueled spark-ignition medium-duty vehicles, including gasoline and ethanol blends.[669] These standards will apply over a useful life of 15 years or 150,000 miles, whichever occurs first, consistent with existing evaporative emission standards for these vehicles and for complete versions.

We are applying the refueling standards for new incomplete vehicles starting with model year 2030. This meets the statutory obligation to allow four years of lead time for new emissions standards for criteria pollutants for vehicles above 6,000 pounds GVWR. This schedule also complements the optional alternative phase-in provisions adopted in our final rule setting these same standards for vehicles above 14,000 pounds GVWR (88 FR 4296, January 24, 2023). Those alternative phase-in provisions allowed

[663] E.M. Liston, American Petroleum Institute, and Stanford Research Institute. A Study of Variables that Effect the Amount of Vapor Emitted During the Refueling of Automobiles. Available online: *http://books.google.com/books?id=KW2IGwAACAAJ*, 1975.

[664] 62 FR 31192 (June 6, 1997) and 63 FR 926 (January 7, 1998).

[665] 65 FR 6698 (February 10, 2000).

[666] 79 FR 23414 (April 28, 2014) and 80 FR 0978 (February 19, 2015).

[667] Incomplete light-duty trucks are already subject to refueling emission standards. The proposed rule mistakenly requested comment on applying refueling emission standards for those vehicles.

[668] 40 CFR 86.1813–17.

[669] Refueling requirements for incomplete medium-duty vehicles that are fueled by CNG or LNG will be the same as the current complete gaseous-fueled Spark-ignition medium-duty vehicle requirements.

for manufacturers to phase in certification of all their incomplete medium-duty and heavy-duty vehicles to the new standards from 2026 through 2030. In the alternative phase-in, manufacturers would certify all their incomplete heavy-duty vehicles above and below 14,000 pounds GVWR to the refueling standards, starting with 40 percent of vehicles in 2026 and 2027, followed by 80 percent of vehicles in 2028 and 2029 before reaching 100 percent of vehicles in 2030.

See the preamble to the proposed rule[670] and RIA Chapter 3.2.7 for a description of ORVR technology and costs, along with a discussion of the feasibility of meeting the new standards.

The proposed rule requested comment on amendments that would account for fuel vapors vented to evaporative or refueling canisters from vehicles with pressurized tanks just prior to fuel cap removal for a refueling event. Most commenters suggested that we follow the approach used by California ARB to require an engineering evaluation to demonstrate that refueling canisters have enough capacity to handle these ''puff losses'' in addition to the vapor directed to the refueling canister during the refueling emission test. Two commenters recommended changing the measurement procedure for refueling emissions as the most effective way to ensure that vehicles with pressurized fuel tanks would not have increased emissions resulting from puff losses. See the section 7.4 of the Response to Comments for a detailed discussion of the comments.

The existing refueling test procedures require vehicle stabilization with no fuel tank pressure before the vehicle enters the Sealed Housing for Evaporative Determination (SHED) for emission measurement. In contrast, the regulation includes a partial refueling test in which EPA may test a vehicle using a streamlined procedure. The partial refueling test requires driving followed by stabilizing the vehicle for one to six hours before the refueling test, without removing the fuel cap. The partial refueling test calls for the fuel cap removal (and tank depressurizing, as applicable) within two minutes of sealing the SHED for the refueling test. This approach includes the canister loading from puff losses, though it does not include SHED measurement to ensure that vapors from depressurizing are vented to the canister. Nevertheless, EPA testing using the existing partial refueling test can confirm with testing that refueling canisters are properly sized to control refueling emissions from vehicles with pressurized fuel tanks.

We are adopting a requirement for manufacturers to attest in their application for certification that their vehicles with pressurized fuel tanks will meet emission standards when tested over the partial refueling emission test. We would expect manufacturers to use their engineering analysis from certifying their vehicles for California ARB to meet this requirement.

The running loss test at 40 CFR 86.134–96(g)(1)(xvi) describes how manufacturers may rely on pressurized fuel tanks as a design strategy. We are amending those provisions to align with the conclusions described in the preceding paragraphs to ensure sufficient canister capacity for pressurized systems.

The amendments described in this section apply on the effective date of this rule. These changes do not require additional lead time because standards already apply for testing with partial refueling test, and California ARB already requires manufacturers to make the demonstration we are adding in this final rule. We also want to adopt the provision related to pressurized fuel tanks without delay to correspond with industry practice for certain vehicles. The requirement to vent puff losses to the canister has been the industry practice for several years, not least because California ARB has adopted this same requirement.

A commenter requested that we address an ambiguity regarding the fuel specifications for testing flexible fuel vehicles, both medium-duty vehicles and heavy-duty vehicles above 14,000 pounds GVWR. The commenter also suggested that we revisit the specification for light-duty vehicles, which is for the test fuel to be based on splash blending ethanol with 9 psi RVP neat gasoline. We recognize that flexible fuel vehicles today will be refueled with some combination of E10 gasoline and a high-level ethanol fuel. The scenario of splash blending ethanol with an E0 fuel is no longer something that in-use vehicles will experience. We are therefore revising the refueling test fuel specification for flexible fuel vehicles to align with the test fuel specification for evaporative emission testing at 40 CFR 86.1810–17(h). The refueling test fuel will instead be Tier 3 gasoline (E10 with RVP at 9 psi). This same conclusion applies for refueling tests with heavy-duty vehicles subject to standards under 40 CFR 1037.103.

7. Light-Duty Vehicle Provisions Aligned With CARB ACC II Program

EPA is finalizing three NMOG+NO_X provisions for light-duty vehicles (LDV, LDT, MDPV) aligned with the California ACC II program. The provisions follow the phase-in schedules described in section III.D.1.i of the preamble. Vehicles outside of the phase-in schedules (interim Tier 4 vehicles) do not have to meet the three NMOG+NO_X provisions aligned with ACC II. Each provision addresses a frequently encountered vehicle operating condition that was not previously captured in EPA test procedures and produces significant criteria pollutant emissions. The operating conditions are high power cold starts in plug-in hybrid vehicles, early drive-away (*i.e.,* drive-away times shorter than in the FTP), and mid-temperature engine starts. The rationale and technical assessment performed by CARB applies not only for vehicles sold in California but for products sold across the country, so EPA is adopting CARB's rational and technology assessment[671] for these three provisions. The phase-in for the three CARB ACC II program provisions follows the criteria pollutant phase-in described in section III.D.1 of the preamble but note that the PHEV high power cold starts provision has two steps with separate start dates. EPA requires vehicle manufacturers to provide data demonstrating compliance with each provision.

i. PHEV High Power Cold Starts

EPA is finalizing NMOG+NO_X emissions standards for PHEV high power cold starts (HPCS), which is when a driver demands more torque than the battery and electric motor can supply and the IC engine is started and immediately produces high torque while also working to light off the catalyst. NMOG+NO_X emissions are measured over the Cold Start US06 Charge-Depleting Emission Test, as described in, 40 CFR 1066.801(c)(10), which references ''California Test Procedures for 2026 and Subsequent Model Year Zero-Emission Vehicles and Plug-in Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes,'' adopted August 25th, 2022.

EPA's final bin-specific standards are shown in Table 53. The bins are somewhat different than the ACC II bins. EPA is not finalizing Bin 125 (that is part of CARB ACC II) to be consistent with EPA's Tier 4 bin structure

[670] 88 FR 29271–29275.

[671] CARB Public Hearing to Consider the Proposed Advanced Clean Cars II Regulations, Staff Report: Initial Statement of Reasons, April 12, 2022.

described in section III.D.2.i of the preamble. Also, EPA is finalizing bins from 0 to 70 in increments of 5 to offer additional resolution to manufacturers. EPA is finalizing Step 1 of this provision to start with MY 2027, one year later than CARB, and is finalizing Step 2 of this provision to start in MY 2030, which is also one year later than CARB. Since all three provisions follow the phase-in schedules described in section III.D.1.i of the preamble, LDT3–4 and MDPV may follow the default phase-in schedule and not adopt these provisions until MY 2030.

TABLE 53—HIGH POWER COLD START STANDARDS

Vehicle emissions category	$NMOG+NO_X$ (g/mi)	
	Step 1: 2027 to 2029 MY	Step 2: 2030+ MY
Bin 70	0.320	0.200
Bin 65	0.300	0.188
Bin 60	0.280	0.175
Bin 55	0.260	0.163
Bin 50	0.240	0.150
Bin 45	0.220	0.138
Bin 40	0.200	0.125
Bin 35	0.175	0.113
Bin 30	0.150	0.100
Bin 25	0.125	0.084
Bin 20	0.100	0.067
Bin 15	0.075	0.051
Bin 10	0.050	0.034
Bin 5	0.025	0.017

For Step 1, PHEVs with Cold Start US06 all-electric range of at least 10 miles are exempt from the standard. For Step 2, PHEVs with Cold Start US06 all-electric range of at least 40 miles are exempt from the standard.

CARB testing identified several existing PHEVs that started on the US06 and met the PHEV HPCS standard by a small margin, demonstrating the feasibility of the standard.

In response to manufacturer comments, EPA is finalizing more bins to provide additional resolution to manufacturers. AAI recommended that EPA extend Step 1 requirements for larger vehicles through MY 2032 and not adopt Step 2. A major manufacturer also requested that EPA not adopt Step 2 for vehicles above 6000 lb GVWR. AAI recommended that manufacturers be allowed to attest to the standard to reduce test burden.

After considering the recommendations, EPA is going forward with both Step 1 and Step 2 and is requiring manufacturers to provide data demonstrating compliance with the standard because according to our modeling of the future fleet and input from AAI and manufacturers, PHEVs may play a significant role in the future vehicle fleet and that would make PHEV HPCS an important operating mode. However, the Agency is providing manufacturers with an extra year to comply with Step 1 and Step 2, relative to the CARB program, to give manufacturers more time to implement design changes necessary to meet the standard.

ii. Early Driveaway

EPA is finalizing $NMOG+NO_X$ standards that address emissions from earlier gear engagement (*i.e.,* moving the shift lever from park to drive in a vehicle with an automatic transmission) and driveaway (*i.e.,* when the vehicle begins to move for the first time after being started) as described by the CARB ACC II program.[672] In a regular 25 °C FTP, gear engagement happens at 15 seconds and driveaway happens at 20 seconds, but studies have shown many drivers begin driving earlier than this. Vehicle manufacturers have historically designed their aftertreatment systems and controls to meet emissions standards based on the timing of the FTP driveaway. However, given the existing field data regarding the propensity of drivers to drive off sooner than the delay represented in the FTP and that vehicle manufacturers have demonstrated that they are able to reduce the emissions associated with this event, it is appropriate to require vehicle manufacturers to reduce emissions from early driveaway.

EPA is finalizing an early driveaway standard that is derived from the CARB ACC II program.[673] The standard uses an early driveaway test described by 40 CFR 1066.801(c)(9) and involves measuring phase 1 $NMOG+ NO_X$ emissions from a modified 25 °C FTP test where gear engagement happens at 6 seconds and driveaway happens at 8 seconds (instead of 15 and 20 seconds) and combining this phase 1 result with results from the other phases of a normal FTP using regular FTP phase weighting. The result must meet the $NMOG+NO_X$ bin standard shown in Table 54 below. For each bin, the early driveaway $NMOG+NO_X$ standard is 12 mg/mile higher than the bin name; for example, the early drive away standard for Bin 30 is 30+12=42 mg/mile.

The bins that EPA is finalizing are slightly different than the ACC II bins. Specifically, EPA is not finalizing Bin 125 as found in CARB ACC II and is finalizing bins from 0 to 70 in increments of 5 to provide manufacturers with additional resolution in certifying test groups to meet the standard.

TABLE 54—EARLY DRIVEAWAY STANDARDS

Vehicle emissions category	$NMOG+NO_X$ (g/mi)
Bin 70	0.082
Bin 65	0.077
Bin 60	0.072
Bin 55	0.067
Bin 50	0.062
Bin 45	0.057
Bin 40	0.052
Bin 35	0.047
Bin 30	0.042
Bin 25	0.037
Bin 20	0.032

[672] CARB Title 16, Section 1961.4. Final Regulation Order. Exhaust Emission Standards and Test Procedures 2026 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

[673] CARB Title 16, Section 1961.4. Final Regulation Order. Exhaust Emission Standards and Test Procedures 2026 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

TABLE 54—EARLY DRIVEAWAY STANDARDS—Continued

Vehicle emissions category	$NMOG+NO_X$ (g/mi)
Bin 15	0.027
Bin 10	0.022
Bin 5	0.017

The modified 25 °C FTP phase 1 is being finalized with tighter speed tolerances than proposed in response to a concern from AAI that without a tighter speed tolerance, a test driver may drive off sooner than the 8 seconds and to ensure the vehicle is fully stopped while the transmission is placed into gear. The speed tolerance of a regular 25 °C FTP test is ±2 mph beyond the lowest or highest point on the trace within 1.0 second of the given time, as described in Part 1066.425(b)(4)(i). For an early driveaway test, EPA is finalizing that vehicle speed may not exceed 0.0 mph until 7.0 seconds and vehicle speed between 7.0 and 7.9 seconds may not exceed 2.0 mph. This reduces the possibility of a test driver driving off significantly earlier than 8 seconds without setting unrealistic requirements on the test driver and doesn't significantly skew the trace to drive-off times larger than 8 seconds. Table 55 below illustrates how the tighter speed tolerance impacts allowable vehicle speed.

TABLE 55—TIGHTER SPEED TOLERANCE FOR EARLY DRIVEAWAY TEST

Time (s)	Trace speed (mph)	Min/max speed in regular FTP (mph)	Min/max speed in early driveaway with tighter tolerances (mph)
6.0	0.0	0.0–2.0	0.0
7.0	0.0	0.0–5.0	0.0–2.0
8.0	3.0	0.0–7.9	0.0–7.9
9.0	5.9	1.0–10.6	1.0–10.6

Vehicles are exempt from the early driveaway bin standards if the vehicle prevents engine starting during the first 20 seconds of a standard 25 °C FTP test and the vehicle does not use technology (*e.g.,* electrically heated catalyst) that would cause the engine or emission controls to be preconditioned such that $NMOG+NO_X$ emissions would be higher during the first 505 seconds of the early driveaway emission test compared to the emissions during the first 505 seconds of the standard FTP emission test.

AAI requested the option to attest to the early drive away provision and recommended a tightening of the speed tolerance during the first seven seconds. EPA is requiring certification test data on the dearly driveaway standard because of the importance of this condition in real-world operation. EPA is finalizing the tighter speed tolerance described above in response to AAI's comment.

iii. Intermediate Soak Mid-Temperature Starts

EPA is finalizing a third provision defined by the CARB ACC II program that addresses $NMOG+NO_X$ emissions from intermediate soak mid-temperature starts.[674] Previous EPA test procedures capture emissions from vehicle cold start and vehicle hot start. However, vehicles in actual operation often experience starts after an intermediate time (*i.e.,* soak times between 10 minutes and 12 hours). Vehicle manufacturers have not been required to control the emissions associated with these mid-temperature starts to the same degree that they manage cold and hot starts, although vehicle manufacturers have demonstrated they are able to address and reduce emissions from intermediate soak mid-temperature starts.

Tier 3 vehicles achieve low start emissions when soak times are short because the engine and aftertreatment are still hot from prior operation. Start emissions after long soak periods are addressed by the 12+ hour soak of the 25 °C FTP, which requires vehicles to quickly heat the catalyst and sensors from an engine at ambient temperature. The mid-temperature intermediate soak provision addresses emissions from intermediate soak times where the engine and aftertreatment have cooled but may still be warmer than ambient temperature.

The intermediate soak mid-temperature starts standards being finalized by EPA are shown in Table 56. EPA is finalizing bins that are closely aligned with ACC II bins. EPA is finalizing a bin structure that includes all CARB ACC II bins except Bin 125 and includes bins from 0 to 70 in increments of 5. EPA is not finalizing Bin 125 because EPA is eliminating this bin from the list of bins available to light-duty vehicles (section III.D.2.i of the preamble). The inclusion of bins from 0 to 70 is to provide manufacturers with additional resolution in certifying test groups to meet the standard.

EPA is requiring manufacturers to submit data for the 40-minute soak requirement that is taken between 39–41 minutes and is allowing manufacturers to attest to meeting the standards at all other soak times using linear interpolation between 10 minutes and 12 hours.

Vehicle Emissions Category	10-minute soak $NMOG+NO_X$ (g/mi)	40-minute soak $NMOG+NO_X$ (g/mi)	3–12 hour soak $NMOG+NO_X$ (g/mi)
Bin 70	0.035	0.054	0.070
Bin 65	0.033	0.050	0.065
Bin 60	0.030	0.046	0.060
Bin 55	0.028	0.042	0.055
Bin 50	0.025	0.038	0.050
Bin 45	0.023	0.035	0.045

[674] CARB Title 16, Section 1961.4. Final Regulation Order. Exhaust Emission Standards and Test Procedures 2026 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.

Vehicle Emissions Category	10-minute soak $NMOG+NO_X$ (g/mi)	40-minute soak $NMOG+NO_X$ (g/mi)	3–12 hour soak $NMOG+NO_X$ (g/mi)
Bin 40	0.020	0.031	0.040
Bin 35	0.018	0.027	0.035
Bin 30	0.015	0.023	0.030
Bin 25	0.013	0.019	0.025
Bin 20	0.010	0.015	0.020
Bin 15	0.008	0.012	0.015
Bin 10	0.005	0.008	0.010
Bin 5	0.003	0.004	0.005

8. Limitation of Commanded Enrichment for Power or Component Protection

At this time, EPA is not finalizing new requirements for the control of enrichment on gasoline vehicles. While we recognize the potential for increases in some vehicle emissions during enriched operation, we also are cognizant of the substantial engineering effort that it would take some manufacturers to eliminate enrichment at all engine speeds and operating conditions, in the same time frame as meeting the other criteria pollutant and GHG requirements of this final program. In light of our recognition of both the potential emissions reductions and engineering effort, the agency plans to continue to investigate this issue and may decide to revisit enrichment controls in a future rulemaking. EPA plans to take a multipronged approach to inform a potential future regulatory action. The agency will continue to gather data on the circumstances under which vehicles use enrichment in the real world. This will include additional EPA-conducted test programs as well as the potential for manufacturer-provided data. EPA also plans to assess the frequency of vehicle activity that results in enrichment, such as trailer towing and other high load, high speed operation. Based on our assessment of measured emissions increases, the circumstances under which enrichment occurs, and the frequency of enrichment, EPA will update our estimates of the impact on emissions inventories due to command enrichment. As part of this process, EPA will also engage with the auto manufacturers and other stakeholders to continue to assess the technologies available to eliminate enrichment under the broadest area of vehicle operation, as well as powertrain development effort, emissions control technology options, lead time and costs. In addition, EPA will continue to review AECD applications to ensure that the AECD process is being used in the manner it was intended. EPA plans to initiate this technical work and stakeholder outreach soon after the release of this final rule, and based on this technical work the Agency may initiate a new rulemaking related to this issue within the next two to three years.

Commenters expressed opposing views on the proposed elimination of the allowance of the use of commanded enrichment. NACAA (National Association of Clean Air Agencies) supported the proposed elimination of enrichment for its health benefits. MECA (Manufacturers of Emissions Control Association) attested to the readiness of technology to support the proposed elimination. While several manufacturers supported the proposal, other OEMs also voiced strong concern with a prohibition on enrichment. Some OEMs argued that eliminating enrichment would require significant powertrain revisions, divert investment from electrification, and/or result in a substantial reduction in engine power.

EPA had proposed a prohibition of commanded enrichment because enrichment results in highly elevated engine-out emissions and reduced effectiveness of the aftertreatment system, causing elevated emissions of carbon monoxide, hydrocarbons, PM, and air toxics including ammonia and PAH, during this operation.

9. Small Volume Manufacturer Criteria Pollutant Emissions Standards

EPA is finalizing the identical criteria pollutant emissions standards for small volume manufacturers (SVMs) as for large manufacturers but is delaying the phase-in of the standards for SVM until 2032 to provide additional lead time to implement the standards.

The phase-in schedule of criteria pollutant standards for SVMs and large manufacturers is discussed in section III.D.1 of the preamble. The criteria pollutant phase-in applies to $NMOG+NO_X$ bin structure, PM, −7 °C $NMOG+NO_X$, CO, HCHO, −7°C CO, and three provisions aligned with CARB ACC II (PHEV high power cold starts, early driveaway, intermediate soak mid-temperature starts). The SVMs light-duty vehicle (LDV, LDT, MDPV) phase-in steps to 100 percent in 2032.

Declining fleet average $NMOG+NO_X$ standards for SVMs and large manufacturers are discussed in section III.D.2 of the preamble. SVMs light-duty vehicle $NMOG+NO_X$ declining fleet averages step from 30 mg/mile to 15 mg/mile in 2032. However, SVMs encounter two fleet average steps between 2027 and 2032 because they were allowed additional time to meet Tier 3 standards. The first step occurs in MY 2028, when SVMs step down from 51 mg/mile to the Tier 3 final fleet average of 30 mg/mile. The first step is aligned with the current Tier 3 requirements and represents no change for the SVMs.[675] The second step is the result of this final rule and will require SVMs to meet an $NMOG+NO_X$ fleet average of 15 mg/mile in MY 2032. 15 mg/mile is the same fleet average requirement as the remainder of the LDV fleet. Implementing the 15 mg/mile standard in MY 2032 provides SVMs with additional lead time to begin compliance with the Tier 4 program.

Since EPA is finalizing a requirement that SVMs must meet the same criteria pollutant emissions standards as large manufacturers, although with a delayed phase-in, in Tier 4 SVMs must provide PM test data, and other criteria pollutant test data, for certification.

EPA is not finalizing SVM MDV standards that differ from large manufacturer MDV standards.

EPA received comments from several stakeholders regarding the proposed criteria pollutant standards. Vehicle manufacturers, including those formally identified as SVMs noted that EPA had traditionally provided more time to meet the final standards and that the same on-going challenges remain for them, including challenges such as limited product lines with which to fleet average, infrequent vehicle redesigns, and lower priority support from the supplier base.

In the Tier 3 rulemaking, EPA established provisions for small volume manufacturers and for those small

[675] EPA did not reopen this step in this rulemaking; rather, as noted in the text, this step was finalized in the Tier 3 final rule.

business manufacturers and operationally independent small volume manufacturers with average annual nationwide sales of 5,000 units or less. As in previous vehicle emissions rulemakings in which we have provided such flexibilities, our reason for doing so is that these entities generally have more implementation difficulty than larger companies. Small companies generally have more limited resources to carry out necessary research and development; they can be a lower priority for emission control technology suppliers than larger companies; they have lower vehicle production volumes over which to spread compliance costs; and they have a limited diversity of product lines, which limits their ability to take advantage of the phase-in and averaging provisions that are major elements of the Tier 3 program. For this FRM, EPA has decided based on the justification used in the Tier 3 to delay SVMs requirements for $NMOG+NO_X$ and for other criteria pollutants until MY 2032.

E. Modifications to the Medium-Duty Passenger Vehicle (MDPV) Definition

EPA is finalizing two modifications to the MDPV definition starting in MY 2027 to address passenger vehicles that could potentially fall outside the prior definition. First, EPA is including in the MDPV definition any pickup at or below 14,000 pounds GVWR with a work factor at or below 4,500 pounds except for pickups with a fixed interior length cargo area of eight feet or larger which would continue to be excluded from the MDPV category.[676] This modification addresses new BEVs that are primarily passenger vehicles but fall above the current 10,000 pound MDPV threshold primarily due to battery pack weight increasing the vehicle's GVWR. EPA believes these vehicles should be in the light-duty vehicle program because they are primarily passenger vehicles and would likely displace the purchase of other passenger vehicles rather than a medium-duty vehicle due to their relatively low utility. In selecting the 4,500-pound work factor cut point, EPA reviewed current vehicle offerings and comments received; based on this evaluation, we believe these thresholds are reasonable and will not pull into the MDPV category work vans or work trucks. Previously, the MDPV category generally included pickups below 10,000 pounds GVWR with a fixed interior length cargo area of less than six feet (72.0 inches).

The second updated MDPV definition modification is to include in the MDPV category any pickups with a GVWR below 9,500 pounds and a fixed interior length cargo area of less than eight feet regardless of whether the vehicle work factor is above 4,500 pounds. Pickups at or above 9,500 pounds up to 14,000 pounds GVWR with a work factor above 4,500 pounds are included as MDPVs only if their fixed interior length cargo area is less than six feet.

Historically, there has been a clear distinction between pickups in the light-duty vehicle category and those in the medium-duty category. Light-duty pickups were those pickups with a GVWR at or below 8,500 pounds and they generally had a GVWR below 8,000 pounds. MD pickups were those pickups that were at or above 8,501 pounds and all such vehicles currently have a GVWR above 9,900 pounds.[677] The changes to the MDPV definition are intended to account for any new pickup offerings that would fall into the GVWR ''space'' at or above 8,501 pounds but below 9,500 pounds, as well as light-duty pickups that whose GVWR exceeds 8,500 pounds as the result of electrification. In addition, the fixed interior length cargo area and work factor requirements have been added to limit the revised MDPV definition to vehicles with their primary utility being passenger transportation and limited cargo, including vehicles up to 14,000 pounds GVWR. EPA is also concerned that differences between the light-duty and medium-duty pickups could become blurred if manufacturers were to offer somewhat more capable pickups with GVWR just above 8,500 pounds to gain access to less stringent emission standards. If EPA were not finalizing these changes to the MDPV definition, manufacturers could, in essence, move their light-duty pickups up into the medium-duty category through relatively minor vehicle modifications, to gain access to less stringent standards. EPA believes it is appropriate to address this possibility given that the light-duty vehicle footprint standards, as finalized, will be more stringent compared to the work factor-based standards for MDVs and could otherwise provide an unintended incentive for manufacturers to take such an approach.

Comments regarding the change in MDPV definition were received from the three manufacturers that have significant product offerings in this space: Ford, GM and Stellantis, as well as the Alliance for Automotive Innovation. Comments included suggested changes to the GVWR and work factor thresholds. EPA adopted two specific recommended changes to the work factor and GVWR thresholds, which are reflected above in the final definition values. In addition, commenters made recommendations for the implementation timing of the definition change, suggesting implementation should be delayed to MY 2030 or that manufacturers should be allowed to opt into the new definition, as well as some specific regulatory text change to provide further clarification for the definition change, such as how the cargo area length should be measured.

Table 57 summarizes the revised MDPV definition in terms of what vehicles will not be covered as MDPVs under EPA's changes to the qualifying criteria.

TABLE 57—SUMMARY OF EXCLUSIONS FOR THE REVISED MDPV DEFINITION

A vehicle would be an MDV and not an MDPV if:		
	WF ≤ 4,500 lb	WF > 4,500 lb
GVWR ≤ 9,500 lb	Cargo area fixed interior length ≥ 94.0 inches	Cargo area fixed interior length ≥ 94.0 inches.
9,500 lb < GVWR ≤ 14,000 lb.	Cargo area fixed interior length ≥ 94.0 inches	Cargo area fixed interior length ≥ 72.0 inches.

[676] In the regulatory text, EPA is finalizing that pickups with an open bed interior length of 94 inches or greater will be excluded, which will exclude pickups with eight-foot open beds (96 inches) with a 2-inch allowance for vehicle design variability. This also applies for the second change to the MDPV definition.

[677] Currently, these pickups are covered by HDV standards in 40 CFR 86.1816–18.

EPA is also clarifying that MDPVs will include only vehicles with seating behind the driver's seat such that vehicles like cargo vans and regular cab pickups with no rear seating will remain in the MDV category and subject to work factor-based standards regardless of the changes to the MDPV definition.

As described in section III.D.2.v of the preamble, we are also adopting an interim provision allowing manufacturers to use credits generated by MY 2027 through 2032 battery electric vehicle (BEV) or fuel cell electric vehicles (FCEV), qualifying as MDPVs, to be used for certifying MDV to the NMOG+NO_X standard for 25°C testing. We are adopting the same interim provision for GHG credits. Manufacturers may use these GHG credits for certifying MDV starting in MY 2027. See 40 CFR 86.1865–12(k)(10).

Prior to MY 2027, a manufacturer may optionally place vehicles that are brought into the MDPV category by the updated MDPV definition revisions into the light-duty vehicles program rather than have those vehicles remain in the MDV program. EPA is finalizing the definition change to be effective starting with MY 2027. However, to ensure the program is compliant with applicable CAA lead time and stability requirements, manufacturers that are building MDPVs that are captured by the expanded definition and are opting for the default schedule will continue to be subject to Tier 3 standards through model year 2030. Details for the final Tier 4 criteria pollutant phase-in are discussed in section III.D.1. In the meantime, manufacturers will continue to certify those vehicles to the Tier 3 standards for medium-duty vehicles in 40 CFR 86.1816–18.

EPA's historic regulatory structure for pickup trucks has been firmly grounded in the products available to consumers and the utility that the vehicles manufacturers have produced. Light-duty pickup GVWRs have been significantly less than the 8,500 pound threshold for LDVs and class 2b and 3 pickups have been built with GVWR's well above 9,000 pounds. In addition, consumers without the need for the additional utility offered by medium-duty pickups, have sound reasons for buying the light-duty versions. Medium-duty pickups, as compared to their light-duty counterparts, tend to be higher priced, less fuel efficient, less maneuverable, and may also have a harsher ride when unloaded due to more capable suspensions. The emissions regulatory structure promulgated by EPA has recognized the substantially different utility offered by these two historically different regulatory classes. However, there are two distinct changes that precipitating EPA's decision to expand the MDPV definition. First, EPA recognizes that light-duty pickup trucks that are electrified could exceed the 8,500 pound threshold, but do not have the same utility traditionally provided by this regulatory class. Secondly, EPA believes that there is the possibility that the pickup market could shift from light-duty versions to medium-duty versions of pickups due to consumer preference for ICE-based pickups. To meet this consumer demand, manufacturers may be inclined to produce pickups which, much like the EV's, exceed the 8,500 pound GCWR threshold, but do not offer the same utility as traditional vehicles in the higher weight class. At this time, EPA is not finalizing fundamental changes to its program that will result a large portion of medium-duty pickups into the light-duty program to address this possibility due to the potential disruption such an approach would have both for the vehicle industry and for consumers needing highly capable work vehicles. EPA plans to monitor vehicle market trends over the next several years to identify any new trends that could potentially lead to the loss of emissions reductions, and if so, to explore appropriate ways to address such a situation.

In an effort to illustrate and quantify the design-related GHG emissions impacts of medium-duty pickups compared to their light-duty counterparts, EPA generated emissions test data for a Ford F–150 and an F–250. For this example, the medium-duty F–250 emitted 170 g/mile more than the light-duty F–150 when operating at similar speeds and loads (RIA Chapter 1.2.1). The GHG emission difference observed in the data indicates that light to medium load operation results in much higher CO_2 emissions in the medium-duty pickup under similar passenger or payload conditions. The medium-duty pickup is designed primarily for regular towing and therefore may have higher emissions under other operating conditions compared to light-duty pickups designed more for transportation of passengers or cargo in the bed.

F. What alternatives did EPA consider?

In the NPRM, EPA sought comment on alternatives for the light- and medium-duty GHG standards levels, as well as the phase-ins. For light-duty GHG standards, we sought comment on a range of light-duty GHG stringency alternatives in addition to the proposed standards. We sought comment on the medium-duty GHG standards for different model years and other aspects of the MDV standards structure. In addition, we sought comment on alternative phase-in schedules for criteria pollutant standards. EPA received comments suggesting alternative levels of stringency and phase-in schedules for the light- and medium-duty standards, for GHG and criteria pollutants. EPA discusses how we assessed comment on these issues and arrived at the final standards and phase-in schedules in sections III.C, III.D, and V of this preamble. EPA further considered comments on alternatives to the level and phase-in scheduled for the standards, which we discuss in RTC section 3.3 (GHG) and section 4.1(criteria pollutants). In the following discussion, we principally discuss the alternatives we considered for the light-duty GHG standards.

For the light-duty GHG standards, EPA sought comment on three alternatives. The proposal's alternatives included a more stringent alternative (Alternative 1), a less stringent alternative (Alternative 2), and an alternative (Alternative 3) that ended at the same level as the proposed standards in 2032, but provided a more linear ramp rate in the standards with the least stringent standards across all alternatives for MYs 2027–2029. As discussed in section III.C.2 of this preamble, based on our updated analysis and in consideration of the public comments, EPA is basing its final standards on the proposal's Alternative 3, and we are also extending the phase-down of certain credit flexibilities to address lead time concerns.

In considering the appropriate light-duty GHG standards for this final rule, EPA has also considered two alternatives, one more stringent (Alternative A) and one less stringent (Alternative B).[678] Alternative A is based on the proposed standards, and compared to the final standards, includes a higher rate of stringency increase in the earlier years (MYs 2027–2029), a more accelerated phase-out of off-cycle credits, and the complete elimination of A/C leakage credits in MY 2027 instead of a gradual ramp-down to a lower value. Alternative A and the final standards both reach the

[678] EPA used the Alternative B nomenclature for this final rule analysis to distinguish it from the NPRM's less stringent alternative (Alternative 2). Alternative B differs from the NPRM Alternative 2: while Alternative B's MY 2032 stringency is similar to that of Alternative 2, Alternative B has a more gradual trajectory and less stringent standards for 2027–2030 (which matches that of the final standards) compared to the NPRM Alternative 2.

same level of footprint CO_2 targets in MY 2032. Alternative B's trajectory is the same as the final standards through 2030, but it ends at a less stringent level than the final standards in MY 2032. These light-duty vehicle alternatives were selected to identify a range of stringencies we believe are appropriate to consider because they represent a range of standards that are anticipated to be feasible considering the public record and our updated analysis and protective of human health and the environment.

The final standards will result in an industry-wide average emissions target of 85 g/mile of CO_2 in MY 2032, representing a nearly 50 percent reduction in average emissions levels from the existing MY 2026 standards[679] established in 2021. Alternative A (based on the proposed standards) is also projected to result in an industry-wide average target for the light-duty fleet of 85 g/mile of CO_2 in MY 2032. Alternative B is projected to result in an industry-wide average target of 95 g/mile of CO_2 in MY 2032, or 10 g/mile higher (less stringent) than the final standards, representing a 43 percent reduction in projected fleet average GHG emissions target levels from the existing MY 2026 standards. Table 58, Table 59, and Table 60 compare the projected targets for the final standards and the alternatives for cars, trucks, and the combined fleet, respectively.

TABLE 58—COMPARISON OF PROJECTED CAR TARGETS FOR THE FINAL STANDARDS AND ALTERNATIVES

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)
2026	131	131	131
2027	139	134	139
2028	125	116	125
2029	112	98	112
2030	99	90	99
2031	86	82	91
2032 and later	73	73	82

TABLE 59—COMPARISON OF PROJECTED TRUCK TARGETS FOR THE FINAL STANDARDS AND ALTERNATIVES

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)
2026	184	184	184
2027	184	164	184
2028	165	143	165
2029	146	121	146
2030	128	112	128
2031	109	102	114
2032 and later	90	90	100

TABLE 60—COMPARISON OF PROJECTED COMBINED FLEET TARGETS FOR THE FINAL STANDARDS AND ALTERNATIVES

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)
2026	168	168	168
2027	170	155	170
2028	153	135	153
2029	136	114	136
2030	119	105	119
2031	102	96	107
2032 and later	85	85	95

Figure 19 compares the projected targets for the final standards and Alternatives A and B with the MY 2026 standard (labeled as the No Action case).

[679] The projected 2026 target has increased to 168 g/mile due to a projected increase in truck share of the fleet.

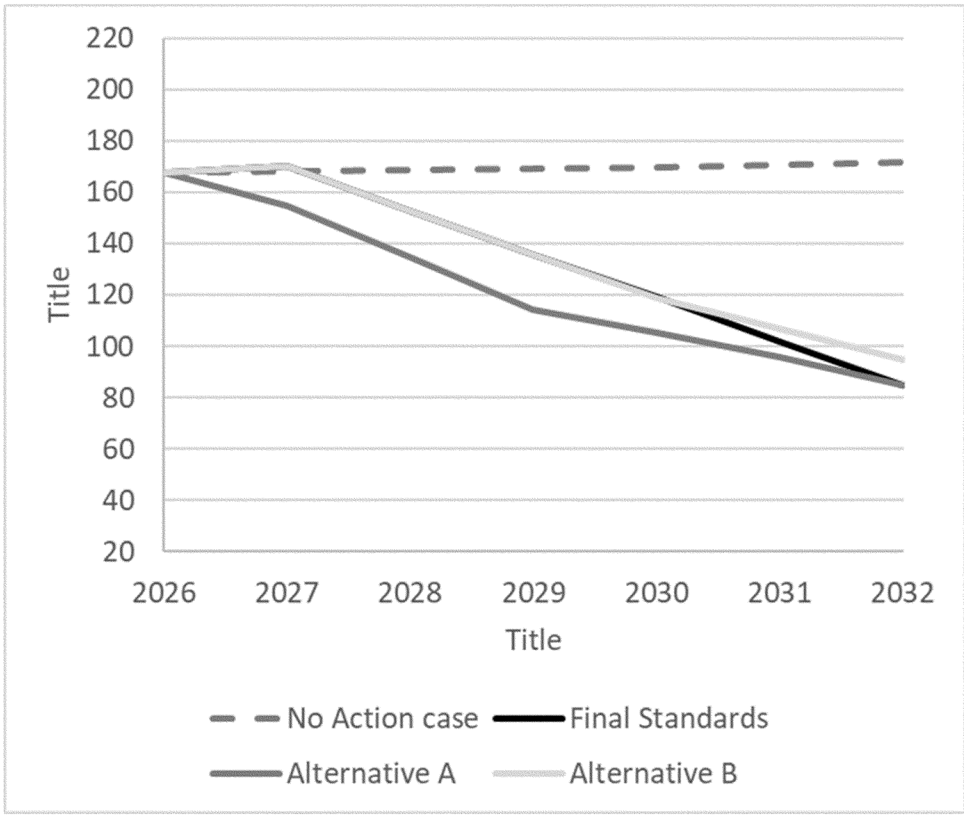

Figure 19: Comparison of Light-Duty Vehicle Projected Fleetwide CO_2 Targets for Alternatives, the Final Standards and the No Action Case. (Note: For 2027–2030, Targets for the Final Standards and Alternative B Are Identical)

For Alternative B, consistent with the final standards, EPA applied different flexibility provisions than under the proposed standards (Alternative A) based on public comments of concerns about lead time for model years 2027–2029. Specially, we revised the proposal's phase-out of two flexibilities: air conditioning (A/C) HFC leakage credits and off-cycle credits. From MY 2026 allowable levels, maximum A/C leakage credits will phase down starting in MY 2027 to a value of 1.6 g/mile for cars and 2.0 g/mile trucks for MY 2031 and later. The cap for off-cycle menu credits will phase down over three model years from the 10 g/mile maximum (for ICE vehicles only) in 2030 to 0 g/mile in 2033. Alternative A maintains the phase-out of HFC leakage credits and off-cycle credits as originally proposed in the NPRM.

Below, we compare the targets again, but in this case we have adjusted (upward) the targets to account for credit flexibilities available to manufacturers. These adjusted targets are meant to provide a common basis for comparing program stringencies between alternatives that have differing levels of credit flexibilities. It should be noted that in EPA's technical assessment, we assume that manufactures will take advantage of credit flexibilities that are cost-effective, and the availability of flexibilities can influence projected compliance costs and technology penetrations even when the footprint target CO_2 curves are the same. As a result, these adjusted targets are more indicative of the industry's overall 2-cycle tailpipe CO_2 targets based on achieving the fleet average levels of off-cycle credits and A/C leakage and efficiency credits (in g/mi) projected in our compliance modeling. Any difference in adjusted targets between years, or between alternatives within a year, is indicative of how much additional emissions reducing technology is needed to meet the targets, independent of credit flexibilities. Table 61, Table 62 and Table 63 show the adjusted targets for cars, trucks and the combined fleet for the final standards, the alternatives and the No Action case:

TABLE 61—PROJECTED CAR TARGETS FOR THE FINAL STANDARDS, ALTERNATIVES AND NO ACTION CASE
[Adjusted]

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)	No action case CO_2 (g/mile)
2026	161	161	161	161
2027	158	144	160	158
2028	142	125	144	158
2029	125	105	127	158
2030	108	95	111	158
2031	93	85	101	159

TABLE 61—PROJECTED CAR TARGETS FOR THE FINAL STANDARDS, ALTERNATIVES AND NO ACTION CASE—Continued

[Adjusted]

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)	No action case CO_2 (g/mile)
2032 and later	78	76	92	159

TABLE 62—PROJECTED TRUCK TARGETS FOR THE FINAL STANDARDS, ALTERNATIVES AND NO ACTION CASE

[Adjusted]

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)	No Action case CO_2 (g/mile)
2026	220	220	220	220
2027	209	176	210	216
2028	186	154	188	216
2029	163	131	165	217
2030	141	119	144	218
2031	118	107	128	219
2032 and later	98	96	114	220

TABLE 63—PROJECTED COMBINED TARGES FOR THE FINAL STANDARDS, ALTERNATIVES AND NO ACTION CASE

Model year	Final standards CO_2 (g/mile)	Alternative A CO_2 (g/mile)	Alternative B CO_2 (g/mile)	No action case CO_2 (g/mile)
2026	201	201	201	201
2027	193	166	195	198
2028	172	145	174	198
2029	151	123	154	199
2030	131	112	134	200
2031	111	101	120	201
2032 and later	92	90	107	202

Figure 20 compares the adjusted targets for the final standards and Alternatives A and B with the MY 2026 standard (labeled as the No Action case), consistent with the values reflected in Table 63 in which we have shifted the fleet average footprint targets upward to account for the expected application of compliance flexibilities (off-cycle, A/C efficiency and A/C leakage credits). Compared to Alternative A (the proposed standards), the adjusted CO_2 target of the final standards decreases more gradually through 2029 before it arrives at the same level of stringency in MY 2032. Further analysis of the alternatives is provided in section IV.G of the preamble and in Chapters 9 and 12 of the RIA. In section V of the preamble, we summarize our rationale for why EPA is adopting the final standards in lieu of any of the alternatives.

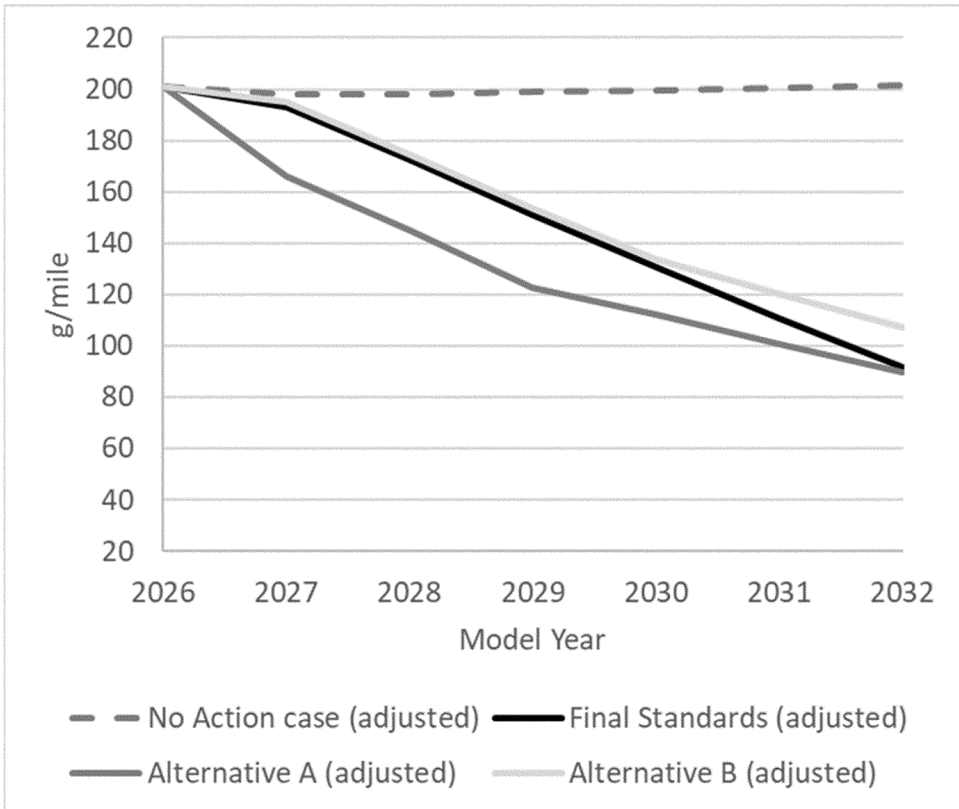

Figure 20: Comparison of Industry Average Adjusted CO_2 Targets for Alternatives, the Final Standards and the No Action Case. Adjusted Targets Include Effects of Expected Off-Cycle, A/C Efficiency and A/C Leakage Credits

EPA considered criteria pollutant standards alternatives within the context of the GHG alternatives outlined above. For each potential set of GHG standards and associated projected technology application, the agency considered if a vehicle manufacturer could comply with both the GHG standards and the final criteria pollutant standards, given a projected mix of technologies. First, as noted in section II.D.2 of the preamble, the agency is finalizing a numerically higher (less stringent) final NMOG+NO_X fleet average. This higher fleet average recognizes both the final GHG standards and our estimates of potential pathways for projected in PHEV technology penetration. In addition, EPA recognizes that vehicle manufacturers have a wide range of emission control technologies available to them which could be adopted, including technologies specific to hybrid and plug-in hybrid vehicles, which would result in substantially lower criteria pollutant emissions. These technologies are outlined in RIA Chapter 3.2.5. As a result of the change to the final NMOG+NO_X fleet average, multiple technology pathways for compliance and the recognition that substantial emission control technologies are available to the manufacturers, across a variety of powertrain architectures, the agency has concluded that each of the GHG alternatives discussed in this section are also feasible for manufacturers to comply with the final criteria pollutant program standards.

G. Certification, Compliance, and Enforcement Provisions

1. Electric Vehicle Test Procedures

Several changes to electric vehicle test procedures are implemented with this rule. This section reviews the general testing requirements that continue to apply to BEVs and PHEVs, and then describes specific changes to these requirements.

To comply with EPA labeling requirements, manufacturers and EPA perform testing of light-duty BEVs to determine miles per gallon equivalent (MPGe) and electric driving range. PHEVs are also tested to determine charge-depleting range. The results of these tests are used to generate range and fuel economy values published on the fuel economy label.

BEV testing consists of performing a full charge-depleting test using the multi-cycle test (MCT) outlined in the 2017 version of SAE standard J1634, Battery Electric Vehicle Energy Consumption and Range Test Procedure. The multi-cycle test consists of 8 cycles: Four urban dynamometer driving schedule (UDDS) cycles, two highway fuel economy test (HFET) cycles, and two constant speed cycles (CSCs).[680] The test is used to determine the vehicle's usable battery energy (UBE) in DC Watt-hours, cycle energy consumption in Watt-hours per mile (Wh/mi), and A/C recharge energy in A/C watt-hours. These results are used to determine the BEV's unadjusted range and MPGe.

The MCT generates unadjusted city (UDDS) and highway (HFET) two-cycle test results. These results are adjusted to 5-cycle values which are then published on the fuel economy label. EPA regulations allow manufacturers to multiply their two-cycle test results using a defined 0.7 adjustment factor or determine a BEV 5-cycle adjustment factor by running all of the EPA 5-cycle tests (FTP, HFET, US06, SC03, and 20 °F FTP). This adjustment is performed to account for the differences between vehicle operation observed on the two-cycle tests and vehicle operation

[680] The MCT consists of 8 cycles and the test results are used to determine city and highway test results. The highway result is determined by averaging the 2 HFET cycles from the MCT; the city result is determined by averaging the 4 UDDS cycles from the MCT. When discussing fuel economy labeling, the city and highway test results are generally referred to as 2-cycle test results.

occurring at higher speeds and loads along with hot and cold ambient temperatures not seen on the UDDS or HFET cycles.

PHEVs include both an internal combustion engine and an electric motor and can be powered by the battery or engine or a combination of both power devices. Charge depleting operation is when the electric motor is primarily propelling the vehicle with energy from the battery. Charge sustaining operation is when the internal combustion engine is contributing energy to power the vehicle and maintain a specific state of charge. PHEVs are tested in both charge depleting and charge sustaining operation to determine the electrical range capability of the vehicle and the charge sustaining fuel economy.

PHEV charge depletion testing consists of performing a single cycle charge depleting UDDS test and a single cycle charge depleting HFET test. These tests are specified in the 2010 version of SAE Standard J1711, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles. The result of these tests is the actual charge depleting distance the vehicle can drive. The actual charge depleting distance is multiplied by a 0.7 adjustment factor to determine the 5-cycle charge depleting range. The UDDS and HFET distances are averaged to determine an estimated all-electric range for the vehicle. Unlike SAE Standard J1634 which is applied to BEVs, SAE Standard J1711 does not specify a methodology for determining UBE when performing charge depleting tests on PHEVs.

As proposed, EPA is making several changes to the testing requirements to support new battery durability and warranty requirements for light-duty and medium-duty BEVs and PHEVs (see section III.G.2 of the preamble).

Compliance with battery durability requirements will require additional testing of BEVs and PHEVs by manufacturers to be performed during the vehicle's useful life and will require additional reporting to demonstrate that the vehicles are meeting the durability standard.

Manufacturers of BEVs and PHEVs will be required to develop and implement an on-board battery state-of-health monitor and demonstrate its accuracy through in-use vehicle testing. For this testing, the tests will be based on the currently used charge depletion tests performed for range and fuel economy labeling of light-duty BEVs and PHEVs, with the addition of the recording of the vehicle monitor value and comparison of the results from the charge depleting test to the monitor value reported by the vehicle. Specifically, light-duty and Class 2b and 3 BEVs will be tested according to the MCT to determine the vehicle's UBE and range. PHEVs will be tested according to the single cycle UDDS and HFET test to determine the vehicle's charge depleting UBE and range. Class 2b and 3 BEVs and PHEVs will be tested at adjusted loaded vehicle weight (ALVW),[681] consistent with the testing required for measuring criteria and GHG emissions. These testing requirements are described in more detail in section III.G.2 of the preamble.

Manufacturers also will be required to demonstrate that the vehicles are meeting the durability requirements at certain points during their useful life. For this purpose, manufacturers will collect and report onboard state-of-health monitor values from a large sample of in-use vehicles, as described further in section III.G.2 of this preamble. This will not involve additional dynamometer testing but only acquisition of monitor data from in-use vehicles.

Due to the lack of a UBE calculation in SAE J1711, to determine UBE for PHEVs, an additional calculation is performed after completion of the PHEV charge depleting test. Under PHEV charge depletion testing, net ampere-hours are measured to determine when the vehicle is no longer depleting the battery, indicating that the vehicle has switched to a mode in which it is maintaining rather than depleting the battery charge. This event marks the conclusion of the charge depletion test but does not result in determination of UBE. To determine UBE for a PHEV, manufacturers will measure the DC discharge energy of the PHEV's rechargeable energy storage system (RESS, *i.e.,* the high-voltage battery) by measuring the change in state-of-charge in ampere-hours over each cycle and the average voltage of each cycle as required by SAE J1711. The measured DC discharge energy in watt-hours for each cycle will be determined by using the methodology to determine the Net Energy Change of the propulsion battery. The DC discharge energy is added for all the charge depleting cycles including the transition cycles used to determine the charge depleting cycle range, R_{cdc} as defined in SAE J1711.

In the proposal, EPA sought comment regarding this methodology for determining UBE for PHEVs. EPA received comments from the Alliance for Automotive Innovation regarding the use of the 2010 version of J1711 for determining the net energy change during PHEV charge depletion testing. The Alliance recommended EPA update the referenced SAE Standard from the 2010 version to the 2023 version of J1711. After reviewing the revisions to J1711, EPA concurs with the Alliance and agrees that the J1711 reference should be updated from the 2010 to the 2023 version. The 2023 version of J1711 has updated the measurements and calculation methodology to determine the Net Energy Change (NEC) for the propulsion battery. These changes address the concerns raised by commentors regarding using only the average voltage measured at the beginning and end of each charge depleting cycle. The updated J1711 standard includes specifications for measuring the DC discharge energy of the propulsion battery or logging the propulsion battery voltage over a vehicle communication network.

EPA also sought comment regarding use of the method described for light-duty vehicles with SAE J1711 for determining UBE for Class 2b and 3 PHEVs. EPA did not receive any comments regarding using SAE J1711 for determining UBE for Class 2b and 3 PHEVs. As EPA has concluded the updated 2023 version of SAE J1711 is appropriate for use for LDVs and LDTs, EPA is also adopting this standard for testing PHEVs to determine the UBE for Class 2b and 3 PHEVs.

EPA also sought comment on whether to perform the tests on Class 2b and 3 PHEVs at ALVW as proposed, or at loaded vehicle weight (LVW), which is curb weight plus 300 pounds. EPA also did not receive any comments regarding testing Class 2b and 3 PHEVs at ALVW and as such is finalizing the agency's proposal to test Class 2b and 3 PHEVs at ALVW when performing charge depletion tests to determine battery UBE and calculate SOCE.

EPA also sought comment regarding the proposed use of the 2017 version of SAE J1634 for determining UBE for class 2b and 3 BEVs. EPA received comments from Mercedes-Benz AG, Rivian, and the Alliance regarding the use of the 2017 version of SAE J1634. Mercedes-Benz AG and the Alliance suggested EPA update to the 2021 version of SAE J1634 from the 2017 version. Rivian submitted comments noting they generally support EPA's proposed approach to EV test procedures, including the proposed use of the 2017 version of SAE J1634 for determining UBE for Class 2b and 3 BEVs. Mercedes-Benz and the Alliance are concerned with the time required to perform MCT

[681] ALVW is the numerical average of vehicle curb weight and gross vehicle weight rating.

tests. Both the Alliance and Mercedes-Benz suggested allowing the use of the 2021 version of SAE J1634 and the shortened MCT (SMCT) and shortened MCT plus (SMCT+) to reduce the time required to determine UBE for BEVs.

In January 2023, EPA updated the BEV 5-cycle test procedures and updated the SAE J1634 reference from the 2012 version to the 2017 version of SAE J1634.[682] At the time the NPRM was published, the 2021 version of J1634 had been completed and published. The Alliance provided comments requesting that EPA update SAE J1634 to the 2021 version. The Alliance reiterated their previous comments regarding their preference for EPA to adopt the 2021 version of J1634 which introduces two new test procedures (SMCT and SMCT+) and includes pre-heating of the battery and cabin for SC03 and −7 °C FTP testing. EPA is still not prepared to adopt the 2021 version of SAE J1634 and will continue to use the 2017 version of SAE J1634. EPA has not determined whether the SMCT and SMCT+ produce results equivalent to those generated using the MCT which is used to determine UBE. The SC03 test and the −7 °C FTP, consisting of 2 UDDS cycles performed with a 10 minute soak between cycles, are used for BEV 5-cycle testing and are not used to determine UBE, nor is UBE measured during these test procedures. Testing to demonstrate compliance with battery durability only requires MCT testing and does not require SC03 or −7 °C FTP testing, therefore requests to revise the SC03 test and the −7 °C FTP are outside of the scope of what is being adopted for this rulemaking.

EPA also sought comment on whether to perform charge depleting tests on Class 2b and 3 BEVs at ALVW as proposed, or at loaded vehicle weight (LVW), which is curb weight plus 300 pounds. Rivian provided comments supportive of testing Class 2b and 3 BEVs at ALVW using the 2017 version of J1634. EPA is finalizing our proposal to test Class 2b & 3 BEVs on the MCT at ALVW using the 2017 version of J1634 to determine UBE.

2. Battery Durability and Warranty

This section describes the battery durability monitoring and performance requirements and the warranty requirements we are finalizing for BEVs and PHEVs. As we explained in the proposal, BEVs and PHEVs are playing an increasing role in vehicle manufacturers' compliance strategies to control emissions from LD and MD vehicles. The battery durability and warranty requirements support BEV and PHEV battery durability and thus support achieving the GHG and $NMOG+NO_X$ emissions reductions projected for the final standards. Further, these requirements support the integrity of the GHG and $NMOG+NO_X$ emissions credit calculations under the ABT program as these calculations are based on mileage over a vehicle's full useful life.[683]

At the outset we note that some commenters, including the Alliance for Automotive Innovation (''the Alliance'') questioned EPA's authority to adopt durability and warranty requirements for batteries in BEVs.[684] The Alliance, however, also agreed that battery degradation monitors and performance requirements are important tools for battery operation and state of health, and provided recommendations for modifying the program. Before describing the final rule provisions relating to durability and warranty, we first address the threshold issue of legal authority.

The regulation of battery durability is clearly within the Agency's authority. EPA's authority to set and enforce durability requirements for emission-related components like batteries is an integral part of its Title II authority. Durability requirements ensure that vehicle manufacturers and the vehicles they produce will continue to comply with emissions standards set under 202(a) over the course of those vehicles' useful lives. Such authority arises both out of section 202(a)(1) and 202(d) (relating to a vehicle's useful life) and section 206(a)(1) and 206(b)(1) (relating to certification requirements for compliance). As is described in detail in the following section, EPA has exercised its authority to set emission durability requirements across a variety of emission-related components for decades.

Similarly, EPA also has clear statutory authority to set warranty standards for BEVs and PHEVs. Section 207(a) and (i) provide clear statutory authority for the warranty requirements. In fact, EPA has already set emission warranty requirements under section 207(a) in 2010 for all components that are used to obtain GHG credits that allow the manufacturer to comply with GHG standards, which includes BEV, PHEV, and hybrid batteries.[685] EPA was not challenged on those requirements. To the extent the Alliance's comment challenges EPA's ability to set warranty requirements generally for any component that is used to obtain GHG credits that allow the manufacturer to comply with GHG standards, it is not timely or cognizant of this already established practice.

In general, BEV batteries, just like batteries in PHEVs and other hybrid vehicles, are emission-related components for two reasons, thus providing EPA authority to set durability and warranty requirements applicable to them. First, they are emission-related by their nature. Durability and warranty requirements for batteries are not, to use the Alliance's analogy, like requiring a warranty for a vehicle component like a vehicle's ''infotainment system'' that has no relevance to a vehicle's emissions. Integrity of a battery in a vehicle with these powertrains is vital to the vehicle's emission performance; integrity of its ''infotainment system'' is not. It is wrong to say that the very component that allows a vehicle to operate entirely without emissions is not emission-related.

Second, for warranty and durability purposes, EPA has historically implemented requirements based on an understanding that ''emission-related'' refers to a manufacturer's ability to comply with emissions standards, regardless of the form of those standards. For standards to be meaningfully applicable across a vehicle's useful life, EPA's assessment of compliance with such standards necessarily includes an evaluation of the performance of the emissions control systems, which for BEVs (and PHEVs) includes the battery system both when the vehicle is new and across its useful life. This is particularly true given the averaging form of standards that EPA uses for GHG and $NMOG+NO_X$ emissions (and which the Alliance continues to support), and which most manufacturers choose for demonstrating compliance. Given the fleet average nature of the standards, the Agency needs to have confidence that the emissions reductions—and thus credits generated —by each BEV and PHEV introduced into the fleet are reflective of the real world. Ensuring that BEVs and PHEVs contain durable batteries is important to assuring the integrity of the averaging process: vehicles will perform in fact for the useful life mileage reflected in any credits they may generate. Put another way, durable batteries are a significant factor in vindicating the averaging form of the standard: that the standard is met per vehicle, and on average per fleet throughout the vehicles' useful life. The

[682] 88 FR 4455.

[683] These two rationales are separate and independent justifications for the requirements.

[684] The Alliance does not challenge the agency's authority to adopt durability and warranty requirements for PHEVs.

[685] See 75 FR 25486.

battery durability and warranty provisions finalized in this rulemaking allow for greater confidence that the batteries installed by vehicle manufacturers are durable and thus support the standards.

In addition to EPA's general authority to promulgate durability requirements under sections 202 and 206, EPA has additional separate and specific authority to require on-board monitoring systems capable of ''accurately identifying for the vehicle's useful life as established under [section 202], emission-related systems deterioration or malfunction.'' Section 202(m)(1)(A).[686] As we discuss at length in this section, EV batteries are ''emission-related systems,'' and thus EPA has the authority to set durability monitoring requirements for such systems over the course of a vehicle's useful life.

The Alliance suggests that EPA does not have authority to set durability or warranty requirements because BEV batteries are not emission-related for two reasons. First, the Alliance argues that because BEVs do not themselves emit, EPA does not have authority to set vehicle specific standards for them, and EPA's warranty and durability authorities rely on EPA's ability to set vehicle specific standards. But EPA does have the authority to set standards for BEVs as they are part of the ''class'' of regulated vehicles. See section III.B.1 of the preamble and RTC section 2 for EPA's full analysis of the relevant statutory provisions. In addition, EPA has traditionally set vehicle-specific standards for BEVs. For instance, LD BEVs, like other LD vehicles, are subject to vehicle-specific, in-use GHG standards. And LD BEVs, like other LD vehicles, also certify to a vehicles-specific bin for $NMOG+NO_X$ compliance, with the BEVs certifying to a Bin 0. MD BEVs are also subject to vehicle-specific standards and MDVs have a similar compliance situation as that applied to LDVs. MDV compliance historically also includes a Bin 0 to accommodate zero emission vehicles. We note that these vehicle-specific standards have applied for many years. For example, EPA established the framework for setting vehicle-specific in-use GHG standards for LD vehicles in the original LD GHG rule in 2010, and we established a separate bin for zero-emitting vehicles in the 2000 Tier 2 criteria pollutant rule.

The Alliance argues second that a component only counts as emission-related if its failure would allow the vehicle to continue operating, but with higher emissions. But nothing in the statute imposes such a limitation. Moreover, while it is true that the failure of a battery would cause the vehicle to stop operating, the same is true for some other vehicle components that have also historically been subject to durability requirements. For instance, EPA has set durability requirements for diesel engines (see 40 CFR 86.1823–08(c)), failure of which could cause the vehicle to stop operating. Similarly, Congress explicitly provided that electronic control modules (ECMs) (described in the statute as ''electronic emissions control units'') are ''specified major emissions control component[s]'' for warranty purposes per section 207(i)(2); failure of ECMs can also cause the vehicle to stop operating, and not necessarily increase the emissions of the vehicle.

The Alliance is also mistaken in suggesting that there is no way for EPA to require an emission-less vehicle[687] to warrant at time of sale that it is ''designed, built, and equipped so as to conform, at time of sale with applicable regulations under [section 202(a)(1) . . . .)] and . . . for its useful life, as determined under [section 202(d)].'') Section 207(a)(1). In fact, automakers warrant at the time of sale that each new vehicle is designed to comply with all applicable emission standards and will be free from defects that may cause noncompliance. They do so with respect to all emission-related components in the manufacturer's application for certification, which include batteries. The final rule's provisions comport entirely with section 207 of the Act.[688]

We intend for the battery durability and warranty requirements finalized in this rule to be entirely separate and severable from the revised emissions standards and other varied components of this rule, and also severable from each other. EPA has considered and adopted battery durability requirements, battery warranty requirements, and the remaining portions of the final rule independently, and each is severable should there be judicial review. If a court were to invalidate any one of these elements of the final rule, as discussed further below, we intend the remainder of this action to remain effective, as we have designed the program to function even if one part of the rule is set aside. For example, if a reviewing court were to invalidate the battery durability requirements, we intend the other components of the rule, including the GHG and $NMOG+NO_X$ standards, to remain effective.

As we explain above, for manufacturers who choose to produce PEVs, durable batteries are important to ensuring that the manufacturer's overall compliance with fleet emissions standards would continue throughout the useful life of the vehicle. The battery durability and warranty provisions EPA is finalizing help assure this outcome. At the same time, we expect that, even if not strictly required, the majority of vehicle manufacturers would still produce vehicles containing durable batteries given their effect on vehicle performance and the competitive nature of the industry. Available data indicates that manufacturers are already providing warranty coverage similar to what is required by the final durability and warranty requirements.[689] [690] [691] [692] [693] Given the competitive nature of the PEV market, we anticipate that manufacturers will continue to do so, regardless of EPA's final rule.

Moreover generally, the battery durability and warranty requirements resemble many other compliance provisions that facilitate manufacturers'

[686] Section 202(m)(1)(A) specifically applies to light-duty vehicles and light-duty trucks, but section 202(m)(1) allows EPA to ''promulgate regulations requiring manufacturers to install such onboard diagnostic systems on heavy-duty vehicles and engines,'' which provides concurrent authority for the MDV battery monitoring requirements discussed in this section.

[687] We note that BEVs can in fact produce vehicle emissions, such as through air conditioning leakages.

[688] The Alliance's comment argues in passing that EPA does not have the authority to designate a BEV battery as a ''specified major emission control component'' with an 8 year or 80,000 mile warranty because it is not a ''pollution control device or component.'' That term is not defined in the Act; for the reasons described in this section, EPA believes that BEV batteries are ''pollution control device or component[s]'' for the same reasons they are ''emission related components.''

[689] United Nations Economic Commission for Europe Informal Working Group on Electric Vehicles and the Environment (UN ECE EVE), ''Battery Durability: Review of EVE 34 discussion,'' May 19, 2020, p. 12. Available at *https://wiki.unece.org/download/attachments/101555222/EVE-35-03e.pdf?api=v2*.

[690] UK Department of Transport, ''Commercial electric vehicle battery warranty analysis,'' April 25, 2023. Available at *https://wiki.unece.org/download/attachments/192840855/EVE-61-08e%20-%20UK%20warranty%20analysis.pdf?api=v2*.

[691] CarEdge.com, ''The Best Electric Vehicle Battery Warranties in 2024,'' January 9, 2024. Accessed on February 16, 2024 at *https://caredge.com/guides/ev-battery-warranties*.

[692] California Air Resources Board, ''Cars and Light-Trucks are Going Zero—Frequently Asked Questions.'' Accessed on February 16, 2024 at *https://ww2.arb.ca.gov/resources/documents/cars-and-light-trucks-are-going-zero-frequently-asked-questions*.

[693] Forbes, ''By The Numbers: Comparing Electric Car Warranties,'' October 31, 2022. Accessed on February 16, 2024 at *https://www.forbes.com/sites/jimgorzelany/2022/10/31/by-the-numbers-comparing-electric-car-warranties/?sh=2ed7a5243fd7*.

ability to comply with the standards, as well as EPA's ability to assure and enforce that compliance. Were a reviewing court to invalidate any compliance provision, that would preclude the agency from applying that particular provision to assure compliance, but it would not mean that the entire regulatory framework should fall with it. Specifically, were a reviewing court to invalidate the final durability and warranty requirements, EPA would continue to have numerous tools at its disposal to assure and enforce compliance of the final standards, including the entire panoply of certification requirements, in-use testing requirements, administrative and judicial enforcement, and so forth, so as to achieve significant emissions reductions. Therefore, EPA is adopting and is capable of implementing final standards entirely separate from the battery durability and warranty requirements. The contrapositive is also true: EPA is adopting and capable of implementing the battery durability and warranty requirements entirely separate from the standards. For example, even without the final standards, we believe the enhanced battery durability and warranty requirements would serve to facilitate compliance with the existing GHG standards established by the 2021 rule. We further discuss the severability of various provisions in this rule in section IX.M of the preamble.

i. Battery Durability

Substantially as proposed, this rulemaking implements battery durability monitoring and performance requirements for light-duty BEVs and PHEVs, and battery durability monitoring requirements for Class 2b and 3 BEVs and PHEVs, beginning with MY 2027.

As described in the proposal and in the introductory section above, EPA is introducing battery durability requirements for several reasons and in accordance with its authority under the Clean Air Act. As required under CAA section 202(a)(1) (''Such standards shall be applicable to such vehicles and engines for their useful life''), EPA emissions standards are applicable for the full useful life of the vehicle. Accordingly, EPA has historically required manufacturers to demonstrate the durability of engines and emission control systems on vehicles with ICE engines and has also specified minimum warranty requirements for ICE emission control components. Without durability demonstration requirements, EPA would not be able to assess whether manufacturers producing vehicles originally in compliance with relevant emissions standards would remain in compliance over the course of the useful life of those vehicles.

For decades, EPA has required vehicle manufacturers to demonstrate that their vehicles will continue to comply with any relevant emissions standards over the course of their useful life.[694] In the 2010 rule, EPA applied the same framework to CO_2 emissions as previously applied for criteria emissions.[695] Consistent with our historical practice, the 2010 rule also recognized that the performance of different emissions-related technologies deteriorates in different ways, and that different technologies warranted differing durability requirements. Given the most common technologies in use at the time, the Agency anticipated that most vehicle models would not have increasing difficulty in complying with CO_2 emissions standards over time. That is, unlike some criteria emissions-related technologies (such as catalytic converters in ICE vehicles) which deteriorate in their ability to reduce criteria emissions over time, EPA determined that as a technical matter, CO_2 emissions from these vehicles would be relatively consistent over time, so that durability requirements specifically related to CO_2 emissions from these vehicles were not needed. However, EPA did anticipate that there would be technologies in the future that would deteriorate in their ability to reduce CO_2 emissions over time and therefore benefit from specific durability requirements.[696] For example, HEVs have both a catalyst that controls criteria pollutants and a high-voltage battery that is integral to its CO_2-related performance, and manufacturers are required to account not only for the effect of catalyst degradation on criteria emissions compliance but also for the effect of battery deterioration on CO_2 compliance.

EPA has already identified the high-voltage battery in hybrid vehicles as a technology warranting specific durability requirements. Specifically, EPA's regulations already require manufacturers of HEVs and PHEVs to account for potential battery degradation that could result in an increase in CO_2 emissions, either due to increased fuel consumption or, specifically for PHEVs, the effect of a reduced electric driving range on the PHEV utility factor value. 40 CFR 86.1823–08(m)(1)(iii) lays out these specific durability requirements for batteries in PHEVs to ensure that PHEVs continue to meet emissions standards over the course of their useful life.[697] The fact that durability requirements already exist for hybrid and PHEV batteries highlights that EPA's action setting requirements for BEV batteries outlined in this final rule is an incremental addition to the scope of EPA's durability requirements writ large.

Today's final rule continues EPA's longstanding policy of ensuring durability for emissions control components and builds upon the existing durability requirements for batteries. Recognizing that PEVs, including both PHEVs and BEVs, are playing an increasing role in automakers' compliance strategies, and that emissions credit calculations are based on mileage over a vehicle's full useful life, EPA similarly has the authority to set requirements ensuring that manufacturers with PEVs in their fleet will continue to comply with relevant emissions standards over the course of those PEVs' useful lives. Under 40 CFR 86.1865–12(k), credits are calculated by determining the grams/mile each vehicle achieves beyond the standard and multiplying that by the number of such vehicles and a lifetime mileage attributed to each vehicle (*e.g.,* 195,264 miles for passenger automobiles and 225,865 miles for light trucks). Having a lifetime mileage figure for each vehicle is integral to calculating the credits attributable to that vehicle, whether those credits are used for calculating compliance with fleet average standards, or for banking or trading. Compliance with fleet average standards depends on all vehicles in the fleet achieving their certified level of emissions performance throughout their useful life. Durability requirements applicable to PEVs assure a certain standard of performance over the entire useful life of the vehicles and thus support the continuation of a manufacturer's overall compliance with fleet emissions standards throughout that useful life. Similarly, EPA would have less confidence that the emissions reductions projected to be achieved by a given set of standards would in fact be realized over the course of the program. Generally, credits generated by PEVs will offset debits generated by vehicles

[694] See, *e.g.,* 71 FR 2810 (Jan. 17, 2006).

[695] 75 FR 25324, 25474 (May 7, 2010) (''EPA requires manufacturers to demonstrate at the time of certification that the new vehicles being certified will continue to meet emission standards throughout their useful life.'').

[696] Id.

[697] While the requirements that currently appear in 40 CFR 86.1823–08(m)(1)(iii) applied to vehicles like PHEVs since the 2010 rule, it was amended to explicitly apply to PHEVs in the HD 2027 Rule. 88 FR 4296, 4459 (January 24, 2023).

with higher emissions. For the environmental benefits that are credited to PEVs to be fully realized under this structure, it is important that their potential to achieve a similar mileage during their lifetime be comparable to that of other vehicles, and this depends in part on the life of the battery. In particular, and especially for BEVs and PHEVs with shorter driving ranges, loss of too large a portion of the original driving range capability as the vehicle ages could reduce its total lifetime mileage, and this lost mileage might be replaced by mileage from other vehicles that have higher emissions. PHEVs specifically could also experience higher fuel consumption and increased tailpipe emissions. While the battery durability requirements were not specifically designed with reference to the full lifetime mileages assumed in the credit calculations, EPA considers the establishment of specific battery durability requirements in line with other programs to be a critical step in recognizing and addressing the importance of PEV durability to the integrity of the credit program as the presence of PEVs continues to increase in the fleet. EPA anticipates that modifications to the durability requirements may be appropriate as more data becomes available regarding the durability of PEV batteries in the field over time.

For instance, although lithium-ion battery technology has been shown to be effective and durable in currently manufactured BEVs and PHEVs, it is also well known that the energy capacity of a battery will naturally degrade to some degree with time and usage. This degradation can result in some reduction in electric driving range as the vehicle ages. Excessive battery degradation in a PHEV could lead to higher fuel consumption and increased criteria pollutant tailpipe emissions, while a degraded battery in a BEV could impact its ability to deliver the lifetime mileage expected. This effectively becomes an issue of durability if it reduces the utility of the vehicle or its useful life, and EPA will closely track developments in this area and propose modifications as they become necessary.

The importance of battery durability in the context of zero- and near-zero emission vehicles, such as BEVs and PHEVs, has been cited by several authorities in recent years. In their 2021 Phase 3 report,[698] the National Academies of Science (NAS) identified battery durability as an important issue with the rise of electrification.[699] Several rulemaking bodies have also recognized the importance of battery durability in a world with rapidly increasing numbers of zero-emission vehicles. In 2015 the United Nations Economic Commission for Europe (UN ECE) began studying the need for a Global Technical Regulation (GTR) governing battery durability in light-duty vehicles. In April 2022 it published United Nations Global Technical Regulation No. 22, ''In-Vehicle Battery Durability for Electrified Vehicles,'' [700] or GTR No. 22, which provides a regulatory structure for contracting parties to set standards for battery durability in light-duty BEVs and PHEVs.[701] The European Commission and other contracting parties have also recognized the importance of durability provisions and are working to adopt the GTR standards in their local regulatory structures. In addition, the California Air Resources Board, as part of the Advanced Clean Cars II (ACC II) program, has also included battery durability [702] and warranty [703] requirements as part of a suite of customer assurance provisions designed to ensure that zero-emission vehicles maintain similar standards for usability, useful life, and maintenance as for ICE vehicles. Additional background on UN GTR No. 22 and the California Air Resources Board battery durability and warranty requirements may be found in RIA Chapter 1.3.

EPA concurs with the emerging consensus that battery durability is an important issue. The ability of a zero-emission vehicle to achieve the expected emission reductions during its lifetime depends in part on the ability of the battery to maintain sufficient driving range, capacity, power, and general operability for a period of use comparable to that of any other vehicle. Durable and reliable electrified vehicles are therefore critical to ensuring that projected emissions reductions are achieved by this program.

GTR No. 22 was developed with extensive input, leadership, and participation from EPA and thus it reflects what EPA considers to be an appropriate framework and set of requirements for ensuring battery durability. EPA therefore considers its integration into the context of this rulemaking to be an appropriate pathway to establishing needed durability standards. In the absence of GTR No. 22, EPA would find it appropriate to adopt a very similar (if not identical) battery durability program, but we also recognize the value for U.S. automakers in adopting requirements that are consistent with international market requirements. Thus, the requirements and general framework of the battery durability program under this rule are largely identical to those outlined in GTR No. 22 and broadly parallel the GTR in terms of the minimum performance requirements, as well as the hardware, monitoring and compliance requirements, the associated statistical methods and metrics that apply to determination of compliance, and criteria for establishing battery durability and monitor families. EPA is incorporating the April 14, 2022, version of GTR No. 22 by reference, except for some naming conventions and procedural changes required to adapt the GTR to EPA-based testing and compliance demonstration, and modification of some specific provisions (for example, not requiring an SOCR monitor).

EPA requested comment on all aspects of the proposed battery durability program, particularly with respect to: The minimum performance requirements, the testing and compliance requirements for Part A and Part B, and the possibility of adopting more stringent or less stringent battery durability standards. EPA has carefully considered the public comments in finalizing the requirements of the durability program.

Several commenters, including several proponents or manufacturers of zero-emission vehicles, expressed support for the provisions and their intent of promoting battery durability. For example, Tesla stated that durability

[698] National Academies of Sciences, Engineering, and Medicine 2021. ''Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy 2025–2035''. Washington, DC: The National Academies Press. *https://doi.org/10.17226/26092.*

[699] Among the findings outlined in that report, NAS noted that: ''battery capacity degradation is considered a barrier for market penetration of BEVs,'' (p. 5–114), and that ''[knowledge of] real-world battery lifetime could have implications on R&D priorities, warranty provision, consumer confidence and acceptance, and role of electrification in fuel economy policy.'' (p. 5–115). NAS also noted that ''life prediction guides battery sizing, warranty, and resale value [and repurposing and recycling]'' (p. 5–115), and discussed at length the complexities of SOH estimation, life-cycle prediction, and testing for battery degradation (p. 5–113 to 5–115).

[700] United Nations Economic Commission for Europe, Addendum 22: United Nations Global Technical Regulation No. 22, United Nations Global Technical Regulation on In-vehicle Battery Durability for Electrified Vehicles, April 14, 2022. Available at: *https://unece.org/sites/default/files/2022-04/ECE_TRANS_180a22e.pdf.*

[701] EPA representatives chaired the informal working group that developed this GTR and worked closely with global regulatory agencies and industry partners to complete its development in a form that could be adopted in various regions of the world, including potentially the United States.

[702] State of California, California Code of Regulations, title 13, section 1962.4.

[703] State of California, California Code of Regulations, title 13, section 1962.8.

monitoring can be useful to ensure emission reduction benefits are met, and to provide integrity to credit trading.

Some commenters, such as the Alliance for Automotive Innovation (''the Alliance''), questioned EPA's authority to establish battery durability and warranty requirements. The Alliance, however, also agreed that battery degradation monitors and performance requirements are important tools for battery operation and state of health, and provided recommendations for modifying the program. Comments relating to authority are addressed in the introductory section above.

Positions varied regarding how the proposed durability and warranty program based on GTR No. 22 should exist alongside the California Air Resources Board (CARB) ACC II durability and warranty program (referred to here as the ''CARB program''). Some commenters stressed the differences between the proposed durability program and the CARB program and stated that it would be difficult for OEMs to comply with two different sets of requirements. Commenters within this group suggested a variety of solutions, including: aligning certain aspects of the proposed program with the CARB program; adopting the CARB program instead of the proposed program; or accepting compliance with the CARB program in lieu of compliance with the proposed program. Volkswagen, Volvo, and the Southern Environmental Law Center strongly encouraged EPA to fully harmonize with CARB, while similarly, BMW recommended adopting a single national approach. In contrast, Nissan and a coalition of environmental NGOs supported adoption of GTR No. 22 as proposed. The Alliance for Automotive Innovation stated that both CARB and EPA should align with global best practices. Mercedes, several environmental NGOs and state organizations recommended that EPA should align with the CARB regulation to avoid conflicting regulatory requirements; Mercedes specifically recommended that EPA allow voluntary compliance with CARB's durability program in lieu of EPA's program. CARB recommended adopting the CARB durability provisions as well as the full suite of consumer assurance provisions under ACC II. Others more generally recommended that EPA work with CARB to modify aspects of the CARB program.

Regarding comments that EPA should work with CARB to modify aspects of the CARB program, EPA considers modification of the CARB program to be outside the scope of this rulemaking. Regarding recommendations that EPA should adopt certain specific provisions of the CARB program (for example, inclusion of a battery reserve capacity declaration, phase-in of monitor accuracy tolerance, exempting shorter-range BEVs or PHEVs from requirements, number of decimal places for the monitor, OBD requirements and data parameters, basis on percentage points vs. percent, etc.), EPA believes that the CARB program and the proposed program based on GTR No. 22, in their entirety, are similarly effective, but that each program achieves that effectiveness by operating as a whole, and taking an a la carte approach of moving specific requirements from the context of one program into the context of another would compromise the integrity of either program. For this reason, EPA is generally not taking an approach of adopting specific individual elements of the CARB program at this time.

However, EPA agrees with commenters' concerns that complying with both CARB and EPA durability programs may require more effort than complying with only one. Some commenters suggested that a solution to many of the issues regarding harmonization with the CARB program could be solved if EPA were to accept compliance with the CARB program in lieu of the federal program. EPA continues to believe that it is possible for manufacturers to comply with both programs simultaneously, as manufacturers that sell in California and so have to comply with the CARB program will often also have to comply with GTR No. 22 in other international jurisdictions, which is very similar to the EPA program. However, EPA also considers the CARB durability program, when viewed in its entirety with its metrics and performance requirements, to be no less effective than the EPA durability program.

Accordingly, EPA will accept manufacturer compliance with the entirety of the CARB ACC II durability program in lieu of the EPA durability program. To utilize this optional pathway, manufacturers must declare their intention to do so, in which case their compliance with the CARB durability program will be deemed as compliance with the EPA durability program. Regardless of whether a manufacturer chooses to follow the CARB or the EPA program for the purpose of satisfying EPA battery durability requirements, failure to comply with the chosen program will result in the same credit loss penalty as under the EPA program. EPA considers the addition of the option to comply with the CARB durability program in lieu of the EPA durability program to be responsive to the various requests to adopt certain specific elements of the CARB program.

EPA also requested comment on the inclusion of a requirement for an SOCR monitor and associated reporting requirements as specified in GTR No. 22. Automakers expressed general support for basing the MPR on a metric of usable energy, or SOCE, as specified in GTR No. 22. Several expressed specific opposition to a range-based metric or SOCR, while some NGOs encouraged use of both SOCE and SOCR. EPA continues to assess that SOCE is sufficient at this time as a basis for the MPR, and notes that at this time GTR No. 22 requires only that an SOCR monitor be implemented and does not use it for enforcement of the MPR. EPA continues to consider the addition of an SOCR monitor in a future rulemaking but at this time is electing not to include this requirement in the final standard, as proposed.

Some commenters expressed uncertainty over whether the EPA program includes the virtual mileage provision of GTR No. 22, which accounts for use of the battery for purposes other than propulsion of the vehicle (*e.g.,* vehicle-to-building (V2B) or vehicle-to-grid (V2G) applications), as we did not specifically mention it in the proposal. EPA clarifies that under the EPA program, virtual mileage is applicable to the mileage used for determining compliance with the durability provisions, as defined in GTR No. 22. However, GTR No. 22 does not include warranty provisions, and so the mileage used for warranty under the EPA program does not include virtual mileage. More discussion may be found where we discuss the warranty portion of the EPA durability and warranty program in section III.G.2.ii of the preamble.

A variety of comments were received regarding minimum performance requirements (MPR) and their enforcement. Some commenters considered the requirements to be too stringent, while others suggested that they could be more stringent. VW recommended that EPA should adopt a single performance requirement of 70 percent at 8 years/100k miles. Tesla supported the proposed MPR as reasonable and achievable, while also advocating for a flexible approach allowing the manufacturer to use good engineering judgment in determining the statistically adequate and representative use of vehicle data. Tesla also supported the decision not to implement an MPR for MDVs.

In response to comments suggesting that the minimum performance requirement (MPR) is too stringent and/or will add significant cost to the vehicle, EPA disagrees. As noted and cited previously, the MPR is very similar to warranty coverage already provided by vehicle manufacturers, indicating that the MPR described in the proposal is already largely being achieved and can continue to be achieved. In developing GTR No. 22, some stakeholders noted that a performance standard that is appropriate in the context of warranty may not necessarily be appropriate in the context of durability requirements, because the corrective action for a warranty failure is limited to the individual vehicles that fail, while the corrective action for a durability failure would involve every vehicle in a durability group. That is, a warranty performance standard is typically determined and remedied on an individual vehicle basis while a durability performance standard is determined and remedied on a durability group basis. However, EPA notes that (a) in the context of failure to meet the battery durability requirement, it is not requiring recall and repair of every battery in a failed durability group, and (b) the GTR specifies that a durability group meets the durability standard even when up to 10 percent of the vehicles in a durability group sample fail the Part B durability determination, without requiring recall and replacement of the battery in those vehicles. Thus, a given performance requirement in the context of the final durability program only becomes more binding than the same standard in the context of warranty if more than 10 percent of vehicles are failing the standard. Given the cost of battery repair and replacement, EPA expects that manufacturers would consider such a high warranty replacement rate to be unacceptable and so are designing batteries to avoid that outcome. EPA therefore continues to consider the durability performance standard to be appropriate and is not modifying the MPR at this time.

Some commenters recommended that EPA adopt only the 8-year, 100,000 mile requirement of the MPR, and not the 5 year, 62,000 mile requirement. EPA acknowledges that GTR No. 22 allows the possibility of local jurisdictions adopting either or both of the requirements. EPA agrees that requiring only the later requirement may reduce test burden. However, EPA also expects that the 5 year requirement will promote battery designs that degrade in a more or less linear fashion over their useful life (as opposed to a battery design that degrades more rapidly in earlier years, which would tend to increase the potential impact of lost range capacity on the total mileage the vehicle can attain over its life). Also, the 5-year requirement allows for an earlier compliance decision if a vehicle is on track to fail the 8-year standard. In EPA's view, these substantial compliance benefits outweigh the added burdens of additional testing. For these reasons we are retaining the 5-year requirement in the program.

The Alliance recommended that, in section 86.1815 of the regulatory text, that we replace the term ''electric vehicles'' with ''BEVs and PHEVs'' to exclude FCEVs from monitoring and durability requirements. Fuel cell vehicles were not included within the technical analysis or scope of GTR No. 22 and EPA has not as yet determined that the monitoring and durability requirements developed under GTR No. 22 are appropriate for FCEVs. Accordingly, EPA has made the requested change to section 86.1815.

The Alliance also requested clarification on whether or not the durability and monitoring requirements are tied to the Tier 4 phase-in per section 86.1815. EPA clarifies that the battery durability and warranty standards for light-duty vehicles under 6,000 pounds begin in model year 2027 and for medium-duty vehicles begin when first certified for Tier 4. See section 86.1815.

Regarding the durability test sample of at least 500 vehicles under Part B of the EPA program, the Alliance noted that distribution of some durability groups of PEVs across the U.S. may be insufficient to support the proposed sample characteristics, and proposed to keep the current sample size of 500 vehicles, but require that no more than 50 percent of the vehicles in the sample be registered in the same region. EPA agrees that, particularly in the early years of the program, some durability groups may be unevenly distributed across the U.S. and is modifying the sample requirements per this suggestion.

The SAVE Coalition recommended that we revise section 86.1815(a) to specify that the monitor should be viewable by the owner of the vehicle, as specified in GTR No. 22, rather than the customer, as specified in section 86.1815(a), to accommodate situations such as autonomous transportation services, where the customer of the autonomous service is not the owner of the vehicle. EPA agrees that ''customer'' may be ambiguous in this application; however, we also believe that using the term ''owner'' might be interpreted as excluding lessees or other parties with a legitimate interest in the state of health of the battery. EPA is clarifying the regulatory text by changing ''customer-accessible'' to ''operator-accessible.'' As the customer of a fully autonomous transport service is not an operator, EPA believes that this modification addresses the commenter's concern.

Some commenters requested clarification as to whether the removal of compliance credits earned by vehicles that fail the durability requirement applies only to GHG credits earned, or also to $NMOG+NO_X$ credits earned. In the proposal, EPA stated that in the case of failure to meet the durability requirements, ''manufacturers would have to adjust their credit balance to remove compliance credits previously earned by those vehicles,'' and the regulatory text stated ''the manufacturer must adjust all credit balances to account for the nonconformity.'' EPA clarifies that in the case of BEVs, the credits affected include GHG and $NMOG+NO_X$ credits. For PHEVs, although PHEVs earn both GHG and $NMOG+NO_X$ credits, the credits affected include only GHG credits. PHEV credits for $NMOG+NO_X$ would not need to be forfeited because testing to determine compliance with $NMOG+NO_X$ standards is based on charge-sustaining mode when the engine is operating, and $NMOG+NO_X$ emissions in this mode are not generally impacted by the amount of grid energy that can be stored in the battery. EPA also clarifies that credit removal for failing the durability requirement, specifically the Minimum Performance Requirement, only applies to LD BEVs and PHEVs.

EPA also clarifies that Annex 3 of GTR No. 22 applies only in jurisdictions where WLTP is used. The quantities that represent $UBE_{measured}$ and $UBE_{certified}$ for the purpose of part 6.3.2 of GTR No. 22 in the context of this rule are specified in the regulatory text.

As finalized, the battery durability requirements consist of two primary components as shown in Table 64. The first component is a requirement for manufacturers to provide a customer-readable battery state-of-health (SOH) monitor for both light-duty and Class 2b and 3 BEVs and PHEVs. The second component is the definition of a minimum performance requirement (MPR) for the SOH of the high voltage battery, applicable only to light-duty BEVs and PHEVs. HEVs and FCEVs are not included in the scope of GTR No. 22 or the durability program.

TABLE 64—APPLICABILITY OF BATTERY DURABILITY REQUIREMENTS TO LIGHT-DUTY AND CLASS 2b/3 VEHICLES

Requirement	Light-duty BEVs and PHEVs	Class 2b and 3 BEVs and PHEVs
Battery State of Health (SOH) Monitor.	Yes	Yes.
Monitor accuracy requirement.	Yes	Yes.
Minimum Performance Requirement (MPR).	Yes	No.

Manufacturers will be required to install a battery SOH monitor which estimates, monitors, and communicates the vehicle's state of certified energy (SOCE) as defined in GTR No. 22, and which can be read by the vehicle operator. This requires manufacturers to implement onboard algorithms to estimate the current state of certified energy of the battery, in terms of its current usable battery energy (UBE) expressed as a percentage of the original UBE when the vehicle was new. The state of certified range (SOCR) monitor defined in GTR No. 22 will not be required.

For light-duty BEVs and PHEVs, the information provided by this monitor will be used for demonstrating compliance with a minimum performance requirement (MPR) which specifies a minimum percentage retention of the original UBE when the vehicle was new. As shown in Table 65, under the final rule, light-duty BEV and PHEV batteries will be subject to an MPR that requires them to retain no less than 80 percent of their original UBE at 5 years or 62,000 miles, and no less than 70 percent at 8 years or 100,000 miles.

TABLE 65—MINIMUM PERFORMANCE REQUIREMENTS

Years or mileage	Light-duty BEVs and PHEVs	Class 2b and 3 BEVs and PHEVs
5 years or 62,000 miles.	80 percent SOCE.	N/A.
8 years or 100,000 miles.	70 percent SOCE.	N/A.

In alignment with GTR No. 22, which does not currently subject UN ECE Category N vehicles of Category 2 (work vehicles that primarily carry goods) to the MPR requirement, Class 2b and 3 PEVs will not be subject to the MPR. The developers of GTR No. 22 chose not to set an MPR for Category 2 PEVs at the time, largely because the early stage of adoption of these vehicles meant that in-use data regarding battery performance of these vehicles was not readily available. MPR requirements for category 2 PEVs were therefore reserved for possible inclusion in a future amendment to the GTR, but monitoring requirements were retained to allow information on degradation to be collected from these vehicles to help inform a future amendment. For similar reasons, EPA is retaining the monitor requirement for Class 2b and 3 PEVs but is not requiring the MPR.

Compliance with the new battery durability requirements will require manufacturers to perform testing beyond what is currently required. Previously, light-duty vehicle manufacturers were required to perform range testing on BEVs and PHEVs only to provide information to inform the EPA fuel economy label, and not for vehicle certification. Class 2b and 3 vehicles did not have the labeling requirement and therefore often did not undergo this testing. Under the new program (as described more fully in section III.G.1 and below), manufacturers of both light-duty and Class 2b and 3 BEVs and PHEVs will perform testing to determine and report the vehicle's UBE when new. In addition, at points during the useful life of the vehicle, manufacturers will demonstrate through in-use vehicle testing that the SOCE monitor meets an accuracy standard.

Manufacturers will group the PEVs that they manufacture into monitor families and battery durability families as defined in GTR No. 22 (and described in more detail in section III.G.3 of this preamble). As described further below, monitor families must comply with a monitor accuracy requirement, and battery durability families must comply with the applicable MPR. Because determination of compliance in either case depends on reference to a certified UBE value, this value must be determined at time of certification. Since the testing program that is currently performed for fuel economy labeling purposes does not necessarily determine such a value for all vehicle configurations that would need it for durability compliance purposes, additional testing of vehicles that would not otherwise need to be tested for labeling purposes may need to be performed at time of certification.

For both light-duty and medium-duty vehicles, as described in the ''Part A'' monitor accuracy provisions outlined in GTR No. 22, manufacturers will be required to meet a standard for accuracy of their on-board SOCE monitors. To determine the accuracy of the monitors, vehicles from each monitor family shall be recruited and procured in-use at each of 2 years and 4 years after the end of production of that monitor family for a model year. The onboard monitor values for SOCE shall be recorded, and each vehicle shall then be tested to determine actual (measured) UBE capability of the battery. As described in section III.G.1 of the preamble, for this testing EPA will require the 2017 version of SAE Standard J1634 for determining UBE for BEVs, and the 2023 version of SAE J1711 for determining UBE for PHEVs. The UBE measured by the test will be used to calculate the measured SOCE of the battery, as the measured UBE divided by the certified UBE. The measured SOCE shall be compared to the value reported by the SOCE monitor prior to the test. The accuracy of the SOCE monitor must not be in error more than 5 percent above the measured SOCE, as defined and determined via the Part A statistical method defined in GTR No. 22. See 40 CFR 86.1811–27, 86.1845–04(g) and 86.1839–01(c) for detailed specifications.

For light-duty vehicles, in a similar manner to the ''Part B'' compliance provisions of GTR No. 22, once having demonstrated Part A accuracy for the SOCE monitor of vehicles within a monitor family, manufacturers shall demonstrate compliance with the MPR by collecting the values of the onboard SOCE monitors of a statistically adequate and representative sample of in-use vehicles, in general no less than 500 vehicles from each battery durability family that shares that monitor family, and reporting the data and results to EPA. The manufacturer shall use good engineering judgment in determining that the sample is statistically adequate and representative of the in-use vehicles comprising each durability family, subject to specific provisions in the regulation and approval by EPA. Manufacturers may obtain this sample by any appropriate method, for example by over-the-air data collection or by other means. A battery durability family passes if 90 percent or more of the monitor values read from the sample are at or above the MPR.

In the case that a monitor family fails the Part A accuracy requirement, the manufacturer will be required to recall the vehicles in the failing monitor family to bring the SOCE monitor into compliance, as demonstrated by passing the Part A statistical test with vehicles using the repaired monitor. In the case that a durability family fails the Part B durability performance requirement, the manufacturer's credit balance will be adjusted to remove compliance credits previously earned by those vehicles. In the case of BEVs, the credits affected include GHG and $NMOG+NO_X$ credits, as BEVs do not earn credits for other pollutants. For PHEVs, the credits affected include only GHG credits, as emissions performance for other pollutants is largely independent of usable battery capacity.

For Part B, GTR No. 22 does not specify a means of data collection. EPA anticipates that many manufacturers might collect this data via means such as telematics (remote, wireless queries) which is becoming increasingly present in new vehicles, or any other sampling technique which accurately collects data from the number of vehicles outlined in the GTR. For example, vehicle manufacturers may choose to physically connect to the required number of vehicles and read the SOCE values directly in lieu of remote, telematics-based data collection. The data collection method used for Part B must identically report the same quantities that were collected for the purpose of the monitor accuracy test under Part A.

Unlike GTR No. 22, EPA is not requiring a state of certified range (SOCR) monitor in addition to an SOCE monitor. In the proposal we noted that some of the organizations and authorities that have examined the issue of battery durability have recognized that monitoring the state of a vehicle's full-charge driving range capability (instead of or in addition to UBE capability) as an indicator of battery durability performance may be an attractive option because driving range is a metric that is more directly experienced and understood by the consumer. GTR No. 22 requires manufacturers to install a state of certified range (SOCR) monitor in addition to an SOCE monitor but it is not required to be customer facing, and its information is collected only for information gathering purposes. Additional discussion of the decision to not include an SOCR monitor in the EPA program is provided in RTC section 16.

Additional background on UN GTR No. 22 and the California Air Resources Board battery durability and warranty requirements may be found in RIA Chapter 1.3.

ii. Battery and Vehicle Component Warranty

EPA is also finalizing new warranty requirements for BEV and PHEV batteries and associated electric powertrain components (*e.g.,* electric machines, inverters, and similar key electric powertrain components). The new warranty requirements build on existing emissions control warranty provisions by establishing specific new requirements tailored to the emission control-related role of the high-voltage battery and associated electric powertrain components in the durability and emissions performance of PEVs.

For light-duty BEVs and PHEVs, EPA is designating the high-voltage battery and associated electric powertrain components as specified major emission control components according to our authority under CAA section 207(i)(2), which assigns a warranty period of 8 years or 80,000 miles for components so designated.

For medium-duty (Class 2b and 3) BEVs and PHEVs, we are establishing a warranty period of 8 years or 80,000 miles for the battery and associated electric powertrain components on these vehicles, according to our authority under CAA section 207(i)(1). The program will provide warranty coverage for the emission control components on Class 2b and 3 BEVs and PHEVs equal to that for the same components on light-duty BEVs and PHEVs.

EPA believes that this practice of ensuring a minimum level of warranty protection for emissions-related components on ICE vehicles should be extended to the high-voltage battery and other electric powertrain components of BEVs and PHEVs for multiple reasons. Recognizing that BEVs and PHEVs are playing an increasing role in manufacturers' compliance strategies, the high-voltage battery and the powertrain components that depend on it are emission control devices critical to the operation and emission performance of BEVs and PHEVs, as they play a critical role in reducing the emissions of PHEVs and in enabling BEVs to operate with zero tailpipe emissions as well as to reduce fleet average emissions, as discussed earlier. Further, EPA anticipates that compliance with the program is likely to be achieved with larger penetrations of BEVs and PHEVs than under the previous program. Although the projected emissions reductions are based on a spectrum of control technologies, in light of the cost-effective reductions achieved, especially by BEVs, EPA anticipates most if not all automakers will include credits generated by BEVs and PHEVs as part of their compliance strategies, even if those credits are obtained from other manufacturers; thus this is a particular concern given that the calculation of credits for averaging (as well as banking and trading) depend on the battery and emission performance being maintained for the full useful life of the vehicle. Additionally, warranty provisions are a strong complement to the battery durability requirements described in III.G.2. We believe that a component under warranty is more likely to be properly maintained and repaired or replaced if it fails, which would help ensure that credits granted for BEV and PHEV sales represent real emission reductions achieved over the life of the vehicle.

In the proposal, EPA requested comment on all aspects of the proposed warranty provisions for light-duty and medium-duty PEVs, batteries, and associated electric powertrain components.

The Alliance commented that warranty requirements should remain at the discretion of individual OEMs rather than be specified by regulation, and that designation of BEV batteries and associated components as specified major emission control components is not consistent with the statute. The commenter asserted that BEVs do not have emissions and therefore our inclusion of BEV components of any kind under the Administrator's authority to specify warranty requirements for emissions-related components is not appropriate. EPA's response to any questions of authority to set durability or warranty requirements for BEV batteries is in the introductory section. Below we provide additional discussion of our authority to establish warranty requirements specifically.

For light-duty vehicles, CAA section 207(i)(1) specifies that the warranty period is 2 years or 24,000 miles of use (whichever first occurs), except for specified major emission control components (SMECC) described in 207(i)(2), for which the warranty period is 8 years or 80,000 miles of use (whichever first occurs). For all other vehicles, which would include medium-duty vehicles (MDVs), CAA 207(i)(1) specifies that the warranty period shall be the period established by the Administrator. For both light-duty and medium-duty vehicles, the Administrator is establishing a warranty period of 8 years and 80,000 miles.

For light-duty vehicles, 207(i)(2) specifically identifies catalytic converters, electronic emissions control units, and onboard emissions diagnostic devices as SMECC. Currently, BEV and PHEV battery and electric powertrain components are not so specified, which limits their coverage requirement to the 2 years or 24,000 miles of CAA section 207(i)(1), a period which EPA believes is not sufficient, given the importance of these components to the operation and emissions performance of these vehicles. As discussed in connection with battery durability, this is of particular concern given that the calculation of fleet average performance and of credits for banking and trading depend on the battery and emissions performance being maintained for the full useful life of the vehicle. However, to allow for designation of other pollution control components as SMECC, CAA section 207(i)(2) provides that the Administrator may so designate any other pollution control device or component, subject to the conditions that the device or component was not in general use on vehicles and engines manufactured prior to the model year 1990 and that the retail cost (exclusive of installation costs) of such device or component exceeds $200 (in 1989 dollars), adjusted for inflation or deflation as calculated by the Administrator at the time of such determination.[704] Adjusted for inflation, the $200 retail cost threshold would be about $500 today. As BEVs and PHEVs and thus their high-voltage battery systems and associated powertrain components were not in general use prior to 1990, and their high-voltage battery systems and associated powertrain components exceed this cost threshold, the Administrator determines that these emission control devices meet the criteria for designation as specified major emission control components. Accordingly, the Administrator designates these components as specified major emission control components according to his authority under CAA section 207(i)(2).

Several environmental NGOs and supplier organizations indicated support of PEV durability and warranty requirements, and referenced statutory language supporting these measures. Tesla advocated for warranty thresholds more consistent with the industry standard, and adoption of a standard 8-year, 80,000 miles warranty with 70 percent UBE. Lucid requested that EPA consider CARB's current battery warranty under ACC II, which is 70 percent SoH for 8 years or 100,000 miles, and aligns with EPA's proposed end point durability standard. In response, the warranty standard is based on the statutory criterion of 8 years or 80,000 miles for SMECC components, which does not specify a failure criterion for batteries. This standard matches Tesla's recommendation but does not specify a UBE requirement as failure criterion, consistent with past EPA practice regarding SMECC component warranty. In the proposed regulatory text EPA had tied the battery warranty failure criterion to the MPR criterion of 70 percent SOCE to provide clarity on what constitutes the need for a warranty repair. However, in light of comments received, additional research and consideration of existing warranty-related provisions in the current regulations, EPA has reconsidered the appropriateness of doing so at this time. EPA is not tying the battery warranty failure criterion to the durability performance requirement but will require manufacturers to specify the warranted percentage SOCE and will require use of the SOCE monitor value in determining a warranty claim, subject to the warranty claim procedures in 40 CFR 85.2106. See the regulatory text and further discussion in section 15.1 of the Response to Comments document. EPA has not yet determined if it is appropriate to specify a warranty failure criterion in this context and will continue to study the matter for possible inclusion in a future rulemaking.

Some commenters raised the issue of whether or not virtual mileage would be included in the mileage applicable to the warranty provisions, with some suggesting that it should be included. However, commenters did not clearly explain why virtual mileage should be extended to warranty mileage simply because it exists in the context of durability. EPA notes that the virtual mileage provision originates in EPA's adoption of GTR No. 22, which developed a concept of virtual mileage specifically for the context of battery durability. GTR No. 22 does not consider or establish warranty provisions. EPA retained the virtual mileage provision in the context of durability for the purpose of maintaining consistency with the GTR design and structure, and not for the purpose of potentially extending a virtual mileage concept to other mileage-related aspects of our regulations.

As an alternative to the inclusion of virtual warranty mileage, some commenters suggested that EPA should exclude vehicles that were used for V2G or V2B from warranty coverage. EPA continues to assess that these provisions are not necessary. We note that the warranty mileage, which does not include virtual mileage, is only 80,000 miles compared to the durability mileage of 100,000 miles. This reduced stringency largely addresses commenters' concerns regarding warranty mileage and likely levels of V2G or V2B usage. EPA also notes that V2G usage may not necessarily imply a shorter battery life as is commonly assumed. Recently, NREL found that a vehicle-to-grid control strategy which lowered the battery's average state of charge (SOC) when parked—while ensuring it was fully recharged in anticipation of the driver's next need—could extend the life of the battery if continued over time.[705] Similarly, a study by Environment and Climate Change Canada, NRC Canada and Transport Canada also found no significant difference in usable battery energy between a vehicle that was used for bidirectional V2G and one that was not, and identified an improved SOC profile resulting from V2G activity as a possible factor.[706]

In the proposed regulatory text, EPA explicitly tied the warranty performance criteria to the durability requirement, *i.e.* an individual vehicle would be deemed as eligible for warranty battery repair if it retains less than 80 percent SOCE at 5 years or 62,000 miles or 70 percent SOCE at 8 years or 80,000 miles. Some commenters stated that an explicit connection between the two was inappropriate, because warranty should be determined by the manufacturer and might legitimately vary between different types of products.

CARB recommended that EPA adopt the CARB warranty provisions, and that EPA explicitly tie battery warranty requirements to the durability performance requirement. However, CARB pointed out that the ''proposal appears to mistakenly tie all non-battery powertrain components to this same battery durability performance requirement when defining failures that merit warranty replacement. Such a connection renders the warranty requirements meaningless for those components.'' CARB went on to recommend that EPA adopt ''an appropriate failure metric(s) for warranty coverage for non-battery components.''

In response to comments that EPA should not specify warranty performance criteria, EPA continues to find that the proposed warranty requirements are equivalent to those that EPA has the authority to require and has historically applied to other specified major emission control-related components for ICE vehicles under EPA's light-duty vehicle regulations,

[704] See 42 U.S.C. 7541(i)(2).

[705] NREL. ''Electric Vehicles Play a Surprising Role in Supporting Grid Resiliency,'' October 12, 2023. Accessed November 5, 2024 at *https://www.nrel.gov/news/program/2023/evs-play-surprising-role-in-supporting-grid-resiliency.html.*

[706] Lapointe, A. et al., ''Effects of Bi-directional Charging on the Battery Energy Capacity and Range of a 2018 Model Year Battery Electric Vehicle,'' 36th International Electric Vehicle Symposium and Exhibition (EVS36), June 11–14, 2023.

and are similarly implemented under the authority of CAA section 207. However, we acknowledge that for analogous warranty requirements as they have pertained to emissions-related ICE powertrain components under the same statute, EPA has typically specified only the years and mileage and not the exact failure criteria that would trigger a warranty repair.[707] Accordingly, at this time we are not tying the battery warranty performance criteria to the durability performance requirement. Instead, we are retaining the 8-year and 80,000 mile warranty duration as specified by the statute, but are allowing the manufacturer to specify the percentage SOCE that will trigger a warranty repair, and also requiring the manufacturer to (a) clearly disclose the warranted percentage SOCE to the customer in writing prior to sale, and (b) establish, describe and disclose an evaluation method that will be used by the manufacturer to determine whether that percentage SOCE has fallen below the warranted percentage, and show to EPA's satisfaction that it is accurate and reliable.

In response to CARB's observation that the 70 percent SOCE stipulation is technically not applicable to associated powertrain components that are not batteries, the removal of the explicit connection addresses this comment. For these components EPA is specifying only the years and mileage terms and not specific failure criteria.

In response to comments that we should clarify what is meant by ''associated powertrain components,'' EPA has revised 40 CFR 85.2103(d)(1)(v) of the regulatory text, which now clarifies that the provision applies to ''all components needed to charge the system, store energy, and transmit power to move the vehicle.''

Other comments are addressed in the RTC.

3. Definitions of Durability Group, Monitor Family, and Battery Durability Family

EPA is revising the durability group definition for vehicles with an IC engine, and adding two new grouping definitions, monitor family and battery durability family, for BEVs and PHEVs.

i. Durability Group Revisions

EPA anticipates the adoption and use of gasoline particulate filters (GPFs) to reduce PM emissions to the levels required with the revised PM standard. Particulate filters are currently utilized on diesel-powered vehicles to meet the existing Tier 3 p.m. standard. EPA's durability group definition in 40 CFR 86.1820–01 includes a catalyst grouping statistic based on the engine displacement and catalyst volume and loading to define the acceptable range of designs that may be combined into a single durability group. Previously, EPA has not required manufacturers to consider PM filters in the determination of the durability group.

PM filters can also be coated with precious metals resulting in the particulate filter performing the functions of a three-way catalyst in addition to reducing particulates. The Agency expects that manufacturers may choose to adopt PM filters with three-way catalyst coatings on some applications to reduce aftertreatment system cost by not increasing the number of substrates. We are accordingly clarifying that manufacturers need to include the volume and precious metal loading of the PM filter along with the corresponding catalyst values when calculating the catalyst grouping statistic. The volume of the PM filter will not be included in the catalyst grouping statistic if the PM filter does not include precious metals.

The durability group is used to specify groups of vehicles which are expected to have similar emission deterioration and emission component durability characteristics throughout their useful life. The inclusion of a particulate filter on a gasoline-fueled vehicle aftertreatment system can have an impact on the durability characteristics of the aftertreatment system and as such the Agency is finalizing its proposal that this device, or the lack of a PM filter in the aftertreatment system, needs to be included in the durability group determination for internal combustion engine aftertreatment systems. Specifically, we are finalizing that vehicles may be included in the same durability group only if all the vehicles have no particulate filter, or if all the vehicles have non-catalyzed particulate filters, or if all the vehicles have catalyzed particulate filters.

We are applying these updates to durability groups equally for both gasoline and diesel applications. However, diesel vehicles certified under 40 CFR part 86, subpart S, generally use a consistent configuration with particulate filters, so the changes are not likely to lead to changes in certification practices for those vehicles. The Agency did not receive any comments on these proposed changes to the durability group definition.

ii. BEV and PHEV Monitor Family

As described in section III.G.2.i of the preamble, EPA is establishing battery durability requirements for BEVs and PHEVs. As part of this durability standard, as proposed, the Agency is finalizing two new groupings for BEVs and PHEVs, the battery monitor family and the battery durability family.

As described in section III.G.2.i of the preamble, based on comments received to the NPRM, EPA will accept manufacturer compliance with the CARB ACC II durability program in lieu of the EPA durability program. Allowing BEV manufacturers to comply with the ACC II durability requirements has resulted in the need to revise the required groupings for BEVs.

In the NPRM it was proposed that BEVs would have battery monitor and battery durability families and would no longer require test group or exhaust emission durability groups. As the California ACC II program groups BEVs by test groups, EPA has concluded that BEVs will still require the definition of an exhaust emission durability group and test group for all BEVs.

In the NPRM it was proposed that PHEVs would have battery monitor and battery durability families in addition to test group and exhaust emission durability groups. PHEVs required keeping the test group and exhaust emission durability groups as these definitions were created to group vehicles based on their exhaust emission characteristics.

As finalized in this rulemaking BEVs and PHEVs which will comply with the California ACC II requirements and will not comply with the EPA requirements will only need to specify a durability family and a test group for these vehicles. BEVs and PHEVs which comply with the EPA requirements will need to specify a durability family, test group, battery monitor family, and battery durability family for these families.

To support the monitor accuracy evaluation requirements described in section III.G.2 of the preamble, manufacturers must install a battery SOH monitor which accurately estimates, monitors, and communicates the SOCE of the high-voltage battery (as defined in GTR No. 22 and described in section III.G.2 of the preamble) at the current point in the vehicle's lifetime. To evaluate the accuracy of the monitor during the life of the vehicle, manufacturers must procure and test consumer vehicles in-use. The SOCE

[707] This has largely been possible because of the way OBD requirements are integrated with the emissions rules, as a material failure of an emission component to perform as designed would typically result in increased emissions that would in turn activate a malfunction indicator lamp (MIL).

monitor is subject to the accuracy standard.

Through the introduction of monitor families for BEVs and PHEVs, EPA seeks to reduce test burden by recognizing that monitor accuracy may be similar for vehicles with sufficiently similar design characteristics that use the same monitor design. As described in GTR No. 22, vehicles that are sufficiently similar in their characteristics such that the monitor can be expected to perform with the same accuracy may be assigned to the same monitor family. The criteria for inclusion in the same monitor family includes characteristics such as the algorithm used for SOCE monitoring, electrified vehicle type (BEV or PHEV), sensor characteristics and sensor configuration, and battery cell characteristics that would not be expected to influence SOCE monitor accuracy.

In the NPRM, EPA proposed that for vehicles to be in the same monitor family, the following conditions must be met: the SOCE monitoring algorithm needs to utilize the same logic and have the same value for all calibration variables used in the algorithm; the algorithm used to determine UBE needs to utilize the same sampling and integration periods and the same integration technique; the locations of the sensor(s) (*i.e.* at the pack, module, or battery cell level) for monitoring DC discharge energy need to be the same; and the accuracy of the sensor(s) and the tolerance of the sensor(s) accuracy used for monitoring energy and range need to be the same. EPA received comments from the Alliance indicating their concern that the proposed requirements are overly restrictive with respect to defining monitor family. Having considered the Alliance's comment, the Agency has decided to remove these requirements on the sensor locations and algorithm requirements from the monitor family determination. The Agency has concluded that the criteria for inclusion in the same monitor family as defined in GTR No. 22 are sufficient. The Agency also is finalizing the proposed requirement that BEVs and PHEVs cannot be included in the same monitor family, as required by GTR No. 22 which is being incorporated by reference.

If a manufacturer determines that additional vehicle characteristics affect the accuracy of SOCE estimation, the manufacturer can request the Administrator to allow the creation of additional monitor families. To request additional monitor families, the manufacturer may seek Agency approval and describe in their application the factors which produce SOCE estimation errors and how the monitor family will be divided to reduce the estimation errors.

Manufacturers can request that the Administrator include in the same monitor family vehicles for which these characteristics would not otherwise allow them to be in the same monitor family (except for including BEVs and PHEVs in the same monitor family). When seeking Agency approval, the manufacturer will need to include data demonstrating that these differences do not cause errors in the estimation of SOCE.

iii. BEV and PHEV Battery Durability Family

In introducing battery durability families for BEVs and PHEVs, EPA seeks to reduce test burden by recognizing that the degradation of UBE (as indicated by SOCE) may be similar for vehicles with sufficiently similar design characteristics. As described in GTR No. 22, vehicles that are sufficiently similar in their characteristics such that the UBE may be expected to degrade in the same way may be assigned to the same battery durability family. EPA is establishing provisions requiring use of the following powertrain characteristics and design features to determine battery durability families: maximum specified charging power, method of battery thermal management, battery capacity, battery (cathode) chemistry, and the net power of the electrical machines. In addition, BEVs and PHEVs cannot be placed in the same battery durability family.

EPA received comments from the Alliance requesting a number of changes to the criteria used to determine battery durability families for BEVs and PHEVs. The Alliance recommended removing the cathode chemistry criteria and including all unique cathode chemistries in a single Li-Ion family. Another commenter expressed uncertainty as to whether variants within specific Li-Ion sub-chemistries, such as NMC or LFP, would be considered the same or different chemistries. The Alliance also suggested removing the maximum charging power criteria. In addition, the Alliance recommended allowing batteries with capacities within 20 percent to be included in the same battery durability family. At this time, the Agency does not have sufficient information to conclude that the revisions the Alliance is suggesting will ensure that all vehicles within a durability family would be expected to degrade in the same manner. For example, it is well known that different lithium-ion chemistries, even within specific sub-chemistries such as NMC or LFP, can exhibit significantly different durability properties. As noted in this section and in the EPA regulations, EPA is providing manufacturers with the option to include in the same durability family vehicles for which these characteristics would not otherwise allow them to be in the same battery durability family. In order to make this inclusion, the manufacturer needs to provide data demonstrating the vehicle differences being included will age similarly and will degrade in an equivalent manner. The option to provide data applies to all of the powertrain characteristics and design features used to determine a battery durability family. Therefore, the Agency is finalizing the requirement to specify battery durability families based on the characteristics and design features described in GTR No. 22 with the provision to allow variations based on the submission of appropriate data demonstrating equivalent degradation. With regard to specific sub-chemistries, EPA clarifies that placement in the same battery durability family is not indicated when chemistry differences exist that would be expected to influence durability. Chemistry differences may include differences such as proportional metal composition of the cathode (for example, NMC811, NMC622, NMC333, etc.), composition of the anode (for example, graphite, graphite with silicon, other forms of carbon), or differences in particle size or morphology of cathode or anode active materials, unless data is provided otherwise as described above.

Manufacturers can request that the Administrator include in the same battery durability family vehicles for which the characteristics and design features described in the above paragraphs would not otherwise allow them to be in the same battery durability family (except for including BEVs and PHEVs in the same battery durability family). The manufacturer will need to include data with their request that demonstrates that these differences do not impact the durability of the vehicles with respect to maintaining UBE throughout the life of the BEV or PHEV.

If a manufacturer determines that additional vehicle characteristics result in durability differences which impact UBE, the manufacturer can request the Administrator to allow the creation of additional battery durability families. To request additional battery durability families the manufacturer will need to seek Agency approval. In their request for approval, the manufacturer must describe the factors which produce differences in vehicle aging and how the durability grouping will be divided to better capture the differences in expected deterioration.

EPA also received comments from the California Air Resources Board and the State of Colorado addressing EPA's proposed BEV durability program. Both Colorado and the California Air Resources Board were supportive of EPA's proposal and in both instances also asked EPA to implement a BEV durability program based on California's durability program adopted in their Advanced Clean Cars II regulation. The final rule accordingly includes an option for manufacturers to demonstrate compliance with battery durability requirements based on certification to CARB's ACC II program. Detailed responses to these comments can be found in the Response to Comments Document.

4. Light-Duty Program Improvements

i. GHG Compliance and Enforcement Requirements

EPA is finalizing its proposal to clarify the certification compliance and enforcement requirements for GHG exhaust emission standards found in 40 CFR 86.1865–12 to more accurately reflect the intention of the 2010 light-duty vehicle GHG rule (75 FR 25324, May 7, 2010). In the 2010 rule, EPA set full useful life greenhouse gas emissions standards with which each vehicle is required to comply. Each vehicle has an individual full useful life greenhouse emission standard which is based on the measured GHG emissions used for fuel economy labeling purposes. Manufacturers determine compliance with the fleet average greenhouse gas standard by combining the individual vehicle's GHG emissions useful life values and comparing this result to the manufacturers fleet average standard. The preamble to the 2010 rule clearly explained that the CAA requires a vehicle to comply with emission standards over its regulatory useful life and affords EPA broad authority for the implementation of this requirement and that EPA has authority to require a manufacturer to remedy any noncompliance issues. EPA also explained that there may be cases where a repairable defect could cause the non-compliance and in those cases a recall could be the appropriate remedy. Alternatively, there may be scenarios in which a GHG non-compliance exists with no repairable cause of the exceedance. Therefore, the remedy can range from adjusting a manufacturer's credit balance to the voluntary or mandatory recall of noncompliant vehicles.

In the 2010 rule, EPA clearly intended to use its existing recall authority to remedy greenhouse gas non-compliances through traditional recalls when appropriate and to use the authority to correct the greenhouse gas credit balance as a remedy when no practical repair for in-use vehicles could be identified. See 75 FR 25474. However, the regulations did not describe these in-use compliance provisions with as much clarity as the preambular statements. Therefore, as proposed, EPA is finalizing clarifications to 40 CFR 86.1865–12(j) to make clear that EPA may use its existing recall authority to remedy greenhouse gas non-compliances when appropriate and specifically may use such authority to correct a manufacturer's greenhouse gas credit balance as a remedy when no practical repair can be identified.

The Alliance for Automotive Innovation commented that they believe such an approach is sensible. However, they stated that EPA does not have authority under section 207 of the CAA to require it. EPA disagrees; section 207 of the CAA clearly gives EPA the authority to require recall of non-compliant vehicles, but does not specify a precise form for such a recall. EPA responds to this comment in full in the Response to Comments.

In the 2010 rule, EPA set vehicle in-use emissions standards for carbon-related exhaust emission (CREE) to be 10 percent above the vehicle-level emission test results or model-type value if no subconfiguration test data are available. This 10 percent factor was intended to account for test-to-test variability or production variability within a subconfiguration or model type. EPA clearly did not intend for this factor to be used as an allowance for manufacturers to design and produce vehicles that generate CO_2 emissions up to 10 percent higher than the actual values they use to certify and to calculate the year end fleet average. In fact, EPA expressed concerns in the rulemaking that ''this in-use compliance factor could be perceived as providing manufacturers with the ability to design their fleets to generate CO_2 emissions up to 10 percent higher than the actual values they use to certify.'' See 75 FR 25476.

For the reasons that EPA articulated in the 2010 rulemaking, EPA expects that some in-use vehicles may generate slightly more CO_2 than the certified values and some vehicles may emit slightly less, but the average CO_2 emissions of a manufacturer's fleet and each model within it should be very close to the levels reported to EPA and used to calculate overall fleet average. The in-use data submitted over the last ten years largely supports this expectation. Nevertheless, EPA believes it is important that manufacturers understand their obligations under the in-use program and that EPA has the appropriate tools to hold manufacturers responsible should they fail to meet these obligations. EPA proposed two regulatory options, either of which would align with our original intent in the 2010 rule.

The first option was to clarify the regulatory language to make it clear that if a manufacturer's in-use data demonstrates that a manufacturer's CO_2 results are consistently higher than the values used for calculation of the fleet average for any class or category of vehicle, EPA may use its authority to correct a manufacturer's greenhouse gas credit balance to ensure the manufacturer's GHG fleet average is representative of the actual vehicles it produces. This means that the credit balance post-correction will reflect the actual in-use performance of the vehicles. In other words, if the manufacturer reports a value of X g/mile in calculating its fleet average, but its vehicles emit X+A g/mile in-use, we may correct the manufacturer's balance by the entire discrepancy (A).

The second option was to set the in-use standards at the vehicle-level emission test results or model-type average value if no subconfiguration test data are available in the GHG report. Under this approach, manufacturers will have the option to voluntarily raise the GHG values submitted in the GHG report if they wish to create an in-use compliance margin. The proposed change in this second option would make the GHG ABT program consistent with all other ABT programs used in the light-duty program. In all other ABT programs (*e.g.,* FTP NMOG+NO_X, MSAT, SFTP), manufacturers must choose a bin level or Family Emissions Limit (FEL) in which to certify. Manufacturers typically design their vehicle to emit well below the bin level or FEL to establish a compliance margin; however, the fleet average emissions are calculated based on the bin level or FEL, not the actual certification level. In those cases, the fleet average emissions calculated in the ABT report would be representative of the actual fleet as long as the vehicles comply with the certified bin level or FEL. Only the light-duty GHG ABT program allowed manufacturers to calculate the fleet average emissions based on the certification level. EPA allowed this with the expectation that vehicles in actual use would not normally emit more CO_2 than they did at the time of certification (*i.e.,* CO_2 emissions are not expected to increase with time or mileage).

The Alliance for Automotive Innovation commented that they opposed the second option, stating that even with perfect in-use performance, they would expect 50 percent of vehicles to exceed the original certification test simply due to test-to-test variation. They acknowledged that most test groups would avoid IUCP given the threshold of 10 percent exceedance for 50 percent of the tested vehicles. They commented that, it is not productive to have 50 percent of all initial tests be identified as failures.

Kia commented that keeping the 10-percent in-use standard is critical as EPA increases the stringency of criteria pollutants and GHG emissions 10-fold. The Alliance for Automotive Innovation commented that they support the first of the two options that maintains the 10 percent allowance.

BMW NA commented that they understand and support EPA in its proposal to align with the intent of the 2010 light-duty GHG rule and are in favor of the ''Option 1.'' However, they requested that EPA updates the proposal to clarify what is meant by ''consistently higher'' results with respect to GHG balance correction.

EPA is finalizing language in 40 CFR 86.1865–12 to make it clear that if a manufacturer's in-use data demonstrates a substantial number of vehicles fail to comply with the in-use GHG standards for any class or category of vehicle, EPA may use its recall authority to remedy a GHG noncompliance. In some cases, this remedy could be a repair of the affected vehicles, and in other cases it could be an adjustment to the GHG credit balance. In either case, the remedy must be adequate to ensure the manufacturer's GHG fleet average is representative of the actual vehicles it produced. This means that, in the case of a credit adjustment, the credit balance post-correction will reflect the actual in-use performance of the vehicles. In other words, if the manufacturer reports a value of X g/mile in calculating its fleet average, but its vehicles emit X+A g/mile in-use, the manufacturer's balance must be adjusted by the entire discrepancy (A). In the case of a repair to the affected vehicles, the remedy would also need to be sufficient such that the repaired vehicles emit the same X g/mile.

The overarching principle of compliance to the fleet average standards is that the calculated fleet average in the GHG report must accurately represent the actual fleet of vehicles a manufacture produced. If a manufacturer knowingly provides false or inaccurate data as part of their GHG report, the manufacturer may be subject to enforcement and EPA may void ab initio the certificates of conformity which relied on that data. Vehicles are covered by a certificate of conformity only if they are in all material respects as described in the manufacturer's application for certification (Part I and Part II) including the GHG report. If vehicles generate substantially more CO_2 emissions in actual use than what was reported, those vehicles are not covered by the certificate of conformity. EPA is finalizing a change to the regulatory language that is designed to clarify the Agency's understanding of its authority to find that vehicles were sold in violation of a condition of a certificate. EPA is finalizing edits to 40 CFR 86.1848–10 to make it clearer that any vehicles sold that fail to meet any condition upon which the certificate was issued are not covered by the certificate and thus were sold in violation of CAA 203(a)(1). EPA did receive adverse comments to this change which are addressed in the RTC document.

EPA also proposed changes to 40 CFR 86.1850–01 to allow the Agency to void ab initio a previously issued certificate of conformity in the list of possible actions the agency may take if a manufacturer commits any of the infractions listed in 40 CFR 86.1850–01(b), namely: if a manufacturer submits false or incomplete information, renders inaccurate any test data which it submits, or fails to make a good engineering judgment. Specifically, EPA proposed removing the word ''knowingly'' from 40 CFR 86.1850–01(d). The Alliance for Automotive Innovation commented that EPA failed to set forth a plausible rationale for the proposed changes. Without taking a position on the substance of the comment, EPA has decided not to finalize the changes to 40 CFR 86.1850–01 as proposed.

ii. In-Use Confirmatory Program (IUCP)

EPA's existing regulations require manufacturers to conduct in-use testing as a condition of certification. Specifically, manufacturers must commit to later procure and test privately-owned vehicles that have been normally used and maintained. The vehicles are tested to determine the in-use levels of criteria pollutants when they are in their first and fourth years of service. This testing is referred to as the In-Use Verification Program (IUVP) testing, which was first implemented as part of EPA's Compliance Assurance Program (CAP) 2000 certification program.[708]

Another component of the CAP 2000 certification program is the In-Use Confirmatory Program (IUCP). This is a manufacturer-conducted in-use test program that can be used as the basis for EPA to order an emission recall (although it is not the only potential basis for recall). For vehicles tested in the IUVP to qualify for IUCP, there is a threshold of 1.30 times the certification emission standard for criteria emissions (*e.g.,* NMOG+NO_X, CO) and an additional requirement that at least 50 percent of the test vehicles for the test group fail for the same substance. If these criteria are met for a test group, the manufacturer is required to test an additional 10 vehicles which are screened for proper use and maintenance.

Since measuring PM below 0.5 mg/mile may require measurement procedure adjustments in some laboratories, EPA is providing a temporary increase in the criteria that trigger an IUCP (in-use confirmatory testing program). The temporary criteria only apply to test groups certifying to the Tier 4 PM standard (0.5 mg/mi) and only extends through 2030 for LDV, LDT, MDPV, and through 2031 for MDV. The temporary criteria consist of a mean test group PM equal to or greater than 1.30 times the standard and the failure rate among vehicles in that test group of 80 percent or higher. The criteria revert to 1.30 times the standard and a failure rate among vehicles in that test group of 50 percent or higher starting in 2031 for LDV, LDT, MDPV, and starting in 2032 for MDV.

The 2010 light-duty GHG rule set full useful life greenhouse gas emissions standards for which each vehicle is required to comply and required in-use testing under the In-Use Verification Program (IUVP) testing provisions.[709] At that time, EPA did not set criteria for In-Use Confirmatory Program (IUCP) for GHG but indicated that IUCP will be a valuable future tool for achieving compliance and that EPA would reassess IUCP thresholds for GHG in a future rule when more data is available.

Since the 2010 light-duty GHG rule, EPA has received in-use greenhouse gas emissions test results from over 9,500 vehicles. EPA believes there is now sufficient data to establish IUCP threshold criteria based on greenhouse gas emissions and that doing so is warranted.

The 2010 light-duty GHG rule established an in-use CO_2 standard to be

[708] 64 FR 23906, May 4, 1999.

[709] 75 FR 25475, May 7, 2010.

10 percent above the vehicle-level emission test results or model-type value if no subconfiguration test data are available. As discussed above, EPA proposed two options for the in-use standard. The first would retain the in-use standard including the 10 percent margin established in the 2010 light-duty GHG rule and the second would eliminate the 10 percent margin from the in-use standard and apply it instead to the IUCP criteria. As discussed above, EPA is finalizing the first option and retaining the 10 percent margin in the in-use standard. Therefore, EPA is finalizing the threshold criteria to trigger IUCP when at least 50 percent of the test vehicles for a test group exceed the relevant in-use CO_2 standard.

The Alliance for Automotive Innovation commented that EPA did not adequately justify the decision to exclude a threshold such as the 1.3 factor used for criteria pollutants in combination with the 50 percent trigger for IUCP testing. EPA disagrees with the comment. In the proposal, EPA explained that EPA did not propose a threshold for the average emissions of the test group (which is 1.3 times for criteria emissions) for a number of reasons. First, unlike criteria pollutants where the in-use standards are generally the same as the certification standards, EPA setting a margin of 10 percent above the reported GHG result for the in-use standard. Adding an additional multiplier on top of that would be unnecessary, and EPA believes a 10 percent exceedance threshold (either as a part of the in-use standard or as a threshold criteria) is appropriate given the Agency's experience with GHG compliance over the past decade. Second, unlike for criteria pollutants, the CO_2 emissions performance of vehicles is generally not expected to deteriorate with age and mileage (see the 2010 light-duty GHG rule). Third, unlike with criteria pollutants, the in-use GHG standards are not consistent within a test group and the compliance level is not determined by the same emissions data vehicle. GHG in-use standards can be different for each subconfiguration or model type. Fourth, the review of the data supports 10 percent above the reported GHG value as an appropriate criterion, because over 95 percent of the test results EPA received complied with this in-use standard based on the 10 percent margin. The final IUCP criteria is intended to capture vehicles with both unusually high increases in CO_2 emissions compared to the reported value and an unusually high failure rate.

Therefore, consistent with our proposal, EPA is not establishing additional criteria based on the average emissions of the test group.

iii. Part 2 Application Changes

As proposed, EPA is finalizing changes to 40 CFR 86.1844–01(e) ''Part 2 Application'' to make it clearer that the Part 2 application must include the part numbers and descriptions of the GHG emissions related parts, components, systems, software or elements of design, and Auxiliary Emission Control Devices (AECDs) including those used to qualify for GHG credits (*e.g.,* air conditioning credits, off cycle credits, advanced technology vehicle credits) as previously specified in EPA guidance letter CD–14–19. These changes are not intended to alter the existing reporting requirements, but rather to clarify the existing requirement.

Also as proposed, EPA is finalizing changes to 40 CFR 85.2110 and 40 CFR 86.1844–01(e) ''Part 2 Application'' to no longer accept paper copies of service manuals, Technical Service Bulletins (TSB), owner's manuals, or warranty booklets. In response to the National Archives and Records Administration (NARA) mandate and OMB's Memorandum for Heads of Executive Departments and Agencies, M–19–21, Transition to Electronic Records, EPA will no longer accept paper copies of these documents.

iv. Fuel Economy and In-Use Verification Test Procedure Streamlining

The ''Federal Test Procedure'' (FTP) defines the process for measuring vehicle exhaust emissions, evaporative emissions, and fuel economy and is outlined in 40 CFR 1066.801(e). The process includes preconditioning steps to ensure the repeatability of the test results, as described in 40 CFR 86.132–96. EPA is finalizing two changes, consistent with our proposal, to the preconditioning process used for testing of only fuel economy data vehicles (FEDVs) (not emission data vehicles) in order reduce the testing burden while maintaining the repeatability and improving the accuracy of the test results.[710] The changes are related to the fuel drain and refueling step and the preconditioning of the evaporative canister. EPA is also removing one fuel drain and refueling step for in-use surveillance vehicles. In addition, we are finalizing our proposed changes to the fuel cap placement during vehicle storage for all emission data and fuel economy vehicles.

Currently, all Fuel Economy Data Vehicles (FEDVs) must follow the regulations for preconditioning before conducting the cold-start portion of the test. Included in this preconditioning is the requirement to drain and refuel the fuel tank twice. We are finalizing our proposal to remove the second fuel drain step, which occurs after running the Urban Dynamometer Driving Schedule (UDDS) preconditioning cycle, but before the cold start test. The fuel drain and refuel step was originally included in the test procedure because fresh fuel was important for carbureted engines and could impact the test results. However, with today's fuel injection systems, EPA's assessment is that the refueling of the vehicle with fresh fuel does not impact the measured fuel economy of the vehicle.[711] Removing this step will save a significant amount of fuel for each test run by the manufacturer or by EPA and reduce the number of voided tests due to mis-fueling and fueling time violations. It will also reduce the labor associated with refueling the vehicle for each test. EPA is also removing this step for in-use vehicle testing on vehicles tested under 40 CFR 86.1845–04 (verification testing). It is difficult to drain fuel from an in-use vehicle because they normally do not have fuel drains. Removing this step will save time and fuel from the in-use verification process as well. EPA will still require this step for in-use confirmatory vehicles tested under 40 CFR 86.1846–01.

EPA is also finalizing its proposal to remove the canister loading and purging steps from the preconditioning for FEDVs. This will provide the following benefits to manufacturers and EPA: the time to run the test will be reduced, less butane will be consumed by the laboratories which reduces the cost of running a test, and the fuel economy measurement accuracy will improve. EPA conservatively estimates that at least 88 kg of butane was consumed by manufacturers in the 2021 calendar year for the purposes of fuel economy testing, based on 909 fuel economy test submissions to EPA and assuming 97 grams of butane per canister. The measurement accuracy will improve because the calculations for fuel economy assume that 100 percent of the fuel consumed during the testing has the carbon balance of the liquid fuel in the tank. The butane vapor that is added

[710] See proposed regulations in 40 CFR 86.132–96 and 1066.801(e).

[711] Memo to Docket. ''EPA FTP Streamlining Test Results.'' See Docket EPA–HQ–OAR–2022–0829. March 2023.

to the canister during preconditioning has a different carbon content, and thus causes very small inaccuracies in the fuel economy results. EPA's test program also shows that the canister loading does not have any statistically significant effect on the fuel economy results from the cold start and highway fuel economy tests.[712]

Finally, the regulations at 40 CFR 86.132–96(a) currently state that fuel caps must be removed during any period when the vehicle is parked outside awaiting testing but fuel caps may be in place while in the test area. As proposed, EPA is amending the regulations to simply require that vehicles be stored in a way that prevents fuel contamination and preserves the integrity of the fuel system. At this time EPA considers the possibility of contaminants getting into the fuel system while the fuel cap is off to be more significant than any possible canister loading. Modern vehicles purge the canister sufficiently during the preconditioning cycles to ensure that tests completed on vehicles that have been parked will not significantly affect test results. Custodians of test vehicles should avoid parking test vehicles outdoors during hot conditions.

EPA did not receive any adverse comments related to the proposed test streamlining described in this section. Ingevity commented that the streamlining steps seem acceptable as long as the full test procedure specified in 40 CFR part 86, subpart B, remains primary for EPA testing. The Agency notes that the appropriate test procedure steps will be followed when testing vehicles to determine compliance with the evaporative emission standards.

v. Miscellaneous Amendments

We are clarifying the pre-certification exemption in 40 CFR 85.1706 by amending the definition of ''pre-certification vehicle'' in 40 CFR 85.1702. The amended regulation limits the exemption to companies that already hold a certificate showing that they meet EPA emission standards. This has been a longstanding practice for highway and nonroad engines and vehicles. Companies that are not certificate holders may continue to request a testing exemption under 40 CFR 85.1705.

Also as proposed, we are updating the test procedures in 40 CFR 86.113–15 to reference test fuel specifications in 40 CFR part 1065 for diesel fuel, natural gas, and LPG. We do not expect this change to cause manufacturers to change the test fuels they use for certification, or to prevent any manufacturer from using carryover data to continue certifying vehicles in later model years. In the case of diesel fuel, the two sets of specifications are very similar except that 40 CFR 1065.703 takes a different approach for aromatic content of the fuel by specifying a minimum aromatic content of 100 g/kg. We expect current diesel test fuels to meet this specification. In the case of natural gas, 40 CFR 1065.715 decreases the minimum methane content from 89 to 87 percent, with corresponding adjustments in allowable levels of nonmethane compounds. In this case too, manufacturers will be able to continue meeting test fuel specifications without changing their current practice. In the case of LPG, 40 CFR 86.113–94 directs manufacturers to ask EPA to approve a test fuel. The final rule specifies, as proposed, that the fuel specifications already published in 40 CFR 1065.720 are appropriate for testing vehicles certified und 40 CFR part 86, subpart S.

The regulation currently requires manufacturers to include information in the application for certification for fuel-fired heaters (40 CFR 86.1844–01(d)(15)). The regulation also requires manufacturers to account for fuel-fired heater emissions in credit calculations for Tier 2 vehicles (40 CFR 86.1860–04(f)(4)). The Tier 3 regulation inadvertently omitted the requirement related to credit calculations in 40 CFR 86.1860–17. As proposed, we are restoring the requirement to account for emissions from fuel-fired heaters in credit calculations in 40 CFR 86.1844–01(d)(15).

This rule includes several structural changes that lead to a need to make the following changes to the regulations for correct terminology and appropriate organization:

- We are replacing cold temperature NMHC standards with cold temperature $NMOG+NO_X$ standards, and we are adding a cold temperature PM standard. The rule includes updates to refer to cold temperature standards generally, or to cold temperature $NMOG+NO_X$ standards instead of, or in addition to, cold temperature NMHC standards. The regulation also now includes references to cold temperature testing as ''−7 °C testing''. 40 CFR 86.1864–10 is similarly adjusted to refer to cold temperature fleet average standards and cold temperature emission credits instead of referencing NMHC credits.
- We are setting separate emission standards for US06 and SC03 driving schedules rather than setting standards based on a composite calculation for the driving schedules that make up the Supplemental FTP. As a result, we are generally adjusting terminology for Tier 4 vehicles to refer to the specific cycles rather than the Supplemental FTP.
- The existing regulation includes several references to Tier 3 standards (or Tier 3 emission credits, etc.). Those references were generally written to say when regulatory provisions started to apply. Some of those provisions need to continue into Tier 4, but not all. The final rule includes new language in several places to clarify whether or how those provisions apply for Tier 4 vehicles.
- The Tier 4 standards apply nearly uniformly for both light-duty and medium-duty vehicles. This contrasts with earlier standards where many requirements and compliance provisions applied differently for light-duty and medium-duty vehicles. For Tier 3, that led us to adopt the light-duty standards in 40 CFR 86.1811–17 and the medium-duty standards in 40 CFR 86.1816–18. As a result, because of the extensive commonality for Tier 4 standards, we are finalizing the new criteria exhaust emission standards for all these vehicles in 40 CFR 86.1811–27 rather than continuing to rely on 40 CFR 86.1816 for medium-duty vehicles.

The rule includes several instances of removing regulatory text that has been obsolete for several years. Removing obsolete text is important to prevent people from making errors from thinking that obsolete text continues to apply. The final rule includes additional housekeeping amendments to remove obsolete text and to remove or update cross references to obsolete or removed regulatory text.

The proposed rule identified labeling information that included obsolete content for incomplete vehicles. We proposed to remove 40 CFR 86.1807–01(d), but are instead amending that paragraph for the final rule to preserve the labeling information, but exclude the references to obsolete regulatory provisions.

One case of obsolete text is related to special test procedures as specified in 40 CFR 86.1840–01. Vehicle manufacturers have completed a transition to following the exhaust test procedures specified in 40 CFR part 1066, such that those new test procedures apply instead of the test procedures in 40 CFR part 86, subpart B, starting with model year 2022. Since we address special test procedures in 40 CFR 1066.10(c), which in turn relies on 40 CFR 1065.10(c)(2), we no longer need to rely on 40 CFR 86.1840–01 for special test procedures. We note the following aspects of the transition for special test

[712] Ibid.

procedures, which we are finalizing as proposed:

- We are applying the provisions for special procedures equally to all vehicles certified under 40 CFR part 86, subpart S. The special test procedures were written in a way that did not apply for incomplete vehicles certified under 40 CFR part 86, subpart S. This is very likely an artifact of the changing scope of the regulation since 2001.
- We are keeping the reference to infrequently regenerating aftertreatment devices in 40 CFR 86.1840–01 as an example of special test procedures to clarify that we are not changing the way manufacturers demonstrate compliance for vehicles with infrequently regenerating aftertreatment devices. Specifically, we are not adopting the measurement and reporting requirements that apply for heavy-duty engines under 40 CFR 1065.680.
- We are applying the provisions related to infrequently regenerating aftertreatment devices equally to all vehicles certified under 40 CFR part 86, subpart S. The provisions in 40 CFR 86.1840–01 were written in a way that they did not apply for medium-duty passenger vehicles. This is very likely an artifact of the changing scope of the regulation since 2001.

We are finalizing the following additional amendments, as proposed:

- Section 85.1510(d): Waiving the requirement for Independent Commercial Importers (ICI) to apply fuel economy labels to electric vehicles. Performing the necessary measurements to determine label values would generally require accessing high-voltage portions of the vehicle's electrical system. Manufacturers can appropriately and safely make these measurements as part of product development and testing. These measurements can pose an unreasonable safety risk when making these measurements on production vehicles. The benefit of labeling information for these vehicles is not enough to outweigh the safety risks of generating that information.
- Section 86.1816–18: The published final rule to adopt the Tier 3 exhaust emission standards for Class 2b and Class 3 vehicles inadvertently increased the numerical value of those standards a trillion-fold by identifying the units as Tg/mile. We are reverting to g/mile as we intended by adopting the Tier 3 standards.

This rule includes expanded provisions for in-use testing under 40 CFR 86.1845–04 as described in sections III.D.5.iii. and III.G.2.i of this preamble. In addition to those new testing requirements, we are taking the opportunity for this final rule to clarify that the provisions allowing manufacturers to request approval to test fewer vehicles also includes an alternative of testing the required number of vehicles by waiving the detailed specifications for test vehicles. For example, if manufacturers are unable to procure the required number of test vehicles meeting specifications for mileage, geographic distribution, and altitude, they may ask for EPA approval to substitute test vehicles that fall short of meeting all those specifications. As always, EPA approval would depend on manufacturers taking all reasonable steps to meet those requirements. We are also allowing for EPA to approve extended deadlines for completing testing to recognize that practical limitations sometimes prevent manufacturers from finishing a test program within the specified time frame.

In reviewing material for the final rule, we realized that the proposed rule did not describe clearly enough how ICIs would need to manage per-vehicle compliance to certify vehicles relative to emission standards that allow or require manufacturers to comply with an averaging standard using emission credits. We are making the following amendments to 40 CFR 85.1515 in the final rule, largely to apply provisions that are consistent with certification practices for manufacturers where appropriate, and that are consistent with the practice of implementing standards for ICIs in recent years:

- The Tier 4 standards apply for ICIs starting in 2032, which is the first model year that small-volume manufacturers must comply with all the Tier 4 standards for light-duty vehicles. ICIs continue to be subject to Tier 3 standards through 2031.
- For both Tier 3 and Tier 4, we are clarifying that each imported vehicle is subject to the fleet average standard where manufacturers are allowed or required to demonstrate compliance based on emission credits. This applies for $NMOG+NO_X$ standards for 25 °C testing, $NMOG+NO_X$ standards for –7 °C testing, and for evaporative emissions.
- For both Tier 3 and Tier 4, we are clarifying that ICIs may purchase emission credits to certify vehicles with emissions higher than the specified standards for any of the averaging-based standards. ICIs would need to purchase credits to enable importation of each vehicle individually. Aside from applying emission credits to those individual vehicles, ICIs would not be allowed to average, bank, or trade emission credits. Using this per-vehicle approach, ICIs would have no need to maintain an account with a balance of credits, and would never be in a situation where deficit credit provisions would apply.
- Where manufacturers certify using emission credits, we specify that the highest allowable emission level is the highest available $NMOG+NO_X$ bin or the evaporative emissions FEL cap.
- We are further clarifying that ICIs may not participate in the averaging, banking, and trading program for GHG emission credits.
- We are removing references to ''motor vehicle engines'' in some places since the ICI provisions no longer apply for heavy-duty engines.
- We are adding OBD to the list of standards and requirements for ICIs to certify vehicles. This is consistent with longstanding guidance.[713]

5. Light- and Medium-Duty Emissions Warranty for Certain ICE Components

As proposed, EPA is designating several emission control components of light-duty ICE vehicles as specified major emission control components. These include components of the diesel Selective Reductant Catalysts (SRC) system, components of the diesel Exhaust Gas Recirculation (EGR) system, and diesel and gasoline particulate filters (DPFs and GPFs). As the result of this designation, these components have the same warranty requirements as other components that have been established as specified major emission control components.

As described in section III.G.3 of the preamble, CAA section 207(i) specifies that the warranty period for light-duty vehicles is 2 years or 24,000 miles of use (whichever first occurs), except the warranty period for specified major emission control components is 8 years or 80,000 miles of use (whichever first occurs). The Act defines the term ''specified major emission control component'' to mean only a catalytic converter, an electronic emissions control unit, and an onboard emissions diagnostic device, except that the Administrator may designate any other pollution control device or component as a specified major emission control component if—

(A) the device or component was not in general use on vehicles and engines manufactured prior to the model year 1990; and

(B) the Administrator determines that the retail cost (exclusive of installation costs) of such device or component exceeds $200 (in 1989 dollars),[714]

[713] ''Guidance for Certification, Fuel Economy and Final Entry of ICI Vehicles'', CCD–03–11 (ICI), November 25, 2003.

[714] Equivalent to approximately $500 today.

adjusted for inflation or deflation as calculated by the Administrator at the time of such determination.

EPA believes that GPFs meet the requirements set forth in CAA section 207(i) and should be designated as specified major emission control components. GPFs were not in general use prior to model year 1990 and their cost exceeds the threshold specified in the CAA. EPA anticipates that manufacturers will choose to comply with the PM standards in this rule through application of a GPF for certain vehicles. In the event of a GPF failure, PM emissions will most likely exceed the standards. It is imperative that a properly functioning GPF be installed on a vehicle in order to achieve the environmental benefits projected by this rulemaking.

In order to meet the current emissions standards, diesel vehicles utilize Selective Reductant Catalysts (SRC) as the primary catalytic converter for NO_X emissions controls and well as a Diesel Oxidation Catalyst (DOC) as the primary catalytic converter for CO and hydrocarbons and a Diesel Particulate Filter (DPF) as the primary catalytic converter to control particulate matter (PM). In the event that any one of these components fail, EPA anticipates that the relevant standard will be exceeded. The proper functioning of each of these components is necessary for the relevant emissions benefits to be achieved.

More specifically, the SCR catalytic converter relies on a system of components needed to inject a liquid reductant called Diesel Exhaust Fluid (DEF) into the catalytic converter. This system includes pumps, injectors, NO_X sensors, DEF level and quality sensors, storage tanks, DEF heaters and other components that all must function properly for the catalytic converter to work. These components meet the criteria for designation as specified major emission control components.

Vehicles with diesel engines do not rely solely on aftertreatment to control emissions. Diesel engines utilize Exhaust Gas Recirculation (EGR) to control engine out emissions as a critical element of the emissions control system. Components of the EGR system such as electronic EGR valves and EGR coolers meet the criteria for designation as specified major emission control components.

The emission-related warranty period for heavy-duty engines and vehicles under CAA section 207(i) is ''the period established by the Administrator by regulation (promulgated prior to November 15, 1990) for such purposes unless the Administrator subsequently modifies such regulation.'' The regulations specify that the warranty period for light heavy-duty vehicles under 40 CFR 1037.120 is 5 years or 50,000 miles of use (whichever first occurs). EPA is clarifying, as proposed, that this same warranty period applies for medium-duty vehicles certified under 40 CFR part 86, subpart S, except that a longer warranty period of 8 years or 80,000 miles applies for engine-related components described in this section as specified major emission control components.

The warranty provisions in CAA section 207(i)(2) do not explicitly apply to medium-duty passenger vehicles. However, as with the new standards in this rule, we are applying, as proposed, warranty requirements to medium-duty passenger vehicles in the same way that they apply to light-duty vehicles. We did not receive substantive comments regarding the proposed changes and clarifications for warranty provisions described in this section.

6. Definition of Light-Duty Truck

EPA has had separate regulatory definitions for light truck for GHG standards and light-duty truck for criteria pollutant standards. The ''light truck'' definition used for determining compliance with the light-duty GHG emission standards (40 CFR 600.002) matches the definition that NHTSA uses in determining compliance with their fuel economy standards (49 CFR 523.5). This definition contains specific vehicle design characteristics that must be met to qualify a vehicle as a truck. The broader ''light-duty truck'' definition used for certifying vehicles to the criteria pollutant standards (40 CFR 86.1803–01) has allowed for some SUVs to qualify as trucks even if the specific vehicle does not contain the truck-like design attributes. The definition also includes some ambiguity that requires the manufacturers and EPA to apply judgment to determine the appropriate classification.

Historically this was not an issue because the car versus truck distinction was clear. Nearly all vehicles were passenger cars or pickup trucks with open cargo beds. The earliest sport utility vehicles (SUVs) were primarily derived from pickup truck platforms and were therefore considered light trucks. However, current versions of some of these SUVs now have car-based platforms with car-like features. Current differences between the two light-truck definitions leads to some SUVs being certified to GHG standards as a truck and to criteria pollutant standards as a car. To address this concern, as proposed, we are transitioning to a single definition of light-duty truck with the implementation of the Tier 4 criteria pollutant emission standards starting in model year 2027.

We are revising the definition of light-duty truck used in the criteria pollutant standards to match the definition of light-truck used in the GHG standards. This change will eliminate any confusion and simplify reporting for manufacturers because each vehicle will be treated consistently as either a car or a truck for all standards and reporting requirements.

Commenters pointed out that the revised definition would cause some vehicle models to become subject to the more stringent evaporative emission standards that apply for light-duty vehicles. We did not intend for the revised definition to cause a change in evaporative emission standards. At the same time, we are aware that the less stringent standards for light-duty trucks were originally intended to reflect differences in fuel tank volumes and other vehicle characteristics related to controlling evaporative emissions. It is apparent that vehicles affected by the changing definition of ''light-duty truck'' are not differentiated from light-duty vehicles based on such vehicle parameters related to evaporative emission control. From that perspective, the revised definition is likely to have the effect of accomplishing the original intent of applying standards corresponding to vehicles with expected evaporative-related characteristics for light-duty vehicles.

To address the concern expressed in the comments, we are therefore adding a provision for the final rule to allow manufacturers to continue to meet the standard for light-duty trucks even if their vehicles are recategorized as light-duty vehicles based on the change in the definition, provided that those vehicle models continue to qualify for carryover certification. With this approach, manufacturers would do new testing to meet the more stringent standard only if they already need to do new testing to certify to the evaporative emission standards. To avoid extending this provision indefinitely, we are including a requirement for manufacturers to meet the more stringent evaporative emission standards for such vehicles starting in model year 2032, even if they would otherwise qualify for carryover certification. Meeting the more stringent standards will likely involve modestly increasing canister volume and upgrading various design features and parameters in line with the technology solutions used for other light-duty vehicles. The several years of lead time will allow manufacturers to plan for making those changes.

H. On-Board Diagnostics Program Updates

EPA regulations state that onboard diagnostics (OBD) systems must generally detect malfunctions in the emission control system, store trouble codes corresponding to detected malfunctions, and alert operators appropriately. EPA adopted at 40 CFR 86.1806–17 a requirement for manufacturers to meet the 2013 California Air Resources Board (CARB) OBD regulation as a requirement for an EPA certificate, with certain additional provisions, clarifications and exceptions, in the Tier 3 Motor Vehicle Emission and Fuel Standards final rulemaking (79 FR 23414, April 28, 2014). Since that time, CARB has made several updates to their OBD regulations and continues to consider changes periodically. In this rule, EPA is updating to the latest version of the CARB OBD regulation (California's 2022 OBD–II requirements that are part of title 13, section 1968.2 of the California Code of Regulations, approved on November 30, 2022). This is accomplished by adding a new 40 CFR 86.1806–27 for model year 2027 and later vehicles. EPA had proposed adding a new monitoring requirement for gasoline particulate filters (GPFs) because the CARB regulation didn't include a specific requirement for them. In follow-up meetings, manufacturers explained they had already certified GPF diagnostics, and comments on the proposed rule recommended relying on CARB regulation as being sufficient for proper diagnostics to be created. Commenters also suggested that adding a separate requirement from EPA would be confusing. EPA has therefore decided to not finalize the proposed GPF monitoring requirements and instead rely on the GPF-related requirements already included in the CARB regulation.

See RTC section 5 for a more detailed discussion of comments related to OBD.

I. Coordination With Federal and State Partners

Executive Order 14037 directs EPA and the Department of Transportation (DOT) to coordinate, as appropriate and consistent with applicable law, during consideration of this rulemaking. EPA has coordinated and consulted with DOT/National Highway Traffic Safety Administration (NHTSA), both on a bilateral level during the development of this rule as well as through the interagency review of the EPA rule led by the Office of Management and Budget. EPA has set some previous light-duty vehicle GHG emission standards in joint rulemakings where NHTSA also established CAFE standards. Most recently, in establishing standards for model year 2023–2026, EPA and NHTSA concluded that it was appropriate to coordinate and consult but not to engage in joint rulemaking. EPA has similarly concluded that it is not necessary for this EPA rule to be issued in a joint action with NHTSA. In reaching this conclusion, EPA notes there is no statutory requirement for joint rulemaking and that the agencies have different statutory mandates and their respective programs have always reflected those differences. As the Supreme Court has noted ''EPA has been charged with protecting the public's 'health' and 'welfare,' a statutory obligation wholly independent of DOT's mandate to promote energy efficiency.'' [715] Although there is no statutory requirement for EPA to consult with NHTSA, EPA has consulted significantly with NHTSA in the development of this rule. For example, staff of the two agencies met frequently to discuss various technical issues including modeling inputs and assumptions, shared technical information, and shared views related to the assessments conducted for each rule. Further technical collaboration between EPA and NHTSA, along with the Department of Energy and National Laboratories, on a wide range to technical topics, is further described below.

EPA also has consulted with analysts from other Federal agencies in developing this rule and the heavy-duty vehicles Phase 3 rulemaking, including the Federal Energy Regulatory Commission (FERC), the Joint Office for Energy and Transportation (which helps coordinate and leverage expertise between the U.S. Department of Energy and the U.S. Department of Transportation to further progress on zero-emission transportation infrastructure), the Department of State, the Department of Labor, the Department of Energy and several National Laboratories. EPA consulted with FERC on this rulemaking regarding potential impacts of these rulemakings on bulk power system reliability and related issues.[716] EPA consulted with the Department of Labor on issues related to employment impacts and worker training. We consulted with the Department of State on critical materials and supply chains. EPA collaborated together with NHTSA, DOE and several National Laboratories on a wide range of topics to support this rulemaking. EPA collaborated with DOE and Argonne National Laboratory on battery cost analyses and critical materials forecasting. EPA, National Renewable Energy Laboratory (NREL), and DOE collaborated on forecasting the development of a national charging infrastructure and projecting regional charging demand for input into EPA's power sector modeling. EPA also coordinated with the Joint Office of Energy and Transportation on charging infrastructure. EPA and the Lawrence Berkeley National Laboratory collaborated on issues of consumer acceptance of plug-in electric vehicles. EPA and the Oak Ridge National Laboratory collaborated on energy security issues. EPA also participated in the Federal Consortium for Advanced Batteries led by DOE and the Joint Office of Energy and Transportation. EPA and DOE also have entered into a Joint Memorandum of Understanding to provide a framework for interagency cooperation and consultation on electric sector resource adequacy and operational reliability.[717]

E.O. 14037 also directs EPA to coordinate with California and other states that are leading the way in reducing vehicle emissions. EPA has engaged with the California Air Resources Board on technical issues in developing this rule. EPA has considered certain aspects of the CARB Advanced Clean Cars II program, adopted in August 2022, as discussed elsewhere in this notice. We also have engaged with other states, including members of the National Association of Clean Air Agencies, Northeast States for Coordinated Air Use Management, and the Ozone Transport Commission. In addition, EPA received public comments from numerous states and state agencies, including the organizations noted above, various coalitions of state and local government Attorneys General, as well as several individual states and state/local environmental protection agencies. These comments and EPA's responses to them are found in the Response to Comments document.

J. Stakeholder Engagement

EPA has conducted extensive engagement with a diverse range of interested stakeholders in developing this rule. We have engaged with those

[715] *Massachusetts* v. *EPA,* 549 U.S. at 532.

[716] Although not a Federal agency, EPA also consulted with the North American Electric Reliability Corporation (NERC). NERC is the Electric Reliability Organization for North America, subject to oversight by FERC.

[717] Joint Memorandum on Interagency Communication and Consultation on Electric Reliability, U.S. Department of Energy and U.S. Environmental Protection Agency, March 8, 2023.

groups with whom E.O. 14037 specifically directs EPA to engage, including labor unions, states, industry, environmental justice organizations and public health experts. In addition, we have engaged with NGOs representing environmental, public health and consumer interests, automotive manufacturers, suppliers, dealers, utilities, charging providers, local governments, Tribal governments, alternative fuels industries, and other organizations.

IV. Technical Assessment of the Standards

A. What approach did EPA use in analyzing the standards?

1. Modeling Approach and Analytical Tools

EPA has conducted an updated technical assessment that extends and improves upon the analysis conducted for the proposal. Where applicable, we have incorporated the most recent and best available data, and revised and updated our inputs, assumptions, and methods in consideration of comments received during the public comment period. In addition to an analysis of the final standards, the updated analysis also includes an assessment of two alternatives that were considered, as well as a revised set of sensitivity cases.[718]

The overall approach used for this final rule is consistent with that of the proposal, as well as our prior rulemakings for GHG and criteria pollutants for light- and medium-duty vehicles. We continue to refer to the extensive body of prior technical work that has underpinned those rules, and incorporated updated tools, models and data, subjected to peer review where appropriate, in conducting this assessment, based on the best available information and the public record. EPA conducted peer review[719] in accordance with OMB's Final Information Quality Bulletin for Peer Review on six analyses supporting this final rule: (1) Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA 2.0), (2) Advanced Light-duty Powertrain and Hybrid Analysis (ALPHA3), (3) Motor Vehicle Emission Simulator (MOVES), (4) The Effects of New-Vehicle Price Changes on New- and Used-Vehicle Markets and Scrappage; (5) Literature Review on U.S. Consumer Acceptance of New Personally Owned Light-Duty Plug-in Electric Vehicles; (6) Cost and Technology Evaluation, Conventional Powertrain Vehicle Compared to an Electrified Powertrain Vehicle, Same Vehicle Class and OEM. Additional information on the peer reviews for these analyses is discussed later in this section as well as the RIA.

As in the proposal, some of the areas of particular focus are related to the significant developments in vehicle electrification that have continued to occur since the 2021 rule. Vehicle manufacturers have continued to introduce PEV products in increased volumes and new market segments, improving the ability to characterize the cost and performance of best-practice designs. Key legislation such as the IRA and the BIL continues to provide significant incentives for both the manufacture and purchase of PEVs, and for the expansion of charging infrastructure. Additionally, in light of public comments received, as well as the levels of electrification that continue to be anticipated under the final standards, EPA's new technical assessment contains additional discussion and updated assessments of battery costs, critical minerals, supply chain development, battery manufacturing capacity, impact of the IRA incentives, PEV charging infrastructure, and impacts on the electric grid.

Our modeling can be broadly divided into two categories. The first category is compliance modeling for the vehicle manufacturers, which includes the potential design and technology application decisions to achieve compliance under the modeled standard. The second category is effects modeling, which is intended to capture how changes in vehicle design and use will impact emissions, fuel consumption, public health and welfare, and other factors that are relevant to a societal benefits-costs analysis.

As in the proposal, EPA is using a significantly updated and peer-reviewed version of the Optimization Model for reducing Emissions of Greenhouse gases from Automobiles (OMEGA) to model vehicle manufacturer compliance with GHG standards. The updates include several provisions which the agency feels improve our overall fleet projection capabilities. In particular, the updated version of OMEGA extends the prior version's projections of cost-effective manufacturer compliance decisions by also accounting for the relationship between manufacturer compliance decisions and consumer demand and including important constraints on technology adoption. As discussed in the proposal, OMEGA is designed specifically around EPA's regulatory program under the Clean Air Act. In addition to modeling of the influence EPA's GHG standards, the updated OMEGA also allows for evaluation of other policies, such as state-level ZEV policies. These features make this updated version of OMEGA well-suited for analyzing standards in a market where PEVs may account for a steadily increasing share of new vehicle sales. EPA has utilized the OMEGA model in evaluating the effects of not only the GHG program but the criteria pollutant emissions program as well.

OMEGA takes as inputs detailed information about existing vehicles, technologies, costs, and definitions of the policies under consideration. From these inputs, the model projects the stock of vehicles and vehicle attributes, and their use over the analysis period. The updated version of the OMEGA model better accounts for the significant evolution over the past decade in vehicle markets, technologies, and mobility services. In particular, recent advancements in PEVs and their introduction into the full range of market segments provides strong evidence that increased vehicle electrification can play an important role in achieving greater levels of emissions reduction in the future. Among the key new features of OMEGA is the representation of consumer-producer interactions when modeling compliance pathways and the associated technology penetration into the vehicle fleet. This capability allows us to project the impacts of the producer and consumer incentives contained in the IRA and BIL legislation. It also allows us to model the rate of consumer acceptance of novel technologies.

EPA received a large number of public comments and recommendations for how to revise the NPRM's OMEGA modeling for this final rulemaking. The vast majority of comments were related to EPA's specific modeling inputs and assumptions and were not, for example, recommending a different modeling approach overall. A summary of updates made to our technical assessment since the NPRM is provided in section IV.A.2 of this preamble. One especially notable update for this final rule is the added capability for OMEGA to consider PHEVs as a compliance technology. OMEGA is described in detail in RIA Chapter 2.2.

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[718] EPA's modeling results are presented in multiple locations throughout the rulemaking documents for convenience and clarity. Although every effort has been made to ensure numerical values appear consistently throughout the preamble, RIA and RTC, to the extent there are any inconsistencies in discussion of modeling results, the results presented in the RIA tables and figures take precedence.

[719] The peer review reports for each analysis are in the docket for this action and at EPA's Science Inventory (*https://cfpub.epa.gov/si/*).

EPA also uses its ALPHA vehicle simulation model to estimate emissions, energy rates, and other relevant vehicle performance estimates. The ALPHA model is described in more detail in Chapter 2 of the RIA. ALPHA simulation results create the inputs to the OMEGA model for the range of technologies considered in this rulemaking. To support both the proposal and the final rule analyses, we built upon our existing library of benchmarked engines and transmissions used in previous rulemakings by adding several new technologies for ICE-based powertrains, and newly refined models of BEV powertrains. For the final rule analysis we added PHEVs to ALPHA, which include both charge-depleting and charge-sustaining models. We also adopted an updated approach for representing the ALPHA simulation results in OMEGA, using 'response surfaces' of emissions and energy rates. These continuous technology representations can be applied across vehicles of different size, weight, and performance characteristics without requiring that vehicles be binned into discrete vehicle classes. The response surface approach also simplifies the model validation process, since the absolute values of absolute emissions and energy rates that are produced can be readily checked against actual vehicle test data. This is in contrast to the validation process needed for the incremental effectiveness values that were estimated in previous rulemakings using either a 'lumped parameter model' or direct table lookup of effectiveness. The modeling in ALPHA and generation of response surfaces is described in RIA Chapter 2.4.

As in the proposal, the technology cost estimates used in this final rule assessment are from both new and previously referenced sources, including some values used in recent rulemakings where those remain the best available estimates. For this final rule assessment, EPA has incorporated findings from several ongoing research efforts that were previously described in the proposal.

We have updated many of our PEV non-battery and ICE technology costs based on a detailed study from FEV, a large engineering firm with considerable experience in the analysis of vehicle technologies which the agency has cited regularly in previous rulemakings. As EPA has historically considered vehicle teardown studies as an important source of detailed cost estimates, this new study included a teardown of two comparable ICE and BEV vehicles, and a review of ICE and PEV component costs from similar teardowns previously conducted by the same firm. The latter work in particular improved on our estimates of technology costs and how they should be scaled depending on engine size, vehicle type, electric motor power, etc.[720] We discuss this study in more detail and present our non-battery and ICE technology costs and scaling approaches in Chapter 2 of the RIA.

Battery costs are an important component of PEV costs. Consistent with prior rulemakings, our battery cost inputs are derived from costs modeled by Argonne National Laboratory's (ANL) BatPaC model. As also indicated in the proposal, and as requested by commenters, we updated our battery cost inputs, by working with ANL to conduct a more detailed analysis of battery costs in which ANL utilized the current version of BatPaC to estimate future battery pack costs by taking into account mineral price forecasts from leading analyst firms, and a technology roadmap of production and chemistry improvements likely to occur over the time frame of the rule.[721] Our use of the battery costs provided by this study result in an increase, compared to the proposal, in our battery cost inputs to OMEGA by between 19 and 34 percent (averaging 24 percent between 2023 and 2035) depending on the year and the size of the battery. These updates to our battery pack cost estimates are also responsive to comments from stakeholders, some of whom considered our costs in the NPRM to be low in comparison to more conservative estimates in the publicly available literature (see Response to Comments document for details). The costing approaches and assumptions are described in more detail in RIA Chapter 2.5.

The main function of the OMEGA compliance modeling is to show how a manufacturer can meet future GHG standards through the application of technologies. Among the many potential pathways that exist for achieving compliance, OMEGA aims to find a pathway that minimizes costs for the manufacturer given a set of inputs that includes technology costs and emissions rates. For any single run with its associated inputs, OMEGA produces merely one possible compliance path to provide information about the feasibility and potential costs of a set of standards. However, manufacturers remain free to adopt very different compliance paths, depending on their assessment of technologies and the vehicle market.

The compliance modeling for this rulemaking also includes constraints on new vehicle production and sales informed by our assessment of manufacturer and consumer decisions, and in some cases account for factors that were not included in the technical assessments in our prior rulemakings. EPA consulted and considered data and forecasts from government agencies, analyst firms, and industry in order to assess capacity for battery production and to thereby establish appropriate constraints on PEV battery production (in terms of gigawatt-hours (GWh) in a given year) during the time frame of the rule.[722] These constraints effectively act as an upper limit on PEV production, particularly during the earlier years of the analysis, and represent, for example, considerations such as availability of critical minerals and the lead time required to construct battery production facilities. For this final rule analysis, we also considered new and updated work provided by the Department of Energy that estimates growth in battery manufacturing capacity and critical mineral production during the time frame of the rule. The development of the battery GWh constraint and the sources considered are described in detail in RIA Chapter 3.1.5.

Consistent with compliance modeling for past rulemakings, the OMEGA model also limits the rate at which new vehicle designs can be introduced by applying redesign cycle constraints (RIA Chapter 2.6). EPA has evaluated historic vehicle data (*e.g.,* the rate of product redesigns) to ensure that the technology production pace in the modeling is feasible. In addition to vehicle production constraints, market assumptions and limits on manufacturer pricing cross-subsidization have been implemented to constrain the number of PEVs that can enter the fleet. EPA has evaluated market projections from both public and proprietary sources to calibrate OMEGA's representation of the consumer market's ICE–PHEV–BEV share response. A detailed discussion of the constraints used in EPA's compliance modeling is provided in RIA Chapter 2.7.

[720] FEV Report and Docket Memo: ''Cost and Technology Evaluation, Conventional & Electrical Powertrain Vehicles, Same Vehicle Class and OEM''.

[721] Argonne National Laboratory, ''Cost Analysis and Projections for U.S.-Manufactured Automotive Lithium-ion Batteries,'' ANL/CSE–24/1, January 2024.

[722] Sources included, among others, Wood Mackenzie proprietary forecasts of battery manufacturing capacity, battery costs, and critical mineral availability; Department of Energy analyses and forecasts of critical mineral availability and battery manufacturing capacity; and other public sources. See RIA Chapters 3.1.4 and 3.1.5 and section IV.C.7 of this preamble for a description of these sources and how they were used.

As in prior rulemakings, this assessment is a projection of the future, and is subject to a range of uncertainties. We have assessed a number of sensitivity cases for key assumptions in order to evaluate how they would impact the results.

2. Analytical Updates Between the Proposal and Final Rule

EPA received numerous public comments addressing our technical record. In response to these comments, and consistent with our general approach to update data when practicable, EPA has reassessed all aspects of our technical analysis based on the public record and the best available data and information. In Table 66, we summarize the major updates made to our technical analyses between the proposal and this final rule. These updates have resulted in a more robust technical analysis that is responsive to numerous public comments.

TABLE 66—MAJOR UPDATES TO TECHNICAL ANALYSIS BETWEEN THE PROPOSAL AND FINAL RULE

Added PHEVs as a technology option within OMEGA.
Updated light-duty vehicle fleet base year from MY 2019 to MY 2022.
Updated from AEO 2022 to AEO 2023 [a].
Updated BEV efficiency.
Updated technology cost inputs.
Updated battery costs per DOE study [b].
Revised battery cost learning approach for consistency with DOE study [b].
Updated OMEGA to not allow GHG backsliding for ICE vehicles.
Updated IRA assumptions.
Updated infrastructure assumptions and analysis.
Updated electric grid assumptions and analysis.
Updated analysis to include lower discount rate (2%).
Updated benefits analysis to latest social cost of GHG measures.
Updated dollar year from 2020 to 2022.
Updated refinery inventory calculation methodology.
Updated estimated impact on domestic refining due to reduced domestic liquid fuel demand.
Updated repair cost methodology for medium-duty vehicles.
Updated refueling time estimates and costs associated with mid-trip charging for BEVs.
Added insurance costs and state sales taxes to the effects calculations.

[a] OMEGA uses AEO for projected car/truck share in future years. AEO 2023 forecasts 70 percent trucks by 2032, which is an increase from AEO 2022 (which had forecast 60 percent trucks in 2032).

[b] Argonne National Laboratory, ''Cost Analysis and Projections for U.S.-Manufactured Automotive Lithium-ion Batteries,'' ANL/CSE–24/1, January 2024.

B. EPA's Approach to Considering the No Action Case and Sensitivities

EPA has assessed the effects of this rule with respect to a No Action case for the final standards and the two alternatives considered. The Office of Management and Budget (OMB) provides guidance for regulatory analysis through Circular A–4.[723] Circular A–4 describes, in general, how a regulatory agency should conduct an analysis in support of a future regulation and includes a requirement for assessing the baseline, or ''No Action,'' condition: ''what the world will be like if the rule were not adopted.'' In addition, Circular A–4 provides that the regulating agency may also consider ''alternative baselines,'' which EPA has considered via several sensitivities for this final rule, similar to the approach used in the proposal. In the development of a No Action case, EPA also considers existing finalized rulemakings. For this rule, the finalized rules considered in the No Action case include the 2014 Tier 3 criteria pollutant regulation, the 2016 Phase 2 GHG standards for medium-duty vehicles, and the 2021 light-duty GHG standards for MYs 2023–2026.

EPA recognizes that, even prior to this rule, the industry and market have already developed considerable momentum toward continuing increases in PEV uptake (as discussed at length throughout this preamble). This dynamic raises an important question about what the projected market penetration for PEVs would be in the absence of these final standards and thus reflected in the No Action case. EPA also recognizes there are many projections from third parties and various stakeholders, all showing increased PEV penetration in the future. There are a range of assumptions that vary across such projections such as consumer adoption, state level policies, financial incentives, manufacturing capacity and vehicle price. Vehicle price is also impacted by range and efficiency assumptions (more efficient EVs require smaller batteries to travel the same distance and smaller batteries cost less). Depending on what specific assumptions regarding the future are made, there can be significant variation in future PEV projections. Increasingly favorable consumer sentiment towards PEVs, decreasing costs (either through a reduction in manufacturing costs or through financial incentives), and a broadening number of PEV product offerings all support a projected higher number of new PEV sales in the future, independent of additional regulatory action. As described in section I.A.2.ii of this preamble, EPA reviewed several recent reports and studies containing PEV projections all of which include the IRA. Altogether, these studies project PEVs spanning a range from 42 to 68 percent of new vehicle sales in 2030. The mid-range projections of PEV sales from these studies, to which we compare our No Action case, range from 48 to 58 percent in 2030.[724] [725] [726] [727] [728] [729]

[723] Note that Circular A–4 has been updated, with final updated guidance being published on November 10, 2023. EPA is continually improving our analytical methods, including working to incorporate this updated guidance, however, the updates to Circular A–4 are not effective for final rules, such as this one, that are submitted to OMB before January 1, 2025, and this updated guidance may not be fully reflected in this analysis. See *https://www.whitehouse.gov/omb/briefing-room/2023/11/09/biden-harris-administration-releases-final-guidance-to-improve-regulatory-analysis/* for more information.

[724] Cole, Cassandra, Michael Droste, Christopher Knittel, Shanjun Li, and James H. Stock. 2023. ''Policies for Electrifying the Light-Duty Fleet in the United States.'' AEA Papers and Proceedings 113:

Continued

EPA notes that in our compliance modeling of the No Action case in OMEGA, the same technical, economic, and consumer inputs and assumptions are used as for the associated Action case. The only difference between the No Action and Action cases for a given central or sensitivity analysis is in the policy definition itself. The concept of an 'analysis context', within which policies are evaluated, is discussed further in RIA Chapter 2. EPA has considered a similar set of factors in our analysis context as those studies conducted by other stakeholders. This includes detailed vehicle and battery cost analyses, impacts of consumer and manufacturing financial incentives (such as those provided by the Inflation Reduction Act), consumer acceptance studies, vehicle performance modeling and technology applications, and battery manufacturing assessments.

The No Action case in our central analysis reaches 39 percent PEVs in 2030, shown in Table 76. We note that the PEV share of new vehicle sales was 7.5 percent in MY 2022, and will likely reach about 12 percent for MY 2023.[730] This projected PEV increase in the No Action case is driven by EPA's projections of the availability of economic incentives for electric vehicles for both manufacturers and consumers provided by the IRA, cost learning for PEV technology over time, an increase in consumer interest and acceptance over that period, and the ongoing effect of the 2021 rule and the associated standards stringency increases in MYs 2023 through 2026. In the absence of this rulemaking, the MY 2026 standards would carry forward indefinitely into future years and define the No Action policy case for this analysis. Notably, the No Action case projections do not include announcements made by manufacturers about their future plans and corporate goals, or state laws that have recently been adopted or are likely to be adopted in the next decade. While our projected PEV penetrations in the No Action case show a substantial increase over time, the 39 percent value in MY 2030 is lower than the mid-range third-party projections described above, as well as some manufacturer announcements.[731] For example, the International Energy Agency (IEA) synthesized industry announcements and concluded that for the U.S. market, OEM targets for light-duty electric vehicle sales match or exceed 50 percent by 2030. The same IEA analysis found that without consideration of these announcements, the projects can also be used to help effect of all existing policies and measures such as IRA and BIL legislation would similarly lead to 50 percent of new light-duty vehicle sales being electric vehicles by 2030.[732]

While we consider manufacturer announcements as additional evidence that high levels of PEV penetration are feasible, for purposes of this analysis we have not integrated manufacturer announcements directly into our modeling of the No Action baseline. Although PEV penetrations in our No Action case may appear conservative, we provide two key reasons why our central No Action case projections of PEV penetration for this rulemaking are lower than announcements from some manufacturers and the mid-range third party projections. First, our analysis is based on the assumption that manufacturers follow a purely cost-minimizing compliance strategy. We do not account for strategic business decisions or corporate policies that might cause a manufacturer to pursue a higher-PEV strategy such as the numerous manufacturer announcements and published corporate goals that suggest this approach may underestimate the rate of PEV adoption in a No Action scenario. Second, our analysis does not include the effect of state-level policies whereas projections from other sources may include those policies. We did not include these policies because many are still not in effect; however, we do anticipate that in the next decade, state-level policies may play an important role in driving PEV penetration. For this reason, we have included a sensitivity No Action case, which includes the ZEV requirements of the California Advanced Clean Car (ACC) II program for California and other participating states.

As a way to explore the impact that alternative assumptions would have on the future PEV penetrations under the No Action case, the agency has also conducted a range of sensitivities in addition to a central No Action case. As described further in section IV.F of this preamble, the sensitivity cases include states' adoption of the California Advanced Clean Cars II (ACC II) program,[733] higher and lower battery costs, faster and slower paces of consumer acceptance of PEVs, no trading of credits between manufacturers, and reduced levels of BEV production (the Alternative Manufacturer Pathways, described in section IV.F.5).[734] Across the sensitivity analyses, No Action case PEV projections for MY 2030 range from 31 to 57 percent, spanning the 39 percent central case value. Our projections through MY 2032 for PEV penetrations in the No Action case are shown in Figure 21.

316–322. doi:*https://doi.org/10.1257/pandp.20231063*.

[725] IEA. 2023. "Global EV Outlook 2023: Catching up with climate ambitions." International Energy Agency.

[726] Forsythe, Connor R., Kenneth T. Gillingham, Jeremy J. Michalek, and Kate S. Whitefoot. 2023. "Technology advancement is driving electric vehicle adoption." PNAS 120 (23). doi:*https://doi.org/10.1073/pnas.2219396120*.

[727] Bloomberg NEF. 2023. "Electric Vehicle Outlook 2023."

[728] U.S. Department of Energy, Office of Policy. 2023. "Investing in American Energy: Significant Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Energy Economy and Emissions Reductions."

[729] Slowik, Peter, Stephanie Searle, Hussein Basma, Josh Miller, Yuanrong Zhou, Felipe Rodriguez, Claire Buysse, et al. 2023. "Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States." International Council on Clean Transportation and Energy Innovation Policy & Technology LLC.

[730] 2023 EPA Automotive Trends Report, EPA–420–R–23–033, December 2023.

[731] A summary of industry announcements and third-party projections of PEV penetrations is provided in Section I.A.2 of the preamble.

[732] International Energy Agency, "Global EV Outlook 2023," p. 117 and p. 121, April 2023. Accessed on August 15, 2023 at *https://www.iea.org/reports/global-ev-outlook-2023*.

[733] EPA has not at this time approved the waiver that would allow California to follow the ACC II program.

[734] While unlikely, for purposes of illustration we also provide an extreme scenario in which no future BEV models are allowed to be sold beyond those already in production in 2022 MY. For this to occur, it would require a 50 percent reduction from 2022 BEV production in our first analysis year, 2023 MY.

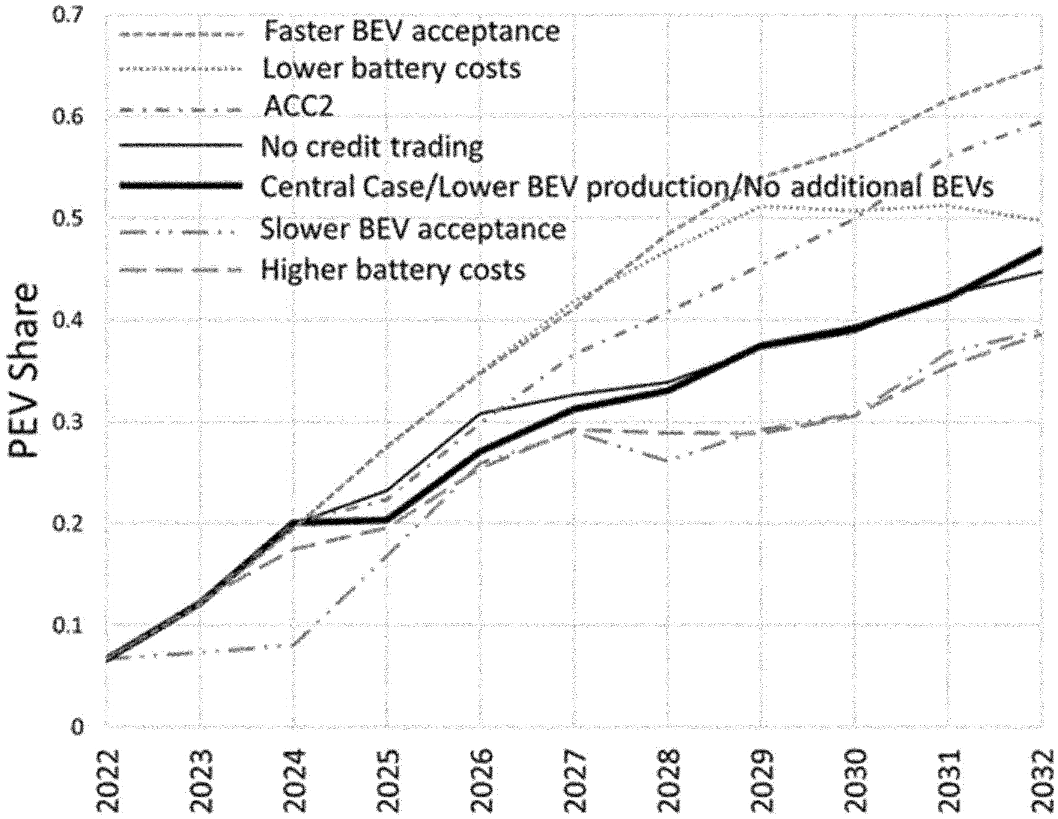

Figure 21: No Action Projections of Light-Duty PEV Penetrations for Central and Sensitivity Cases

We acknowledge the range of possible assumptions, and that EPA's central No Action case is more conservative than other projections that include state-level policies and/or manufacturer announced plans. We believe that our approach of assessing multiple potential No Action cases provides a technically robust method of determining the feasibility and costs associated with the emissions reductions required by the standards.

C. How did EPA Consider Technology Feasibility and Related Issues?

1. Light- and Medium-Duty Technology Feasibility

The standards established by this rule continue EPA's longstanding approach of setting performance-based emissions standards that result in an appropriate and achievable trajectory of emissions reductions. EPA sets emission standards based on consideration of available and projected technologies, consistent with the factors EPA must consider when establishing standards under the Clean Air Act. As with prior rules, as part of the development of this rulemaking EPA has assessed the feasibility of the standards in light of current and anticipated progress by automakers in developing and deploying emissions-reducing technologies.

Compliance with EPA GHG and criteria pollutant standards over the past decade has been achieved predominantly through the application of advanced technologies and improved aftertreatment systems to internal combustion engine (ICE) vehicles. For example, in the development of the 2012 GHG rule, a significant portion of EPA's analysis included an assessment of technologies available to manufacturers for achieving compliance with the standards, and ICE technologies were identified as playing a major role in manufacturer compliance with the emission reductions required by that rule.

In that same time frame, as EPA standards have increased in stringency, automakers have relied to an increasing degree on a range of electrification technologies, including hybrid electric vehicles (HEVs) and, in recent years, plug-in hybrid electric vehicles (PHEVs) and battery-electric vehicles (BEVs). This trend in technology application is evidence of a continuing recognition of electrification as an effective technology for both criteria pollutant and GHG compliance. As many ICE technologies have now reached high penetrations across the breadth of manufacturers' product lines, electrification technology has become increasingly attractive as a cost-effective pathway to further emission reductions.

The advantages of powertrain electrification are evident along a continuum of technologies, starting with HEV vehicle architectures, which have provided vehicle manufacturers with a powerful technology path for reducing both GHG and criteria pollutant emissions. For example, the blending of ICE and electric power allows manufacturers to control the engine for optimal efficiency and operating conditions to reduce criteria pollutants, and the higher voltage battery provides the opportunity to preheat the catalyst to reduce cold start emissions. HEVs continue to play an important and potentially increasing role in reducing emissions. In addition to Toyota's Prius line which has sold millions of units in the U.S. since its introduction to the U.S. in MY 2001, Toyota and other OEMs have brought HEV architectures to other sedans as well as crossovers, SUVs and pickups. For example, Ford has said that 10 percent of its F–150 pickup buyers and 56 percent its Maverick pickup buyers choose the hybrid powertrain option over the ICE version, and that hybrid options will soon be added across its model lineup.[735] Reports indicate that HEVs are beginning to experience increased interest and in 2023 were on pace to comprise more than 8 percent of U.S. car sales.[736] While the potential for reductions in tailpipe emissions by HEVs is not as great as for PEVs and BEVs, HEVs on the market today often offer a lower price point and for some manufacturers are playing an important role in compliance with the current standards.

As ICE and HEV technologies have progressed over the past two decades, and as battery costs continued to decline, automakers also began including PHEVs and BEVs (together referred to as PEVs or plug-in electric vehicles) in their product lines, and today there is a rapidly increasing diversity of these vehicles already on the market and planned for production. In EPA's 2021 rule that set GHG emission standards for MYs 2023 through 2026, we projected (as one example pathway) that manufacturers could comply with the 2026 standards with about 17 percent PEVs at the industry-wide level, reflecting the increased cost-effectiveness of PEV technologies in achieving compliance with increasingly stringent emissions standards. In light of subsequent developments including the BIL and IRA, we now project that manufacturers will sell 27 percent PEVs in 2026 under the standards that are currently in place.

These developments are also driven by the need to compete in a diverse market, as transportation policies to control pollution continue to be implemented across the U.S. and across the world. An increasing number of U.S. states have taken actions to shift the light-duty fleet toward zero-emissions technology. In 2022, California finalized the Advanced Clean Cars II (ACC II) rule [737] [738] that specifies, by 2035, all new light-duty vehicles sold in the state are to be zero-emission vehicles.[739] Twelve additional states have adopted all or most of the zero-emission vehicle phase-in requirements under ACC II, including Colorado,[740] Delaware,[741] Maryland,[742] Massachusetts,[743] [744] New Jersey,[745] New Mexico,[746] New York,[747] [748] Oregon,[749] Rhode Island,[750] Vermont,[751] Virginia,[752] and Washington.[753]

[735] Motley Fool, ''Ford Motor Company (F) Q2 2023 Earnings Call Transcript,'' July 28, 2023. Accessed on February 16, 2024 at *https://www.fool.com/earnings/call-transcripts/2023/07/28/ford-motor-company-f-q2-2023-earnings-call-transcr/*.

[736] CNBC, ''Why automakers are turning to hybrids in the middle of the industry's EV transition,'' December 8, 2023. Accessed on February 16, 2024 at *https://www.cnbc.com/2023/12/08/automakers-turn-to-hybrids-ev-transition.html*.

[737] EPA has not at this time approved the waiver that would allow California to follow the ACC II program.

[738] California Air Resources Board, ''California moves to accelerate to 100% new zero-emission vehicle sales by 2035,'' Press Release, August 25, 2022. Accessed on Nov. 3, 2022 at *https://ww2.arb.ca.gov/news/california-moves-accelerate-100-new-zero-emission-vehicle-sales-2035*.

[739] State of California Office of the Governor, ''Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change,'' Press Release, September 23, 2020.

[740] State of Colorado, ''Colorado accelerates access to clean cars to improve air quality, grow economy, and increase vehicle options for Coloradans,'' Press Release, October 20, 2023. Accessed on January 1, 2024 at *https://cdphe.colorado.gov/press-release/colorado-accelerates-access-to-clean-cars-to-improve-air-quality-grow-economy-and*.

[741] State of Delaware, '' DNREC Finalizes Clean Car Regulations,'' November 29, 2023. Accessed on January 1, 2024 at *https://news.delaware.gov/2023/11/29/dnrec-finalizes-clean-car-regulations/*.

[742] Maryland Department of the Environment, ''Advanced Clean Cars II.'' Accessed on January 1, 2024 at *https://mde.maryland.gov/programs/air/MobileSources/Pages/Clean-Energy-and-Cars.aspx*.

[743] Boston.com, ''Following California's lead, state will likely ban all sales of new gas-powered cars by 2035,'' August 27, 2022. Accessed November 3, 2022 at *https://www.boston.com/news/local-news/2022/08/27/following-californias-lead-state-will-likely-ban-all-sales-of-new-gas-powered-cars-by-2035/*.

[744] Commonwealth of Massachusetts, ''Request for Comment on Clean Energy and Climate Plan for 2030,'' December 30, 2020.

[745] New Jersey Office of the Governor, ''Murphy Administration Adopts Zero-Emission Vehicle Standards to Improve Air Quality, Fight Climate Change, and Promote Clean Vehicle Choice,'' November 21, 2023. Accessed on January 1, 2024 at *https://www.nj.gov/governor/news/news/562023/20231121a.shtml*.

[746] *https://www.env.nm.gov/transportation/*.

[747] New York State Senate, Senate Bill S2758, 2021–2022 Legislative Session. January 25, 2021.

[748] Governor of New York Press Office, ''In Advance of Climate Week 2021, Governor Hochul Announces New Actions to Make New York's Transportation Sector Greener, Reduce Climate-Altering Emissions,'' September 8, 2021. Accessed on September 16, 2021 at *https://www.governor.ny.gov/news/advance-climate-week-2021-governor-hochul-announces-new-actions-make-new-yorks-transportation*.

[749] *https://www.oregon.gov/deq/rulemaking/pages/cleancarsii.aspx*.

[750] *https://dem.ri.gov/environmental-protection-bureau/air-resources/advanced-clean-cars-ii-advanced-clean-trucks*.

[751] *https://dec.vermont.gov/air-quality/laws/recent-regs*.

[752] Commonwealth of Virginia State Air Pollution Control Board, 9VAC5 Chapter 95, Regulation for Low Emissions and Zero Emissions Vehicle Standards. Accessed on November 3, 2023 at *https://www.deq.virginia.gov/home/showpublisheddocument/14793/638043628046200000*.

[753] Washington Department of Ecology, ''Washington sets path to phase out gas vehicles by 2035,'' Press Release, Sept. 7, 2022. Accessed on Nov. 3, 2022 at *https://ecology.wa.gov/About-us/Who-we-are/News/2022/Sept-7-Clean-Vehicles-Public-Comment*.

In addition to the U.S., auto manufacturers also compete in a global market that is becoming increasingly electrified. Globally, at least 20 countries, as well as numerous local jurisdictions, have announced targets for shifting all new passenger car sales to zero-emission vehicles in the coming years, including Norway (2025); Austria, the Netherlands, Denmark, Iceland, India, Ireland, Israel, Scotland, Singapore, Sweden, and Slovenia (2030); Canada, Chile, Germany, Thailand, and the United Kingdom (2035); and France, Spain, and Sri Lanka (2040).[754] [755] [756] [757] [758] [759] In addition, in March 2023 the European Union approved a measure to phase out sales of ICE passenger vehicles in its 27 member countries by 2035.[760] [761] [762] Many of these announcements extend to light commercial vehicles as well, and several also target a shift to 100 percent all-electric medium- and heavy-duty vehicle sales (Norway targeting 2030, Austria 2035, and Canada and the United Kingdom 2040). Together, about half of annual global light-duty sales are in countries with various levels of zero-emission vehicle targets by 2035,[763] up from about 25 percent in 2022.[764] As of late 2023, 17 automotive brands globally had announced corporate targets for phasing out ICE technology, representing 32 percent of the global automotive market.[765] In 2023, 22 percent of new car registrations in the European Union were either BEVs or PHEVs,[766] led by Norway which reached about 80 percent BEV and 89 percent combined BEV and PHEV sales.

These trends echo an ongoing global shift toward electrification. Global light-duty passenger PEV sales surpassed 10 million in 2022, up from 6.6 million in 2021, bringing the total number of PEVs on the road to more than 26 million globally.[767] [768] For fully-electric BEVs, global sales rose to 7.8 million in 2022, an increase of about 68 percent from the previous year and representing about 10 percent of the new global light-duty passenger vehicle market.[769] [770] Leading sales forecasts predict that PEV sales will continue to accelerate globally in the years to come. For example, in June 2023, Bloomberg New Energy Finance reported that global PEV sales were 10.5 million in 2022 and forecasted that annual sales will rise to 27 million in 2026 (implying an annual growth rate of about 27 percent from 2022), with total global PEV stock rising from 27 million in 2022 to more than 100 million by 2026.[771]

While ICE vehicles and HEVs together retain the largest share of the market, the year-over-year growth in U.S. PEV sales suggests that an increasing share of new vehicle buyers are concluding that a PEV is the best vehicle to meet their needs. Many PEVs already on the market today cost less to operate than ICE vehicles, offer improved performance and handling, have a driving range similar to that of ICE vehicles, and can be charged at a growing network of public chargers as well as at home.[772] [773] [774] [775] [776] [777] PEV owners often describe these advantages as key factors motivating their purchase.[778] A 2022 survey by Consumer Reports shows that more than one-third of Americans would either seriously consider or definitely buy or lease a BEV today, if they were in the market for a vehicle.[779] Given that acceptance grows with familiarity as noted in the survey article, and most consumers are currently much less familiar with BEVs than with ICE vehicles, this share is expected to rapidly grow as familiarity increases in

[754] Environment and Climate Change Canada, ''Achieving a Zero-Emission Future for Light-Duty Vehicles: Stakeholder Engagement Discussion Document December 17,'' EC21255, December 17, 2021. Accessed on February 13, 2023 at *https://www.canada.ca/content/dam/eccc/documents/pdf/cepa/achieving-zero-emission-future-light-duty-vehicles.pdf.*

[755] International Council on Clean Transportation, ''Update on the global transition to electric vehicles through 2019,'' July 2020.

[756] International Council on Clean Transportation, ''Growing momentum: Global overview of government targets for phasing out new internal combustion engine vehicles,'' posted 11 November 2020, accessed April 28, 2021 at *https://theicct.org/blog/staff/global-ice-phaseout-nov2020.*

[757] United Kingdom Department for Transport, ''Government sets out path to zero emission vehicles by 2035,'' September 28, 2023. Accessed on December 1, 2023 at *https://www.gov.uk/government/news/government-sets-out-path-to-zero-emission-vehicles-by-2035.*

[758] Government of Canada, ''Proposed regulated sales targets for zero-emission vehicles,'' December 21, 2022. Accessed on December 1, 2023 at *https://www.canada.ca/en/environment-climate-change/news/2022/12/proposed-regulated-sales-targets-for-zero-emission-vehicles.html.*

[759] Reuters, ''Canada to ban sale of new fuel-powered cars and light trucks from 2035,'' June 29, 2021. Accessed July 1, 2021 from *https://www.reuters.com/world/americas/canada-ban-sale-new-fuel-powered-cars-light-trucks-2035-2021-06-29/.*

[760] Reuters, ''EU approves effective ban on new fossil fuel cars from 2035,'' October 28, 2022. Accessed on Nov. 2, 2022 at *https://www.reuters.com/markets/europe/eu-approves-effective-ban-new-fossil-fuel-cars-2035-2022-10-27/.*

[761] European Commission, ''Fit for 55: EU reaches new milestone to make all new cars and vans zero-emission from 2035,'' March 28, 2023. Accessed on January 1, 2024 at *https://climate.ec.europa.eu/news-your-voice/news/fit-55-eu-reaches-new-milestone-make-all-new-cars-and-vans-zero-emission-2035-2023-03-28-_en.*

[762] Reuters, ''EU lawmakers approve effective 2035 ban on new fossil fuel cars,'' February 14, 2023. Accessed on February 26, 2023 at *https://www.reuters.com/business/autos-transportation/eu-lawmakers-approve-effective-2035-ban-new-fossil-fuel-cars-2023-02-14/.*

[763] International Energy Agency, ''Global EV Outlook 2023,'' p. 65, May 2023. Accessed on November 28, 2023 at *https://iea.blob.core.windows.net/assets/dacf14d2-eabc-498a-8263-9f97fd5dc327/GEVO2023.pdf.*

[764] International Energy Agency, ''Global EV Outlook 2022,'' p. 57, May 2022. Accessed on November 18, 2022 at *https://iea.blob.core.windows.net/assets/e0d2081d-487d-4818-8c59-69b638969f9e/GlobalElectricVehicleOutlook2022.pdf.*

[765] BloombergNEF, ''Zero-Emission Vehicles Factbook: A BloombergNEF special report prepared for COP28, December 2023, p. 52.

[766] European Automobile Manufacturers' Association (ACEA), '' New car registrations: +13.9% in 2023; battery electric 14.6% market share,'' January 18, 2024. Accessed on February 15, 2024 at *https://www.acea.auto/pc-registrations/new-car-registrations-13-9-in-2023-battery-electric-14-6-market-share/.*

[767] International Energy Agency, ''Global EV Outlook 2022,'' p. 107, May 2022. Accessed on November 18, 2022 at *https://iea.blob.core.windows.net/assets/e0d2081d-487d-4818-8c59-69b638969f9e/GlobalElectricVehicleOutlook2022.pdf.*

[768] International Energy Agency, ''Trends in electric light-duty vehicles.'' Accessed on November 28, 2023 at *https://www.iea.org/reports/global-ev-outlook-2023/trends-in-electric-light-duty-vehicles.*

[769] Boston, W., ''EVs Made Up 10% of All New Cars Sold Last Year,'' Wall Street Journal, January 16, 2023.

[770] Colias, M., ''U.S. EV Sales Jolted Higher in 2022 as Newcomers Target Tesla,'' Wall Street Journal, January 6, 2023.

[771] Bloomberg NEF. 2023. ''Electric Vehicle Outlook 2023.''

[772] Department of Energy Vehicle Technologies Office, Transportation Analysis Fact of the Week #1186, ''The National Average Cost of Fuel for an Electric Vehicle is about 60% Less than for a Gasoline Vehicle,'' May 17, 2021.

[773] Department of Energy Vehicle Technologies Office, Transportation Analysis Fact of the Week #1190, ''Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles,'' June 14, 2021.

[774] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022.

[775] Consumer Reports, ''Electric Cars 101: The Answers to All Your EV Questions,'' November 5, 2020. Accessed June 8, 2021 at *https://www.consumerreports.org/hybrids-evs/electric-cars-101-the-answers-to-all-your-ev-questions/.*

[776] Department of Energy Vehicle Technologies Office, Transportation Analysis Fact of the Week #1253, ''Fourteen Model Year 2022 Light-Duty Electric Vehicle Models Have a Driving Range of 300 Miles or Greater,'' August 29, 2022.

[777] Department of Energy Alternative Fuels Data Center, Electric Vehicle Charging Station Locations. Accessed on May 19, 2021 at *https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC.*

[778] Hardman, S., and Tal, G., ''Understanding discontinuance among California's electric vehicle owners,'' Nature Energy, v.538 n.6, May 2021 (pp. 538–545).

[779] Consumer Reports, ''More Americans Would Buy an Electric Vehicle, and Some Consumers Would Use Low-Carbon Fuels, Survey Shows,'' July 7, 2022. Accessed on March 8, 2023 at *https://www.consumerreports.org/hybrids-evs/interest-in-electric-vehicles-and-low-carbon-fuels-survey-a8457332578/.*

response to increasing numbers of BEVs on the road and growing visibility of charging infrastructure. Most PEV owners who purchase a subsequent vehicle choose another PEV, and often express resistance to returning to an ICE vehicle after experiencing PEV ownership.[780] [781]

In addition to the light-duty vehicle sector, the medium-duty sector is also experiencing a shift toward electrification in several important market segments. As described in section I.A.2 of this preamble, numerous commitments to produce all-electric medium-duty delivery vans have been announced by large fleet-operating businesses in partnerships with various OEMs. This rapid shift to BEVs in a fleet that is currently predominantly gasoline- and diesel-fueled suggests that the operators of these fleets consider BEV delivery vans the best available and most cost-effective technology for meeting their needs. Owing to the large size of these vehicle fleets, this segment alone is likely to represent a significant portion of the future electrification of the medium-duty vehicle fleet.

EPA believes the PHEV architecture may also lend itself well to future pickup truck and large SUV applications, which may also include some MDV pickup truck applications. A PHEV pickup or large SUV architecture would provide several benefits: some amount of zero-emission electric range (depending on battery size); increased total vehicle range during heavy towing and hauling operations using both charge depleting and charge sustaining modes (depending on ICE-powertrain sizing); job-site utility with auxiliary power capabilities similar to portable worksite generators, and the efficiency improvements normally associated with strong hybrids that provide regenerative braking, extended engine idle-off, and launch assist for high torque demand applications. Depending on the vehicle architecture, PHEVs used in pickup truck applications may also offer additional capabilities, similar to BEV pickups, with respect to torque control and/or torque vectoring to reduce wheel slip during launch in very heavy trailer towing applications. In addition, PHEVs may help provide a bridge for consumers that may not be ready to adopt a fully electric vehicle.

One major manufacturer, Stellantis, recently announced a new PHEV pickup truck, the 2025 Ram 1500 Ramcharger.[782] Specifications include a 92-kWh battery pack, a 135-kW generator, over 490 kW of drive system power, an estimated 14,000-pound tow capability and a 2,625-pound payload capacity. Press reports estimate all-electric range of approximately 145 miles.[783]

The MY 2023 Jeep Grand Cherokee 4xe PHEV with the Trailhawk package is a current-production example of a large SUV with significant tow capability. The vehicle has a 6,125-pound GVWR and a 12,125-pound GCWR using a combination of a 270-bhp turbocharged GDI engine with P2 and P0 electric machines of 100kW and 33kW, respectively. The vehicle also uses a 17.3 kWh battery pack that provides 25 miles of all-electric range. The MY 2023 Jeep Wrangler 4xe uses a similar powertrain and battery pack. The Wrangler 4xe equipped with the ''Rubicon'' package has a 6,400-pound GVWR and a 9,200-pound GCWR.

PHEV light-duty and MDV pickup trucks also show considerable promise for reducing CO_2 emissions. A study conducted by EPA, Southwest Research Institute, and Argonne National Laboratory[784] that modeled PHEV light-duty and MDV pickup truck configurations with significant all-electric ranged showed approximately 80 percent reductions in CO_2 emissions could be achieved when taking into account fully-phased-in 2031 fleet utility factors (see section III.C.8.i) for plug-in hybrids in the U.S. The modeling also simulated the SAE J2807 towing performance standard, which includes trailer towing up the Davis Dam grade on Arizona State Route 68. The modeling results showed that a GCWR 19,500 pounds (trailer weight of 13,000 pounds) could be maintained for the modeled LDT4 pickup truck PHEV configuration and that a GCWR of 29,500 pounds (trailer weight of approximately 20,000 pounds) could be maintained for the modeled PHEV MDV pickup truck during blended or charge-sustaining operation.

These trends in light- and medium-duty vehicle technology suggest that electrification is already poised to play a rapidly increasing role in the on-road fleet and provides further evidence that BEV and PHEV technologies are increasingly seen as an effective and feasible set of vehicle technologies that are available to manufacturers to achieve further emissions reductions.

Recent literature indicates that consumer affinity for PEVs is strong. A recent study utilizing data from all new light-duty vehicles sold in the U.S. between 2014 and 2020 focused on comparisons of BEVs with their closest ICE counterparts, and found that BEVs are preferred to the ICE counterpart in some vehicle segments.[785] In addition, when comparing all BEV sales with sales of the closest ICE counterparts, BEVs attain a market share of over 30 percent, which is significantly greater than the BEV market share among all vehicles.[786] This suggests that the share of PEVs in the marketplace is, at least partially, constrained due to the lack of offerings needed to convert existing demand into market share.[787] However, the number and diversity of electrified vehicle models is rapidly increasing.[788] For example, the number of PEV models available for sale in the U.S. has grown from about 24 in MY 2015 to about 60 in MY 2021 and over 180 in MY 2023, with offerings in a growing range of vehicle segments.[789] Data from JD Power and Associates shows that MY 2023 BEVs and PHEVs are now available as sedans, sport utility vehicles, and pickup trucks. In addition, the greatest offering of PEVs is in the popular crossover/SUV segment.[790]

According to the U.S. Bureau of Labor Statistics, growing consumer demand and growing automaker commitments to electrification are important factors in the growth of PEV sales and that growth will be further supported by policy measures including the BIL and the IRA.[791] As the presence of PEVs in the

[780] Muller, J., ''Most electric car buyers don't switch back to gas,'' Axios.com. Accessed on February 24, 2023 at *https://www.axios.com/2022/10/05/ev-adoption-loyalty-electric-cars.*

[781] Hardman, S., and Tal, G., ''Understanding discontinuance among California's electric vehicle owners,'' Nature Energy, v.538 n.6, May 2021 (pp. 538–545).

[782] *https://www.ramtrucks.com/revolution/ram-1500-ramcharger.html*, accessed 12/12/2023.

[783] ''2025 Ram 1500 Ramcharger Avoids the Range Anxiety of EV Trucks''. Car and Driver, 11/7/2023, *https://www.caranddriver.com/news/a45734742/2025-ram-1500-ramcharger-revealed/*, accessed 12/12/2023.

[784] Bhattacharjya, S., Chambon, P., Conway, G., et al. 2024. ''Heavy-light-duty and Medium-duty Range-extended Electric Truck Study—Final Report''. Report submitted to Docket EPA–HQ–OAR–2022–0829.

[785] Gillingham, K.T., A.A. van Benthem, S. Weber, M.A. Saafi, and X. He. 2023. ''Has Consumer Acceptance of Electric Vehicles Been Increasing: Evidence from Microdata on Every New Vehicle Sale in the United States.'' AEA Papers and Proceedings, 113:329–35.

[786] Id.

[787] Id.

[788] Muratori et al., ''The rise of electric vehicles—2020 status and future expectations,'' Progress in Energy v3n2 (2021), March 25, 2021. Accessed July 15, 2021 at *https://iopscience.iop.org/article/10.1088/2516-1083/abe0ad.*

[789] *Fueleconomy.gov,* 2015 Fuel Economy Guide, 2021 Fuel Economy Guide, and 2023 Fuel Economy Guide.

[790] Taylor, M., Fujita, K.S., Campbell, N., 2024, ''The False Dichotomies of Plug-in Electric Vehicle Markets'' Lawrence Berkeley National Laboratory.

[791] U.S. Bureau of Labor Statistics, ''Charging into the future: the transition to electric vehicles,'' Beyond the Numbers v12 n4, February 2023.

fleet increases, consumers are encountering PEVs more often in their daily experience. Many analysts believe that as PEVs continue to increase in market share, PEV ownership will continue to broaden its appeal as consumers gain more exposure and experience with the technology and with the benefits of PEV ownership,[792] with some analysts suggesting that rapidly accelerating PEV adoption may then result.[793] [794] [795]

While PEVs are typically offered at a higher price than comparable ICE vehicles at this time, the price difference for BEVs, which have only an electric powertrain, is widely expected to narrow or disappear as the cost of batteries and other components fall in the coming years.[796] Among the many studies that address cost parity of BEVs vs. ICE vehicles, an emerging consensus suggests that purchase price parity is likely to begin occurring by the mid- to late-2020s for some vehicle segments and models, and for a broader segment of the market on a total cost of ownership (TCO) basis.[797] [798] By some accounts, a compact car with a relatively small battery (for example, a 40 kilowatt-hour (kWh) battery and approximately 150 miles of range) may already be possible to produce and sell for the same price as a compact ICE vehicle.[799] For larger vehicles and/or those with a longer range (either of which necessitate a larger battery), many analysts expect examples of price parity to increasingly appear over the mid- to late-2020s. Assessments of price parity often do not include the effect of various state and Federal purchase incentives. For example, the 30D Clean Vehicle Credit under the IRA provides a purchase incentive of up to $7,500, effectively making some BEVs more affordable to buy today than comparable ICE vehicles. Additionally, the Commercial Clean Vehicle Credit under the IRA permits commercial purchasers of light-duty PEVs to receive a credit equivalent to the incremental cost of the PEV versus a comparable ICE vehicle, up to $7,500, allowing this savings to be reflected in the lease terms offered to consumer lessees.[800] Many expect TCO parity to precede price parity by several years, as it accounts for the reduced cost of operation and maintenance for BEVs.[801] [802] For example, Kelley Blue Book already estimates that the vehicle with lowest TCO in both the full-size pickup and luxury car classes of vehicle is a BEV.[803] [804] Based on average annual mileage, BloombergNEF states that in the U.S., electric SUVs have already achieved lower TCO than similar ICE vehicles, and for higher mileages, BEVs have lower TCO than similar small, medium, and large ICE vehicles.[805] Because businesses tend to pay close attention to TCO of business property, TCO parity of BEVs is likely to be of particular interest to commercial and fleet operators.

Figure 22, taken from work by the Environmental Defense Fund, shows how the number of PHEV and BEV models available in the U.S. has steadily grown, and many public model announcements by manufacturers indicate further growth will occur in the years to come.

Available at: *https://www.bls.gov/opub/btn/volume-12/charging-into-the-future-the-transition-to-electric-vehicles.htm*.

[792] Jackman, D. K., K. S. Fujita (LBNL), H. C. Yang (LBNL), AND M. Taylor (LBNL). Literature Review of U.S. Consumer Acceptance of New Personally Owned Light-Duty (LD) Plug-in Electric Vehicles (PEVs). U.S. Environmental Protection Agency, Washington, DC Available at: *https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=353465*.

[793] Car and Driver, ''Electric Cars' Turning Point May Be Happening as U.S. Sales Numbers Start Climb,'' August 8, 2022. Accessed on February 24, 2023 at *https://www.caranddriver.com/news/a39998609/electric-car-sales-usa/*.

[794] Randall, T., ''US Crosses the Electric-Car Tipping Point for Mass Adoption,'' Bloomberg.com, July 9, 2022. Accessed on February 24, 2023 at *https://www.bloomberg.com/news/articles/2022-07-09/us-electric-car-sales-reach-key-milestone*.

[795] Romano, P., ''EV adoption has reached a tipping point. Here's how today's electric fleets will shape the future of mobility,'' Fortune, October 11, 2022. Accessed on February 24, 2023 at *https://fortune.com/2022/10/11/ev-adoption-tesla-semi-tipping-point-electric-fleets-future-mobility-pasquale-romano/*.

[796] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022.

[797] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022.

[798] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer Commitments and Public Policy Initiatives Supporting Electric Mobility in the U.S. and Worldwide,'' September 2022.

[799] Walton, R., ''Electric vehicle models expected to triple in 4 years as declining battery costs boost adoption,'' *UtilityDive.com,* December 14, 2020.

[800] Internal Revenue Service, ''Frequently asked questions about the New, Previously-Owned and Qualified Commercial Clean Vehicles Credit,'' December 26, 2023 at *https://www.irs.gov/newsroom/frequently-asked-questions-about-the-new-previously-owned-and-qualified-commercial-clean-vehicles-credit*.

[801] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022.

[802] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer Commitments and Public Policy Initiatives Supporting Electric Mobility in the U.S. and Worldwide,'' September 2022.

[803] Kelley Blue Book, ''What is 5-Year Cost to Own?'', Full-size Pickup Truck selected (Ford F–150 Lighting is lowest TCO). Accessed on February 28, 2023 at *https://www.kbb.com/new-cars/total-cost-of-ownership/*.

[804] Kelley Blue Book, ''What is 5-Year Cost to Own?'', Luxury Car selected (Polestar 2 and Tesla Model 3 are lowest TCO). Accessed on February 28, 2023 at *https://www.kbb.com/new-cars/total-cost-of-ownership/*.

[805] BloombergNEF, ''Zero-Emission Vehicles Factbook,'' December 2023, p. 36. Accessed on February 4, 2024 at *https://assets.bbhub.io/professional/sites/24/2023-COP28-ZEV-Factbook.pdf*.

[806] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer & Commercial Fleet Electrification Commitments Supporting Electric Mobility in the United States,'' April 2023, p. 7.

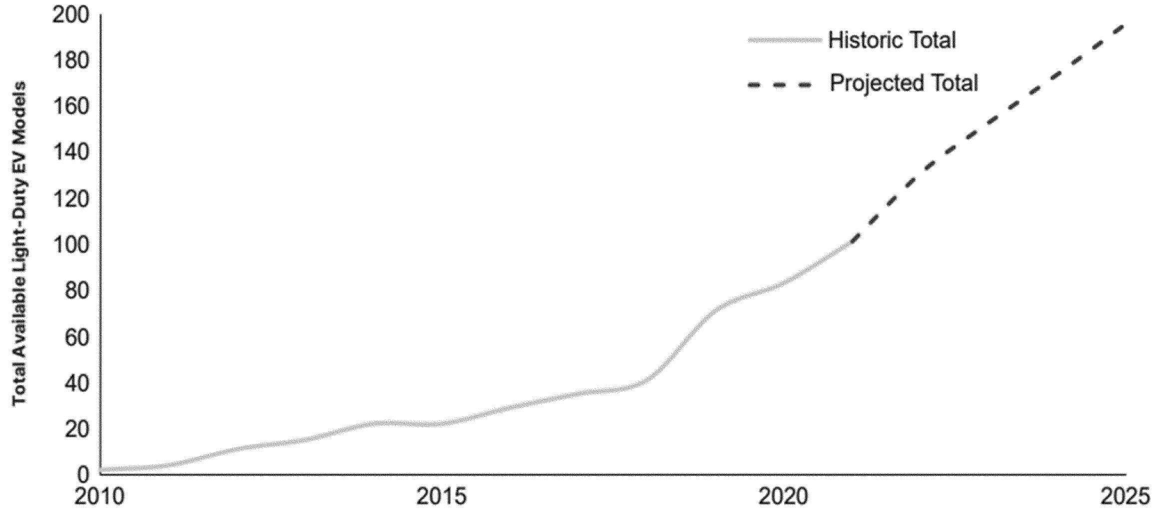

Figure 22: Projection of Total Light-Duty PHEV and BEV U.S. Models Available by Year (EDF 2023)[806]

Globally and domestically, these ongoing announcements indicate a strong industry momentum toward electrification that is common to every major manufacturer. Given the breadth of these announcements, it is informative to consider the penetrations of PEVs that they imply when taken collectively.

Table 67 compiles public announcements of U.S. and global electrification targets to date by major manufacturers. Assuming that the MY 2022 U.S. sales shares for each manufacturer were to persist in 2030, these targets would collectively imply a U.S. PEV sales share of nearly 50 percent in 2030, consisting primarily of BEVs. A version of this table with supporting citations for each automaker announcement, and the raw data with additional tabulations, are available in the Docket.[807]

TABLE 67—EXAMPLE OF U.S. ELECTRIFIED NEW SALES PERCENTAGES IMPLIED BY OEM ANNOUNCEMENTS FOR 2030 OR BEFORE

2022 U.S. Sales Rank	OEM	Share of total 2022 U.S. sales [1] %	Stated PEV share in 2030 [2] %	Powertrain [3]	Implied OEM contribution to 2030 total PEV market share %
1	General Motors	16.4	50	PEV	8.2
2	Toyota	15.4	33 [4]	BEV	5.1
3	Ford	13.1	50	BEV	6.5
4	Stellantis	11.2	50	BEV	5.6
5	Honda	7.2	40	BEV	2.9
6	Hyundai	5.7	50	BEV	2.8
7	Nissan	5.3	40	BEV	2.1
8	Kia	5.0	45	BEV	2.3
9	Subaru	4.1	50	BEV	2.0%
10	Volkswagen, Audi	3.6	50	BEV	1.8
11	Tesla	3.4	100	BEV	3.4
12	Mercedes-Benz	2.6	50	PEV	1.3
13	BMW	2.6	50	BEV	1.3
14	Mazda	2.1	25	BEV	0.5
15	Volvo	0.8	100	BEV	0.8
16	Mitsubishi	0.6	50	PEV [5]	0.3
17	Porsche	0.5	80	BEV	0.4
18	Land Rover	0.4	60	BEV	0.3
19	Jaguar	0.07	100	BEV	0.07
20	Lucid	0.02	100	BEV	0.02
	Total	100.0			47.7

Notes:
[1] 2022 U.S. sales shares based on data from Ward's Automotive Intelligence.
[2] Where a U.S. target was not specified, the global target was assumed for the U.S.
[3] PEV comprises both BEV and PHEV. In addition, PEV and BEV may include fuel cell electric vehicles (FCEV).
[4] Based on announced goal of 3.5 million BEVs globally in 2030, divided by 10.5 million vehicles sold in 2022.
[5] Announcement includes unspecified amount of HEVs.

[807] See Memo to Docket ID No. EPA–HQ–OAR–2022–0829 titled ''Electrification Announcements and Implied PEV Penetration by 2030.''

EPA understands that manufacturer announcements such as these are not binding, and often are conditioned as forward-looking projections that are subject to uncertainty. However, the breadth and scale of these announcements across the entire industry signals that manufacturers are confident in the suitability and attractiveness of PEV technology to serve the needs of a large portion of light-duty vehicle buyers.

As seen in Figure 23, an analysis by the International Energy Agency (IEA) similarly concludes that the 2030 U.S. zero-emission vehicle sales share collectively implied by such announcements (''range of OEM declarations'') would amount to nearly 50 percent if not more, far exceeding the 20 percent that IEA considers sufficient to meet pre-IRA U.S. policies and regulations (''Stated Policies'' scenario).[808]

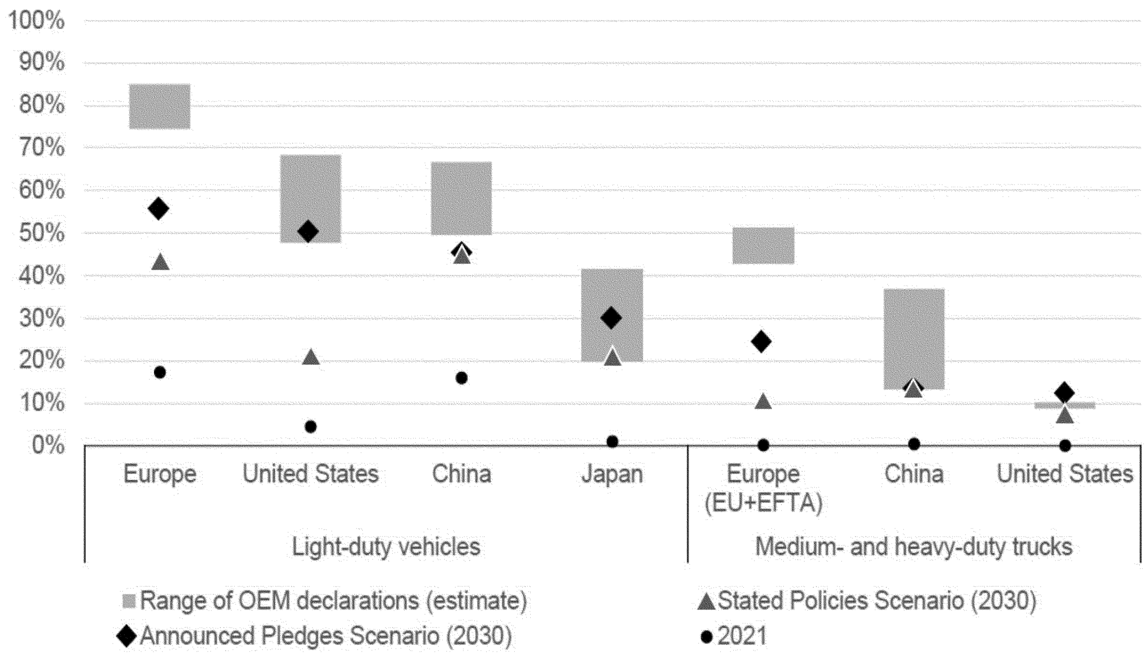

Figure 23: Estimated Zero-Emission Vehicle Sales Shares Resulting From OEM Announcements Compared to Stated and Potential Policies (IEA 2022)

These announcements and others like them continue a pattern over the past several years in which most major manufacturers have taken steps to significantly invest in zero-emission technologies and reduce their reliance on the internal-combustion engine in various markets around the globe,[809 810] including allocating large amounts of new investment to electrification technologies.

A 2021 analysis by the Center for Automotive Research showed that a significant shift in North American investment was already occurring toward electrification technologies, with $36 billion of about $38 billion in total automaker manufacturing facility investments announced in 2021 being slated for electrification-related manufacturing in North America, with a similar proportion and amount expected for 2022.[811] For example, in September 2021, Toyota announced large new investments in battery production and development to support an increasing focus on electrification,[812] and in December 2021, announced plans to increase this investment.[813] In December 2021, Hyundai closed its engine development division at its research and development center in Namyang, South Korea in order to refocus on BEV development.[814] By October 2022, another analysis indicated that 37 of the world's automakers had announced plans to invest a total of almost $1.2 trillion by 2030 toward electrification,[815] a large portion of which would be used for construction of manufacturing facilities for vehicles, battery cells and packs, and materials, supporting up to 5.8 terawatt-hours of battery production and 54 million BEVs per year globally.[816] For example, in summer 2022, Hyundai announced an investment of $5.5 billion

[808] International Energy Agency, ''Global EV Outlook 2022,'' p. 107, May 2022. Accessed on November 18, 2022 at *https://iea.blob.core.windows.net/assets/e0d2081d-487d-4818-8c59-69b638969f9e/GlobalElectricVehicleOutlook2022.pdf.*

[809] Environmental Defense Fund and M.J. Bradley & Associates, ''Electric Vehicle Market Status—Update, Manufacturer Commitments to Future Electric Mobility in the U.S. and Worldwide,'' April 2021.

[810] International Council on Clean Transportation, ''The end of the road? An overview of combustion-engine car phase-out announcements across Europe,'' May 10, 2020.

[811] Center for Automotive Research, ''Automakers Invest Billions in North American EV and Battery Manufacturing Facilities,'' July 21, 2022. Retrieved on November 10, 2022 at *https://www.cargroup.org/automakers-invest-billions-in-north-american-ev-and-battery-manufacturing-facilities/.*

[812] Toyota Motor Corporation, ''Video: Media briefing & Investors briefing on batteries and carbon neutrality'' (transcript), September 7, 2021. Accessed on September 16, 2021 at *https://global.toyota/en/newsroom/corporate/35971839.html#presentation.*

[813] Toyota Motor Corporation, ''Video: Media Briefing on Battery EV Strategies,'' Press Release, December 14, 2021. Accessed on December 14, 2021 at *https://global.toyota/en/newsroom/corporate/36428993.html.*

[814] Do, Byung-Uk, Kim, Il-Gue, ''Hyundai Motor closes engine development division'', The Korea Economic Daily, December 23, 2021. Accessed on November 29, 2022 at *https://www.kedglobal.com/electric-vehicles/newsView/ked202112230013.*

[815] Reuters, ''A Reuters analysis of 37 global automakers found that they plan to invest nearly $1.2 trillion in electric vehicles and batteries through 2030,'' October 21, 2022. Accessed on November 4, 2022 at *https://graphics.reuters.com/AUTOS-INVESTMENT/ELECTRIC/akpeqgzqypr/.*

[816] Reuters, ''Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030,'' October 25, 2022. Accessed on November 4, 2022 at *https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/.*

to fund new battery and electric vehicle manufacturing facilities in Georgia, and recently announced a $1.9 billion joint venture with SK Innovation to fund additional battery manufacturing in the U.S.[817] [818] And in 2023, Ford announced plans for a new battery plant in Michigan, part of $17.6 billion in investments in electrification announced by Ford and its partners since 2019.[819] [820] By mid-2023 the International Energy Agency indicated that as of the previous March, major manufacturers had announced post-IRA investments in North American supply chains totaling at least $52 billion, mostly in battery manufacturing, battery components and vehicle assembly.[821] By January 2024, a White House accounting of BIL and IRA investments indicated that the total had increased to at least $155 billion.[822] The U.S. Department of Energy indicates this represents over $120 billion in over 200 new or expanded minerals, materials processing, and manufacturing facilities and over $35 billion in over 140 new or expanded sites for EV assembly, EV component, or charger manufacturing.[823]

In the proposal for this rulemaking, EPA did not specifically model the adoption of PHEV architectures, although the agency acknowledged that PHEVs could provide significant reductions in GHG emissions, and that some vehicle manufacturers may choose to utilize this technology as part of their technology offering portfolio. For example, PHEVs may be effective at meeting specific types of customer needs and may provide manufacturers with an additional technology option with which to meet emissions standards (as some firms are already doing today). We also indicated that we were considering adding PHEVs as a technology option in the analysis for the final rule, and asked for comment on this possibility, and on technology costs and configurations we presented at the time.

Several commenters criticized the lack of PHEVs as a technology option in the analysis of the proposed standards. Commenters on this topic universally supported the addition of PHEVs in the compliance modeling for the final rulemaking analysis. As indicated in the proposal, and in response to comments received during the public comment period, EPA has updated its analysis to include PHEVs as a technology option for both light-duty and medium-duty vehicles.

Many commenters suggested that due to their smaller battery packs, PHEVs could reduce the demand for critical minerals and provide a viable pathway to GHG compliance should critical mineral supplies be less than projected. In response to commenters' concerns about potential limits on availability of critical minerals, EPA shows technologically feasible paths to compliance that rely more on PHEVs, resulting in much lower battery demand than in the central case.

In its comments, Auto Innovators requested that EPA include PHEVs such that they comprise at least 20 percent of PEVs in the compliance results. While that could be a potential outcome, the OMEGA model is designed to identify lowest-cost compliance pathways to performance-based standards, based on all technology options available in the model. EPA did not find any rationale for setting a minimum PHEV to BEV ratio (for example, as an input constraint). However, in modeling results for the 2030–2032 timeframe, PHEVs do account for over 10 percent of the total PEVs in the final standards analysis.

ICCT suggested that adding more technologies, including PHEVs, could reduce costs of compliance. EPA agrees that the inclusion of more technology choices should generally offer more cost-effective pathways to compliance. While we did not evaluate the impact of each update in data and assumptions for this final rulemaking analysis individually, it is likely that an analysis that excluded PHEVs would have higher costs.

EPA also requested comment on the types of PHEV architectures that EPA should consider in this final rulemaking analysis, including whether or not EPA should explicitly model PHEVs in light-duty and MDV pickup applications. In the proposal, EPA described ongoing contract work with Southwest Research Institute (SwRI) to investigate likely technology architectures of both PHEV and internal combustion engine range-extended electric light-duty and MDV pickup trucks to support analysis for the final rule. EPA also requested any relevant performance or utility data that may help inform our modeling and analyses.

In their comments, Auto Innovators and Toyota both recommended that EPA include the more capable strong-PHEV designs that meet US06 high power cold starts, as well as the range-extending architecture that EPA has modeled through its contract with SwRI. Toyota commented that PHEVs could apply to all light-duty vehicles; accordingly, EPA has included PHEVs as a technology option across all body styles. Stellantis highlighted the high-capability pickup truck segment as a key area where PHEVs would be beneficial. In this analysis, EPA has made the simplifying technical assumption that PHEVs will meet basic all-electric range requirements to qualify as ZEVs under ACC II[824] and ACT[825] for light-duty and medium-duty vehicles, respectively, as we think it is reasonable to assume that manufacturers will design PHEVs as nationwide products. For a more detailed description of EPA's PHEV model architectures, including battery and motor sizing as well as cost assumptions, please refer to RIA Chapter 2.6.1.4.

As stated in the proposal, EPA conducted contract work with SwRI to investigate likely technology architectures of both PHEV and ICE range-extended electric light-duty and MDV pickup trucks that we anticipated would provide data informative to the final rule. We have included modeling of PHEV architectures comparable to those included in SwRI's final report within our analysis. For more information, please refer to RIA Chapter 3.5. In addition, within the proposal's DRIA Chapter 2.6.1.4 ''PHEV Powertrain Costs,'' EPA provided component technology descriptions and cost

[817] Velez, C. ''Hyundai and SK On to bring even more EV battery plants to U.S.'' CBT News, November 29, 2022. Accessed on November 29, 2022 at *https://www.cbtnews.com/hyundai-and-sk-on-to-bring-even-more-ev-battery-plants-to-u-s/*.

[818] Lee, J., Yang, H. ''Hyundai Motor, SK On sign EV battery supply pact for N. America'', Reuters, November 29, 2022. Accessed on November 29, 2022 at *https://www.reuters.com/business/autos-transportation/hyundai-motor-group-sk-ev-battery-supply-pact-n-america-2022–11–29/*.

[819] Ford Motor Company, ''Ford Taps Michigan for new LFP Battery Plant; New Battery Chemistry Offers Customers Value, Durability, Fast Charging, Creates 2,500 More New American Jobs,'' Press Release, February 13, 2023. *https://media.ford.com/content/fordmedia/fna/us/en/news/2023/02/13/ford-taps-michigan-for-new-lfp-battery-plant--new-battery-chemis.html*.

[820] New York Times, ''Ford Resumes Work on E.V. Battery Plant in Michigan, at Reduced Scale,'' November 21, 2023.

[821] International Energy Agency, ''Global EV Outlook 2023,'' p. 12, May 2023. Accessed on November 28, 2023 at *https://iea.blob.core.windows.net/assets/dacf14d2-eabc-498a-8263-9f97fd5dc327/GEVO2023.pdf*.

[822] U.S. Department of Energy, '' Building America's Clean Energy Future,'' at *https://www.whitehouse.gov/invest/*. Accessed on February 16, 2024.

[823] U.S. Department of Energy, ''Building America's Clean Energy Future,'' at *https://www.energy.gov/invest*. Accessed February 4, 2024.

[824] California Air Resources Board, ''California moves to accelerate to 100% new zero-emission vehicle sales by 2035,'' Press Release, August 25, 2022. Accessed on Nov. 3, 2022 at *https://ww2.arb.ca.gov/news/california-moves-accelerate-100-new-zero-emission-vehicle-sales-2035*.

[825] California Air Resources Board, Advanced Clean Trucks Regulation, Final Statement of Reasons, March 2021. Accessed on Jan 8, 2024 at *https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2019/act2019/fsor.pdf*.

estimates that include the major components needed to manufacture a PHEV, including batteries, e-motors, power electronics, and other ancillary systems. We requested comment on these PHEV cost estimates and noted that in the final rule we may rely upon the estimates and other information gathered through the public comment process and our ongoing technical work.

In the proposal, we noted that many light- and medium-duty PHEVs purchased for commercial use would be eligible for the Commercial Clean Vehicle Credit (45W), which provides a credit of up to $7,500 for qualified vehicles with gross vehicle weight ratings (GVWRs) of under 14,000 pounds.[826] As the amount of the credit depends on the GVWR and the incremental cost of the vehicle relative to a comparable ICE vehicle, EPA requested comment on estimating the amount of the credit that will on average apply to commercial MDV PHEVs, such as PHEV pickups, and other commercial PHEVs and BEVs. We did not receive comment on this topic.

In addition to the inclusion of PHEVs as a technology option, EPA also updated its characterization of other ICE and HEV vehicle technologies in its ALPHA modeling (see RIA Chapter 2.4). These updates included new hybrid architectures such as a series-parallel P4 hybrid for light-duty trucks, a range-extending PHEV configuration for medium-duty trucks, and new engines for medium-duty diesels, including a large bore gasoline PFI engine and an updated map for its diesel engine. ALPHA engine maps and motor maps for HEV, PHEV and BEV technologies are presented in RIA Chapter 3.5.

In RIA Chapter 3.1, we provide discussion of recent trends and feasibility of light-duty and medium-duty vehicle technologies that manufacturers have available to meet the standards. Other aspects of PEV feasibility, such as technology costs, consumer acceptance, charging infrastructure accessibility, supply chain security, manufacturing capacity, critical mineral availability, and effects of BEV penetration on upstream emissions are discussed in the respective chapters of the RIA.

EPA received comments from automotive suppliers and some environmental NGOs that suggested we should model continued advances in ICE technology in both light-duty and medium-duty vehicles. Some commenters (*e.g.,* ACEEE and ICCT) recommended that EPA should include in its modeling additional advanced ICE technology for medium-duty vehicles, especially MD pickups.

EPA agrees that there is a potential for continued GHG reductions in ICE engine designs and manufacturers may choose to improve the efficiency of their ICE powertrains as part of their pathway for compliance. EPA's experience with modeling ICE powertrain technologies is that improvements are often targeting common loss mechanisms: reductions in pumping losses, reduction of friction and parasitics, improved combustion, broader and higher thermal efficiency, and on-cycle optimization of engine operation. In our modeling, one technology can often be used as a surrogate to reflect a range of technologies that address similar levels of improvements. For example, EPA has observed that an ''advanced gasoline engine'' could represent technologies ranging from Atkinson cycle engines to turbo downsized engines with the overall reduction in GHG emissions and costs of similar magnitude. While we do not model every unique technology combination that could potentially be implemented by manufacturers, our modeling of ICE powertrains should generally represent the emissions reduction potential and costs of advanced engine technologies. Nevertheless, we acknowledge that there are a wide range of possible ICE powertrain combinations available to manufacturers, beyond those included in EPA modeling, and that some of these technology implementations may outperform EPA's assessment of potential GHG reductions.

As evidenced by their public announcements, manufacturers have signaled a clear shift to focus on the development of electrified powertrains. Through conversations with OEMs, several companies have indicated that they are diverting their R&D budgets towards development of electric vehicles, and others have publicly indicated that the upcoming generation of internal combustion engines will be the last new designs.[827] [828] Accordingly, ICE engineering departments at automakers are being reallocated to electric vehicle design, development, and integration functions, or are contracting commensurate with the reductions in new internal combustion engine programs.

This shift towards significantly greater adoption and deployment of electrification technologies makes it possible for manufacturers to achieve significantly greater emissions reductions than would be feasible relying solely on improved efficiencies of internal combustion engines. Accordingly, EPA focused its modeling efforts on those technologies which we anticipate OEMs will likely choose to adopt in support of these standards. EPA's analysis projects that manufacturers will use electrification as their primary compliance pathway, given the significantly more favorable cost effectiveness of electrified powertrains in achieving more stringent GHG standards.

Our assessment of technology generally represents the potential for cost-effective improvements and parallels the increased manufacturer focus on electrification. For these reasons, EPA has prioritized its modeling updates towards electrified technologies, rather than continued ICE advances. However, by maintaining performance-based GHG standards, the agency keeps in place a compliance architecture which fully recognizes all available technologies that result in reduced GHG emissions. Table 4 of the executive summary highlights three potential pathways which show a range of technology penetrations, and the sensitivities described in section IV.F of this preamble illustrate additional pathways to compliance.

2. Approach to Estimating Electrification Technology Costs

Costs for electrification technologies, such as batteries and other electrified vehicle components, are an important input to the feasibility analysis. This section provides a general review of how battery and other electrification component costs were updated for this final rule analysis. A more detailed discussion of the electrification cost estimates and the sources we considered may be found in RIA Chapter 2. EPA responses to all of the comments on this topic may be found in RTC section 12.2.

Our battery costs for the final rule analysis are higher than in the proposal, due to a number of factors that we took into consideration, both from the public comments and from the completion of ongoing and additional research that we described in the proposal.

For the proposal, EPA used Argonne National Laboratory's (ANL) BatPaC model version 5.0 (then current) to generate base year (2022) direct manufacturing cost estimates for battery packs at an annual production volume of 250,000 packs. To estimate battery cost in future years, the proposal applied an annual cost reduction by

[826] Up to $40,000 for qualified Class 4 and higher vehicles above 14,000 pounds GVWR.

[827] *https://www.motor1.com/news/660320/vw-passat-tiguan-last-ice/.*

[828] *https://www.reuters.com/business/autos-transportation/mercedes-benz-launches-e-class-its-last-new-combustion-engine-model-2023-04-25/.*

means of a learning equation that included the effect of cumulative production of batteries (in GWh) under each modeled compliance scenario. To validate these results, we compared them to industry forecasts and other literature regarding expected costs for BEV battery packs in future years.

Forecasting of future battery costs is a very active research area, particularly at this time of rapidly increasing demand in an actively evolving industry. In the proposal, we noted that the battery costs we were using in the proposal analysis were nominally lower than the average pack cost that was reported in a late-breaking Bloomberg New Energy Finance (BNEF) report released on December 6, 2022. This annual battery price survey by BNEF indicated that after years of steady decline, the global average price for lithium-ion battery packs (volume-weighted across the passenger, commercial, bus, and stationary markets) had climbed by about 7 percent in 2022.[829] [830] For passenger vehicle BEV batteries the average price paid was reported to be $138 per kWh. We noted that there was uncertainty in comparing the BNEF survey costs to the modeled costs in our analysis due to possible differences in pack size, construction, or application. Since that time, the 2023 BNEF survey has reported that pack costs across the industry fell by 14 percent in 2023, with an average of $128 per kWh for passenger BEVs. This further illustrates the dynamic nature of the battery market and of battery price projections.

In light of the 2022 BNEF report, we noted that we would consider this and any other new forecasts of battery cost or similar information, as they became available and to the extent possible, for the final rule analysis. We also noted that we would be working with ANL to continue updating our estimates of battery cost by considering adjustments to key inputs to the BatPaC model to represent expected improvements to production processes, forecasts of future mineral costs, and design improvements.

In the proposal, EPA requested comment on all aspects of the battery and non-battery costs used in the NPRM analysis, including base year battery costs, future battery costs, electric vehicle driving range, and similar issues that would affect how battery and non-battery costs should be modeled. We received a variety of comments relating to current and future battery pack costs, and partly in response to these comments we have made significant updates to our battery cost assumptions.

Some commenters, primarily from environmental NGOs, electric vehicle manufacturers, and the electrification industry, stated that the battery costs in the proposal were either appropriate or too high. Other commenters, primarily representing major automakers, the fuels industry, and various advocacy groups, stated that the costs were too low. Many of those who felt that the costs were too low referred to uncertainty surrounding near-term and long-term mineral costs and cited (among other references) the aforementioned December 2022 BNEF survey as evidence that our base year battery costs were too low. These commenters also referred to volatility of mineral and component prices that might be expected during a time of rapid increase in demand and suggested that we should consider scenarios in which battery costs decline at a slower rate than we had assumed, or do not decline at all. Some specifically suggested that we consider a paper by Mauler et al.[831] that outlined the impact of future mineral costs on cell manufacturing costs under several pricing scenarios and set our battery costs and/or our battery cost sensitivities using the results of that paper. These commenters also criticized specific assumptions that they felt caused our battery costs to be too low, including too high a production volume in the base year, too high a learning rate in future years, use of cumulative GWh of battery production as an input to the battery cost learning equation, too low a labor rate, and a number of specific engineering considerations that they contend are exerting pressure to keep battery costs high independent of manufacturing cost improvements.

Other commenters stated that our use of nickel-based cathode chemistry (NMC) did not recognize the potentially lower cost of lithium-iron phosphate (LFP) cathode chemistry, and that this chemistry has less exposure to uncertainties related to critical minerals.

Regarding PHEVs, we also received comment advocating for inclusion of longer-range PHEVs in the analysis, and that these vehicles could use the same batteries as BEVs, owing to the relatively large size of the battery.

To update our estimate of current and future battery pack costs, and as mentioned in the proposal, we worked with the Department of Energy and Argonne National Laboratory to develop a year-by-year projection of battery costs from 2023 to 2035, using specific inputs that represent ANL's expert view of the current state-of-the-art and of the path of future battery chemistries and the battery manufacturing industry.[832] By default, BatPaC estimates only a current-year battery production cost and does not support the specification of a future year for cost estimation purposes. However, some parameters can be modified within BatPaC to represent anticipated improvements in specific aspects of cell and pack production. For example, cell yield is controlled by an input parameter that can be modified to represent higher cell yields likely to result from learning-by-doing and improved manufacturing processes. ANL identified several parameters that could similarly represent future improvements. This allowed ANL to estimate future pack costs in each of several specific future years from 2023 to 2035, allowing cost trends over time to be characterized by a mathematical regression.

A major element of the approach was to select BatPaC input parameters to reflect current and future technology advances and calculate the cost of batteries for different classes of vehicles at their anticipated production volumes. Material cost inputs to the BatPaC simulations were based on forecasted material prices by Benchmark Mineral Intelligence. That is, pack costs were estimated from current and anticipated future battery materials, cell and pack design parameters, and market prices and vehicle penetration. Pack cost improvements in future years were represented at three levels: manufacturing (increasing cell yield and plant capacity), pack (reducing cell and module numbers and increasing cell capacity), and cell (changing active material compositions and increasing electrode thickness). The simulations yielded battery pack cost estimates that can be represented by correlations for model years 2023 to 2035.

As with the pack designs modeled by EPA for the proposal, the pack designs modeled by ANL follow recent trends in PEV battery design and configuration in high-production PEV models. Pack

[829] Bloomberg New Energy Finance, ''Rising Battery Prices Threaten to Derail the Arrival of Affordable EVs,'' December 6, 2022. Accessed on December 6, 2022 at: *https://www.bloomberg.com/news/articles/2022-12-06/rising-battery-prices-threaten-to-derail-the-arrival-of-affordable-evs*.

[830] Bloomberg New Energy Finance, ''Lithium-ion Battery Pack Prices Rise for First Time to an Average of $151/kWh,'' December 6, 2022. Accessed on December 6, 2022 at: *https://about.bnef.com/blog/lithium-ion-battery-pack-prices-rise-for-first-time-to-an-average-of-151-kwh/*.

[831] Mauler et al., ''Technological innovation vs. tightening raw material markets: falling battery costs put at risk,'' Energy Advances, v.1, pp. 136–145 (2022).

[832] Argonne National Laboratory, ''Cost Analysis and Projections for U.S.-Manufactured Automotive Lithium-ion Batteries,'' ANL/CSE–24/1, January 2024.

topologies, cell sizes, and chemistry are consistent with those seen in emerging high-production battery platforms, such as for example the GM Ultium battery platform, the VW MEB vehicle platform, and the Hyundai E–GMP vehicle platform. ANL then considered the potential for continued improvements in chemistry and manufacturing over the time frame of the rule.

The ANL analysis provided EPA with several equations for battery pack direct manufacturing costs as a function of model year and battery capacity (kWh), for both nickel-based (NMC) chemistry and iron-phosphate based (LFP) chemistry. We have incorporated these costs into the analysis in place of the costs that were used for the proposal.

As a result of this updated work, and as seen in Figure 24, our updated battery direct manufacturing costs for the final rule are significantly higher than in the proposal. Using an example of a 100-kWh battery, Figure 24 compares the updated FRM battery costs (central case and sensitivities) to the costs and sensitivities used in the proposal.

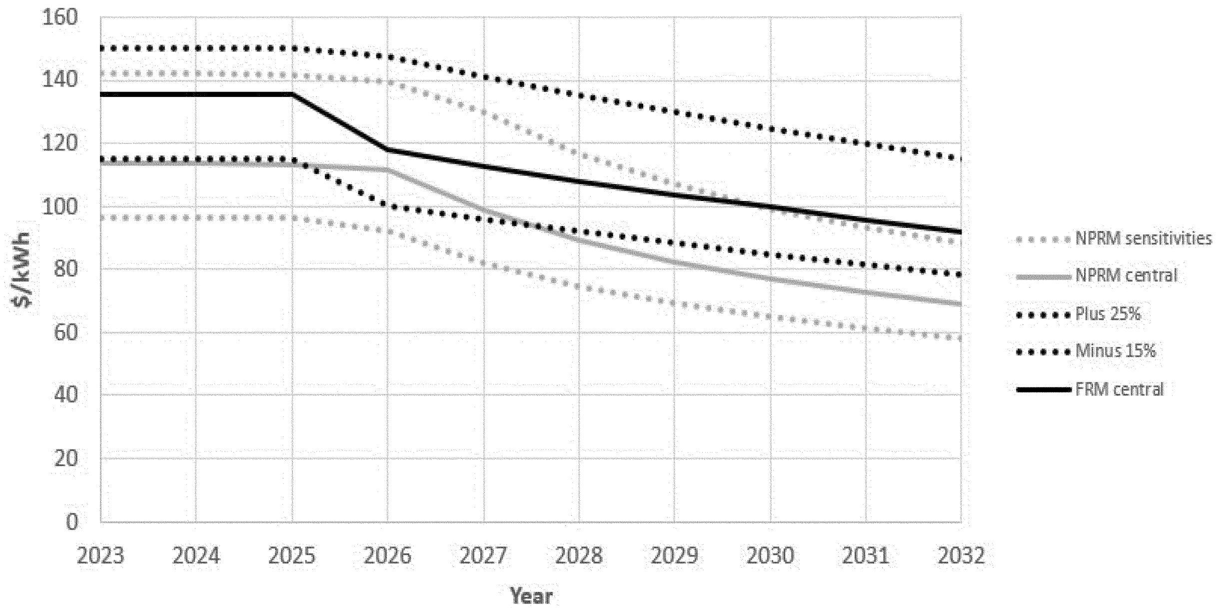

Figure 24: Comparison of OMEGA Input Costs for a 100-kWh Battery, NPRM to FRM

As seen in Table 68, our battery cost inputs (example shown for a 100 kWh battery) have increased by an average of 26 percent compared to the proposal, ranging from about 21 percent higher in the early years to about 36 percent higher in the later years.

TABLE 68—DIFFERENCE IN BATTERY COST PER KWH FROM NPRM TO FRM, 100-KWH BATTERY EXAMPLE

Year	NPRM	FRM	Difference (%)
2023	114	138	21
2024	114	138	21
2025	113	137	21
2026	111	120	8
2027	99	115	16
2028	89	110	24
2029	83	106	27
2030	77	101	31
2031	73	97	33
2032	69	94	36
2033	66	90	36
2034	64	87	35
2035	62	83	34

The increase in cost is largely a product of the most recent trends and forecasts of future mineral costs being now explicitly represented via the ANL work,[833] and also are an outcome of basing the future costs on a specific set of technology pathways instead of applying a year-over-year cost reduction rate. Most other forecasts of future battery costs, including some of those that we cited in the proposal, are based largely on application of a historical cost reduction rate (*i.e.,* learning rate), without reference to the specific technology pathways that might lead to those cost reductions. ANL's approach is consistent with that of the Mauler

[833] Id.

paper,[834] which also identified and modeled a specific set of technology pathways. EPA acknowledges one potential criticism of such an approach is that it may lead to conservative results, because it excludes the potential effect of currently unanticipated or highly uncertain developments that may nonetheless come to fruition. On the other hand, basing the costs on specific high confidence pathways allows the basis of the projections to have greater transparency.

Accordingly, these updated battery costs are responsive to many of the comments. First, the ANL work accounts more explicitly for the potential effect of critical mineral prices on the cost of batteries over time. We worked with ANL to make available medium- and long-term mineral price forecasts from Benchmark Mineral Intelligence, a leading minerals analysis firm. These were then used to estimate electrode material prices over the years of the ANL analysis. This is one factor contributing to the higher battery costs used in our updated analysis. Second, as one outcome of this update, in the early years of the program, our battery cost inputs are now in closer agreement with the 2022 BNEF battery price survey, which commenters widely mentioned. Finally, the generally higher costs are responsive to general comments stating the position that our assumptions for current and future battery costs were too low. Because it allowed us to account for the most recent trends and developments, in particular by more fully considering the potential impact of mineral demand and the specific impact of anticipated advancements in lithium-ion technology and manufacturing, our use of the costs forecast by ANL is responsive to these comments.

As another way to account for commenter concerns about uncertainty in near-term battery costs, we have retained a plateau in costs between 2023 and 2025, in which our battery cost assumptions do not decline as would be indicated by the ANL equations for 2024 and 2025, but instead stay at the cost indicated by the ANL equations for 2023. Because the ANL cost equations account for the effect of projected mineral prices and do not indicate that battery costs will remain elevated at 2023 levels for 2024 and 2025, our retention of the plateau is a conservative assumption.

[834] Mauler et al., ''Technological innovation vs. tightening raw material markets: falling battery costs put at risk,'' Energy Advances, 2022, v. 1, pp. 136–145.

Some commenters raised the possibility that batteries manufactured in the U.S. (in order to capture the various IRA incentives) would experience higher labor rates. We also recognized the fact that, during the comment period and afterward, several major U.S. automakers were negotiating new labor contracts, with an emphasis on electrification. To represent higher labor costs, the ANL equations that EPA used are based on a $50 per hour labor cost ($70 per hour including variable overhead/benefits), which represents the assumption that U.S. battery plants will largely operate under the same labor agreements as major automotive plants. In comparison to the battery costs used in the NPRM analysis, which were based on the default value in BatPaC of $25 per hour ($35 including variable overhead/benefits), the higher labor cost resulted in an increase in pack cost per kWh of about two to three percent. It is well understood in the industry, and confirmed by BatPaC modeling, that labor is a relatively small portion of battery cost in comparison to material costs. The two to three percent increase is also generally consistent with recent remarks by General Motors that their new contract with the United Auto Workers would increase battery cell prices by about $3 per kWh.[835]

In response to comments regarding the ability of longer-range PHEVs to use BEV batteries, we note that the ANL battery cost equations were developed with consideration of higher power-to-energy ratios at the lower end of their kWh capacity range, making those battery sizes applicable to either BEVs or PHEVs. In the updated analysis, only longer-range PHEVs[836] are placed into the fleet, and their battery costs are derived from the same equations as BEVs.

Our consideration of the public comments led to another update to our method of accounting for future learning. In the proposal, EPA introduced a method of accounting for learning-by-doing by considering cumulative production of batteries (in GWh) resulting from various policy scenarios modeled by OMEGA. When the OMEGA model generated a compliant fleet in a given future year of the analysis, battery costs for BEVs in that year were determined dynamically, by applying a learning cost reduction factor to the base year cost. The learning factor was calculated in part based on the cumulative GWh of battery production necessary to supply the number of BEVs that OMEGA had thus far placed in the analysis fleet, up to that analysis year. This approach was consistent with ''learning by doing,'' a standard basis for representing cost reductions due to learning in which a specific percentage cost reduction occurs with each doubling of cumulative production over time. This dynamic method of assigning a cost reduction due to learning meant that different OMEGA runs that result in different cumulative battery production levels would project somewhat different battery costs. In the proposal, EPA requested comment on our use of cumulative GWh as a determinant of learning effects, and evidence and data related to the potential use of global battery production volumes instead of domestic volumes in that context, and/or the use of battery production volumes in related sectors.

[835] LaReau, J.L., ''GM labor contracts will add $1.5 billion to costs, but here's how GM expects to offset it,'' Detroit Free Press, November 29, 2023.

[836] In OMEGA, EPA assumed that light-duty vehicle PHEV batteries would be sized for 40 miles of all-electric range over the US06 cycle, while medium-duty PHEVs would be sized to drive 75 miles over the UDDS while tested at ALVW.

For several reasons, in the current analysis we chose to return to our previous practice of representing future battery cost reductions as a function of time rather than a function of cumulative GWh produced. Some commenters stated that the proposal's method was new with respect to previous analyses and lacked sufficient documentation; that it failed to establish a baseline that included global production; and that it should have been based on cumulative global production rather than only cumulative domestic production.

In light of these comments, we make several observations here. Because OMEGA does not model global demand for batteries, considering global demand is difficult in the context of this analysis. Also, the establishment of a baseline would require data on historical production of batteries both domestic and globally, which itself would be subject to uncertainty. We also note that some commenters stated the importance of alignment of EPA standards with those of the NHTSA CAFE proposal, which is consistent with the use of similar battery costs. Unlike the EPA compliance model, NHTSA's compliance model does not support the use of the cumulative GWh production approach, meaning that alignment on battery costs would be difficult if EPA were to continue using the proposal approach. Another relevant factor is both agencies' use of the ANL battery cost study, which promotes such alignment. The future battery cost equations provided by ANL incorporate fixed assumptions for battery cost reductions over time and do not support cumulative GWh of battery production as an input. We also found that the use of cumulative GWh as a factor in the cost of batteries made it difficult to communicate the battery costs that were used in the analysis, because under this approach the battery costs would vary with each compliance scenario due to differences in projected PEV penetration among the scenarios. Although we continue to believe that a battery cost learning method based on cumulative production can offer the advantage of allowing battery costs in a given compliance scenario to be properly responsive to large differences in battery demand and production among the scenarios, we have decided not to continue the use of this method at this time.

For 2023 to 2035, we use the battery cost equations developed by ANL for our battery cost assumptions, and because these are based on application of specific technology pathways, we no longer develop costs for those years by means of a time-based cost reduction factor. For years after 2035, where the ANL equations no longer apply, a cost reduction factor remains necessary, and for those years we implemented a 1.5 percent year-over-year cost reduction. Our use of 1.5 percent results in a rate of cost reduction within the range of long-term reductions commonly encountered in the literature. Moreover, we selected this specific figure because it is consistent with preventing projected battery costs in the far future from declining to levels that have not commonly found support in the literature. A 1.5 percent year over year cost reduction would limit battery cost from declining lower than about $60 per kWh in 2055, a figure that is similar to or conservative with respect to a number of long-range forecasts found in the literature. For example, this is generally consistent with projections found in a review of battery cost forecasting methods by Mauler et al.,[837] which describes a comprehensive survey of battery cost projections that average to a projection of $70 per kWh in 2050 (which at the rate of cost reduction implied in the paper, would be equivalent to $63 per kWh in 2055).

In response to comments and updated work from ANL, EPA also updated the OMEGA inputs for specific energy of HEV, PHEV and BEV battery packs. The ANL battery cost study included projections of the future specific energy of NMC and LFP battery packs, as provided by the BatPaC model that also determined their cost. This has resulted in somewhat lighter batteries over time than assumed in the NPRM analysis, where improvements in specific energy were not modeled.

In response to comments recommending inclusion of LFP chemistries, our updated battery costs are now a weighted average of ANL's cost equations for LFP and NMC batteries, with a weighting derived from forecasts of LFP cathode or battery production likely to be present in the U.S. PEV market. LFP is already present in a small portion of light-duty PEVs and its share is expected to increase in the future, due to its lower cost and absence of the critical minerals such as cobalt, manganese, and nickel. LFP chemistry is also potentially applicable to some medium-duty vehicles such as delivery vans, whose larger size may better accommodate the lower energy density of this chemistry. The weighting ranges from 8 percent LFP in 2023, 16 percent in 2025 and leveling off at 19 percent in 2028. For more discussion of the LFP weighting, see RIA Chapter 2.

We also received comment on the upper and lower battery cost sensitivities that we considered in the proposal, where we included sensitivities for battery pack costs that were 25 percent higher and 15 percent lower (on a $/kWh basis) than the battery pack costs in the central case. Some commenters who felt that our battery costs were too low and/or our learning rates were too high disagreed with the basis of the upper and lower sensitivity percentages as being arbitrary and/or insufficient, particularly on the high side. Some commenters specifically felt that EPA should have used an upper sensitivity of greater than 25 percent, or not limited to a fixed percentage over time, in order to capture what they believe is a more appropriate range of uncertainty. In particular, some commenters indicated that we should have considered Mauler et al. (2022) in setting the high sensitivity.

EPA continues to believe that a fixed percentage above and below the central case can be an appropriate way to establish upper and lower bounds for a sensitivity, if the resulting band can be shown to adequately cover a range of reasonably plausible outcomes for future battery costs. For the updated analysis, we examined the appropriateness of the plus 25 percent and minus 15 percent range as applied to the updated central case battery costs which are significantly higher than in the proposal. We also examined the Mauler et al. paper and compared the range of scenarios expressed there to the band of costs that would be defined by this range.[838]

Figure 25 shows, for an example 100 kWh battery pack, how this band of sensitivities compares to the Mauler scenarios (which extend only to the year 2030). It shows that retaining the 25 and 15 percent sensitivities around the updated central case costs establishes a band that largely includes the Mauler scenarios, including almost all of the highest Mauler scenario, in which costs do not decline at all. The highest Mauler scenario, although not defined by the authors past 2030, presumably would continue its elevated price scenario indefinitely if it were so extended. However, such a scenario of perpetually elevated cost does not appear to be widely supported among analysts and is not consistent with the most recent forecasts of mineral prices through the same time frame, which indicate generally declining or flat costs for virtually every battery critical mineral.[839] [840]

Regarding the lower case sensitivity, we note that the most recent annual BNEF battery price survey, which was released in November 2023, indicates that battery prices fell by 14 percent since the 2022 survey was published, and forecasts costs of $113 per kWh in 2025 and $80 per kWh in 2030.[841] This contrasts sharply with the 7 percent increase that was reported in the 2022 survey, strongly suggesting that battery costs have begun to resume their historical downward trend, and reinforcing our expectation that the highest Mauler scenario is unlikely. This is also another factor that supports our characterization of our updated battery costs as conservative. BNEF's projections for 2026 and 2030 align well

[837] Mauler et al., ''Battery cost forecasting: a review of methods and results with an outlook to 2050,'' Energy Environ. Sci, v.14, pp. 4712–4739 (2021).

[838] While the Mauler paper reported cell costs instead of pack costs, we converted the Mauler cell cost to pack cost by dividing the Mauler cell cost by 0.8, as suggested by the Alliance comments that examined the Mauler paper. We also note that pack costs tend to decline with pack size, and Mauler's cell costs are by definition independent of pack size. Therefore, our choice of a 100-kWh pack for comparison to Mauler's converted cell costs may be conservative, as our depicted costs would be higher for a smaller pack.

[839] Wood Mackenzie, ''Electric Vehicle & Battery Supply Chain Short-term outlook January 2024'', slide 29, February 2, 2024 (filename: evbsc-short-term-outlook-january-2024.pdf). Available to subscribers.

[840] Wood Mackenzie, ''Global cathode and precursor short-term outlook January 2024,'' slide 5, January 2024 (filename: global-cathode-and-precursor-market-short-term-outlook-january-2024.pdf). Available to subscribers.

[841] BloombergNEF, ''Lithium-Ion Battery Pack Prices Hit Record Low of $139/kWh,'' November 27, 2023. Accessed on December 6, 2023 at *https://about.bnef.com/blog/lithium-ion-battery-pack-prices-hit-record-low-of-139-kwh/*.

with our minus 15 percent lower sensitivity, as seen in Figure 25.

Because the range of sensitivities largely includes the extremes represented by the Mauler et al. paper (which was specifically cited by commenters), as well as the latest BNEF forecast for 2026 and 2030, EPA considers the plus 25 percent and minus 15 percent sensitivities in the updated analysis to be responsive to commenters' concerns. Specifically for 2023 to 2025, we truncated the high sensitivity at $150 per kWh,[842] based on EPA's assessment of current battery costs as already lower than $150 per kWh and near-term trends not indicative of an increase, as described in this section.

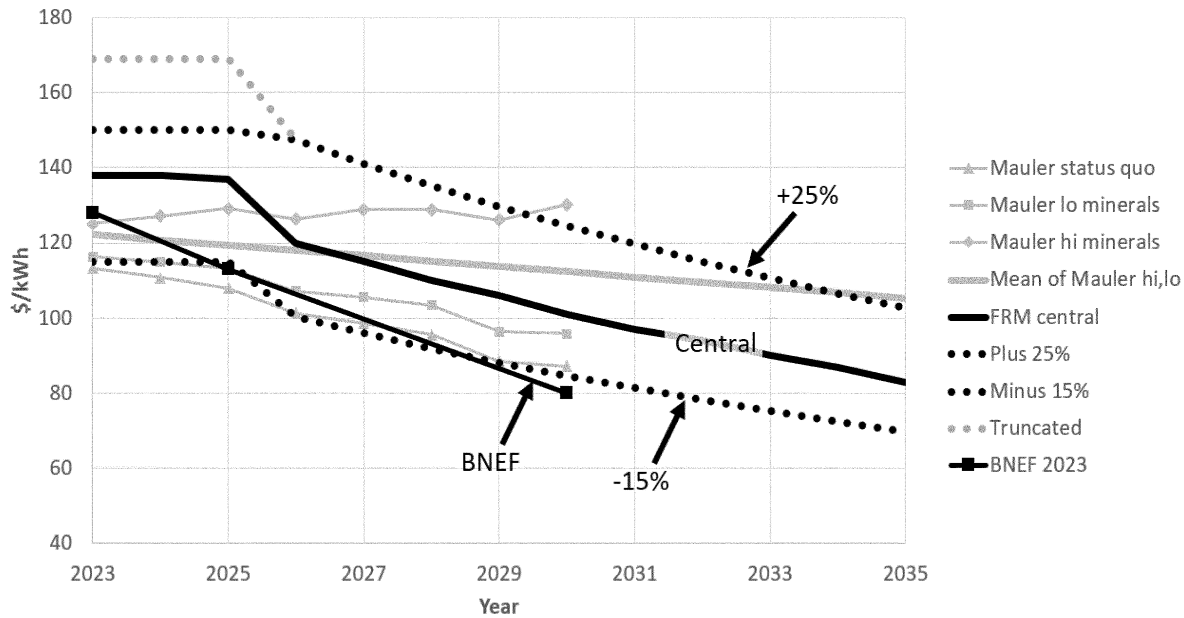

Figure 25: Battery Cost Sensitivity Ranges in the Updated Analysis

In light of the updates described above and consideration of public comment, EPA considers the updated battery direct manufacturing cost estimates and the sensitivities to be reasonable and conservative, based on the record and best available information at this time. In particular, considering recent forecasts for falling mineral prices during the next several years, and the trend of falling battery prices recently indicated by the 2023 BNEF battery price survey, we consider it more likely that the central case may prove to be an overestimate than an underestimate. We also note that the battery costs in the lower sensitivity case are similar to the trajectory of the BNEF forecast, suggesting that the program costs may be more similar to that indicated by the lower battery cost sensitivity if the BNEF forecast proves accurate. A more detailed discussion of the development of the battery cost estimates used in this final rule and the sources we considered may be found in RIA Chapter 2.

The battery cost estimates discussed thus far do not include the effect of tax credits available to battery manufacturers under the Inflation Reduction Act. These include the cell and module production tax credit of up to $45 per kWh available to manufacturers under IRC 45X, and the additional tax credit for 10 percent of the production cost of (a) critical minerals and (b) electrode active materials available to manufacturers under 45X.

In the proposal, EPA estimated potential future uptake of the IRA credits and how they would impact manufacturing costs for batteries over the time frame of the rule. We requested comment on all aspects of our accounting for the IRA credits, including not only the values used for the credits but also whether or not we should also account for the additional 10 percent provisions for electrode active materials and critical mineral production, which we did not estimate for the proposal.

The 45X cell and module credit provides a $35 per kWh tax credit for U.S. manufacture of battery cells, and an additional $10 per kWh for U.S. manufacture of battery modules. 45X also provides a credit equal to 10 percent of the manufacturing cost of electrode active materials and another 10 percent for the manufacturing cost of critical minerals if produced in the U.S. The credits phase out from 2030 to 2032 (with the exception of the 10 percent for critical minerals, which continues indefinitely).

In the proposal, we assumed that manufacturer ability to take advantage of the $35 cell credit and the $10 module credit would ramp up linearly from 60 percent of total cells and modules in 2023 (based on the approximate percentage of U.S.-based battery and cell manufacturing likely to be eligible today for the credit)[843 844 845] to 100 percent in 2027, and then ramping down by 25 percent per year as the credit phases out from 2030 (75

[842] The computed +25% values that were reduced to $150/kWh are represented by the line labeled ''Truncated'' in Figure 25.

[843] U.S. Department of Energy, ''FOTW #1192, June 28, 2021: Most U.S. Light-Duty Plug-In Electric Vehicle Battery Cells and Packs Produced Domestically from 2018 to 2020,'' June 28, 2021. *https://www.energy.gov/eere/vehicles/articles/fotw-1192-june-28-2021-most-us-light-duty-plug-electric-vehicle-battery*.

[844] Argonne National Laboratory, ''Lithium-Ion Battery Supply Chain for E-Drive Vehicles in the United States: 2010–2020,'' ANL/ESD–21/3, March 2021.

[845] U.S. Department of Energy, ''Vehicle Technologies Office Transportation Analysis Fact of the Week #1278, Most Battery Cells and Battery Packs in Plug-in Vehicles Sold in the United States From 2010 to 2021 Were Domestically Produced,'' February 20, 2023.

percent) through 2033 (zero percent). In making these assumptions we noted that many large U.S. battery production facilities were being actively developed by OEMs and their suppliers and their announced or expected capacities appeared sufficient to meet U.S. demand for batteries as projected by OMEGA.

We received comment on a variety of aspects of our modeling of 45X. Common themes included: questioning the ability of U.S. battery manufacturing facilities currently planned or under construction to ramp up quickly enough; the lack of accounting for the 10 percent electrode active material and critical mineral credit; the ability for imported vehicles to benefit from the credit in accounting for their battery cost; and the assumption that all of the value of the 45X credit would be realized as a cost reduction by OEMs when purchasing cells or packs from suppliers.

Comments received on our modeling of the 45X cell and module credit led us to further investigate our inputs for the phase-in schedule and average amount realized. This included working with the Department of Energy and Argonne National Lab (ANL) to update our assessment of U.S. battery manufacturing facilities and to account for gradual ramp-up of these facilities over time. As discussed in section IV.C.7 of this preamble, the updated analysis largely confirmed the previous assessment that currently planned U.S. battery cell manufacturing capacity is poised to meet projected U.S. demand during the time frame of the rule, even after explicitly accounting for a typical ramp-up period as assessed by DOE and ANL.

Regarding the ability of imported PEVs to benefit from 45X, some commenters stated that imported PEVs are likely to continue to comprise some portion of the market in the future, and because they arrive fully assembled including the battery, this portion of the PEV market is unlikely to benefit from the 45X cell and module credit. EPA agrees that imported vehicles are likely to continue to comprise some portion of the future PEV market. We also note, however, that even foreign manufacturers might in some cases be able to benefit from a reduced battery cost by purchasing cells or battery packs from U.S. suppliers that are able to claim the credit. Even if this possibility is not widely utilized, imported PEVs must compete with the presence of domestic PEVs that do benefit from the credit and may become a smaller part of the fleet over time due to this factor. For example, European battery maker Northvolt's CEO Peter Carlsson has said that with the IRA incentives available in the U.S., ''it is basically impossible to operate in the North American market from anywhere else,'' and has been actively pursuing opportunities to build plants in the U.S. as a result.[846] It is also becoming apparent that foreign manufacturers will often be able to benefit from local incentives in their country of origin that act to reduce the cost of their batteries. Programs offered to battery manufacturers in other countries have already begun to compete with the IRA to provide a similar competitive cost advantage for their own manufacturers. As an example, European battery maker Northvolt was recently awarded a 700 million Euro direct grant and a 202 million Euro guarantee for a 60 GWh plant in Germany that the company says prevented a move to the U.S.,[847] and the company also received a support package in Canada for a multi-billion dollar plant in Quebec for which the Canadian government, Ottawa, and Quebec will provide up to $2.7 billion for construction as well as ''production support to match the Inflation Reduction Act's Advanced Manufacturing Production Credit and value of the 45X tax credit.'' [848]

Regarding the passing of 45X credit savings realized by cell and module suppliers to OEMs via the selling price of the cells or modules, we continue to expect that many suppliers and OEMs will work closely together as they currently do through contractual agreements and partnerships and that these close connections will promote fair pricing arrangements. The large U.S. production capacity that is projected for the time frame of the rule also suggests that the market will be competitive and that suppliers will be motivated to pass credit savings along to customers in order to compete on price. OEMs that vertically integrate will not be subject to these variables and should be able to realize the full amount of the credit through their integrated operations.

Although EPA believes that these factors are likely to counteract commenters' concerns about these issues, EPA also acknowledges that at this early stage of the IRA credit availability, some uncertainty remains about the average amount of the available 45X cell and module credit that will in fact be realized across the U.S. PEV fleet. For example, if cells or modules are exported from the U.S. for use in vehicles that are then imported to the U.S., the value of the 45X credit, even if passed along to the purchaser of the cells or modules, would be offset to some degree by logistics and transportation costs. While local subsidies may exist in many jurisdictions to rival the 45X credit, there is no assurance that they will have the same value. We also note that ANL projections of U.S. battery cell manufacturing capacity prior to the time frame of the rule through 2025 (see section IV.C.7 of this preamble, at Figure 36) is roughly 50 percent of projected demand under the compliance scenarios, suggesting that only about half of PEV batteries may be claiming the 45X cell and module credit in those years preceding the rule. Accordingly to help account for uncertainties including (a) imported vehicles not necessarily having access to the credit, (b) the possibility that U.S. cell manufacturing facilities will not ramp up as quickly as announced, and (c) ANL's reduced projection of U.S. cell plant capacity from 2023 through 2025, we have conservatively reduced our estimates for the average value of the 45X cell and module credits from 2023. Specifically we have modified the yearly average amount as shown in Table 69. In general, we reduced the 2023 value to 50 percent of the available $45 (from 60 percent in the NPRM), and ramped up the value more slowly, to 75 percent in 2030. By 2030, we expect that enough lead time will have occurred (primarily, for manufacturers to secure 45X-qualifying battery supply and increase share of PEVs assembled in North America rather than imported), to gradually rejoin our original estimate of 100 percent of the available credit (now phased down by statute to $11.25) by 2032.

EPA considers these updated values to be responsive to the comments and to be a reasonable and conservative estimate of the 45X cell and module credit across the industry, reflecting current uncertainties. Over time, we expect that the impact of 45X on OEM battery manufacturing cost will become more evident and could turn out to be higher. For our low battery cost sensitivity case, we have retained the NPRM assumptions for 45X. We note

[846] Automotive News Europe, ''VW, BMW battery supplier Northvolt could reap billions from Biden's EV bill,'' February 15, 2023. Accessed on February 2, 2024 at *https://europe.autonews.com/automakers/northvolt-could-reap-billions-us-green-tax-incentives*.

[847] Power Technology, ''Northvolt secures €902m to build EV battery plant in Germany over US,'' January 10, 2024. Accessed on February 2, 2024 at *https://www.power-technology.com/news/northvolt-ev-battery-plant-germany-us/?cf-view&cf-closed*.

[848] CBC News, ''EV battery giant Northvolt to build multibillion-dollar plant in Quebec,'' September 28, 2023. Accessed on February 2, 2024 at *https://www.cbc.ca/news/canada/montreal/quebec-northvolt-ev-battery-factory-1.6980767*.

that many commenters supported our NPRM assumptions for 45X, and we continue to consider those values to represent a fully reasonable future outcome although we have chosen to use lower and more conservative values in the central case.

TABLE 69—UPDATES TO 45X CELL AND MODULE PRODUCTION TAX CREDITS, AVERAGE VALUE ACROSS PEV FLEET ($/KWH) IN OMEGA

Year	NPRM	FRM	FRM % of maximum available credit
2023	$27	$22.50	50.0
2024	31.50	24.11	53.6
2025	36	25.71	57.1
2026	40.50	27.32	60.7
2027	45	28.93	64.3
2028	45	30.54	67.9
2029	45	32.14	71.4
2030	33.75	25.31	75
2031	22.50	19.69	87.5
2032	11.25	11.25	100
2033	0	0	

We also received comment that the 10 percent credit for electrode active materials and critical minerals under 45X could be significant, and therefore should be included in the analysis. To investigate this possibility, we consulted with the Department of Energy and Argonne National Laboratory to characterize the potential value of the 10 percent provisions of 45X on a dollar per kWh basis. ANL determined that the maximum value of the credits would change over time, as critical minerals become a larger share of battery manufacturing cost due to efficiencies in other material and manufacturing costs. As shown in Table 70, the maximum value for the electrode active materials (EAM) credit, or both the EAM credit and the critical minerals (CM) credit, would range from $5.60 to $10.70 per kWh in 2026 and decline to $3.50 to $7.60 per kWh in 2030, depending on chemistry. The decline is a result of ANL's projection that the amount (and hence manufacturing cost) of critical mineral content will decline over time due to improved cell chemistries for which minerals comprise a diminishing portion of total cost.

TABLE 70—POTENTIAL VALUE OF 45X 10 PERCENT CM AND EAM CREDITS FOR A 75-KWH BATTERY

	High performance (Ni/Mn)			Low Cost (LFP)		
	2026	2030	2035	2026	2030	2035
EAM only, Δ $/kWh	7.2	4.5		5.6	3.5	
EAM + CM, Δ $/kWh	10.7	7.6	1.8	7.2	4.9	1.4

While these tax credits will be significant to manufacturers that produce EAM and CM in the U.S., their effect on average battery manufacturing cost across the fleet depends on the degree to which the average battery uses U.S.-produced EAM and CM. Because qualifying production of CM and EAM is unlikely to be sufficient to supply all U.S. PEV batteries based on announcements quantified at the time of ANL's analysis, the average value of the credit on a per kWh basis will be less than the figures above. Because of the uncertainty in predicting the degree of utilization across the industry, and the relatively small average value of the resulting credit, we have chosen to not include an estimate of the 10 percent credits in this analysis. Because some manufacturers will likely be in a position to qualify for some portion of the credit, this is a conservative assumption.

As we did in the proposal, we applied the 45X credits after the RPE markup. Because RPE is meant to be a multiplier against the direct manufacturing cost, and the 45X credit does not reduce the actual direct manufacturing cost at the factory but only compensates the cost after the fact, it was most appropriate to apply the 45X credit to the marked-up cost. The 45X cell and module credits per kWh were applied by first marking up the direct manufacturing cost by the 1.5 RPE factor to determine the indirect cost (*i.e.,* 50 percent of the manufacturing cost), then deducting the credit amount from the marked-up cost to create a post-credit marked-up cost. The post-credit direct manufacturing cost would then become the post-credit marked-up cost minus the indirect cost. Details on the application of the 45X credit in OMEGA can be found in RIA Chapter 2.5.2.1.4 and 2.6.8.

The IRA also includes consumer purchase incentives, which do not affect battery manufacturing cost, but reduce vehicle purchase cost to consumers. A substantial Clean Vehicle Credit (IRC 30D) of up to $7,500 is available to eligible buyers of eligible PEVs, subject to a number of requirements such as location of final assembly (in North America), critical minerals and battery component origin, vehicle retail price, and buyer income. Similarly, a Commercial Clean Vehicle Credit (IRC 45W) of up to $7,500 is available for light-duty vehicles purchased for commercial use. Consistent with the statutory text of the IRA and longstanding tax rules regarding leasing, vehicles leased to consumers (rather than sold) are commercial vehicles and can qualify for the credit to be paid to the lessor, equal to the excess of the purchase price for such vehicle over the price of a comparable internal combustion engine vehicle.[849] EPA recognizes that this guidance could lead to increased relevance of 45W for vehicles and buyers that would not otherwise be eligible for the 30D. Relevant considerations in quantifying the extent to which the 45W may influence cost of PEVs to consumers would include factors such as the degree to which the value of the 45W credit (paid to lessor) would be represented in reduced payments to the lessee, and the degree to which manufacturers and dealers that currently sell vehicles outright choose to adopt a leasing model.

Because of the sourcing and eligibility requirements of the 30D credit and the uncertainties regarding relative utilization of the 45W credit, EPA did not assume in the proposal that all BEV sales would qualify for the full $7,500 30D or 45W credit. However, we did acknowledge that some portion of the market that is unable to capture the 30D credit may be capable of utilizing the 45W credit. For these reasons, in the analysis for the proposal, we applied only a portion of the $7,500 maximum from either incentive. For 2023, in the proposal, we estimated that an average credit amount (across all PEV purchases) of $3,750 per vehicle could reasonably be expected to be realized through a combination of the 30D and 45W tax credits. For later years, we recognized that the attractiveness of the credits to manufacturers and consumers would likely increase eligibility over time. To reflect this, we ramped the value linearly to $6,000 by 2032, the last year of the credits. The proposal analysis did not ramp to the full theoretical value of $7,500, in expectation that not all purchases will qualify for 30D due to MSRP or income requirements, and that not all PEVs are likely to enter the market through leasing.

We received a number of comments regarding our estimation of the 30D and 45W credits in the proposal. Commenters that emphasized the potential for IRA consumer incentives such as 30D and 45W to reduce vehicle cost to the consumer expressed broad support for EPA's inclusion of the credits in the analysis and did not disagree with EPA's year by year estimates of the average realized value of 30D and 45W credits. A variety of other commenters expressed the view that our estimates may have been too optimistic for various reasons. These reasons centered around their views regarding: the ability of U.S. battery manufacturing facilities and mineral mining and processing to ramp up rapidly enough to provide the critical minerals and battery components necessary to claim the credit; the ability of the domestic battery supply chain to grow fast enough to fulfill the increasing requirements for domestic sourcing for 30D eligibility; that the basis for the chosen values was unclear; that the impact of critical mineral and component sourcing requirements, and income and MSRP limits, was not quantified; and uncertainty surrounding the then-unreleased Treasury guidance regarding specific requirements for sourcing, particularly the Foreign Entity of Concern (FEOC) requirement. Some commenters also expressed skepticism that leasing rates under the 45W provision would increase sufficiently to achieve the modeled assumptions for 30D and 45W combined.

These comments led us to revisit our assumptions for the combined effect of the 30D and 45W credits over the time frame of the rule. We requested the Department of Energy to perform an independent assessment[850] of the potential for average combined realization of 30D and 45W across the fleet for each year of the rule, taking into account the various eligibility constraints, trends in leasing, and rate of growth in U.S. battery manufacturing facilities including an accounting for gradual ramp-up over time. The assessment was performed by DOE analysts across multiple offices and National Laboratories using the latest market data at the automaker level including data on critical minerals, battery components, status of the automotive supply chain, and PEV adoption. This work resulted in a set of year-by-year estimates of fleet-average credit values for the combined effect of 30D and 45W, shown in Table 71.

DOE projected that the market-weighted average PEV can receive around $3,900 per vehicle in 2023 between the 30D and 45W credits, increasing to $6,000 in 2032. The figures are very close to the those that EPA used in the proposal.

TABLE 71—DOE ESTIMATES FOR 30D AND 45W CLEAN VEHICLE CREDIT

Model year	NPRM	DOE	Difference
2022	$0	$0	
2023	3750	3900	+150
2024	4000	4300	+300
2025	4250	4400	+150
2026	4500	4400	−100
2027	4750	4800	+50
2028	5000	5000	
2029	5250	5200	−50
2030	5500	5500	
2031	5750	5800	+50
2032	6000	6000	
2033	0	0	

Data sources underlying these projections include: PEV penetration rates based on EPA's projections from its 2021 rule for MYs 2023–2026 standards and the proposed standards for MYs 2027–2032; OEM production shares as of MY 2021 from the EPA Automotive Trends Database; share of cars and light trucks from the U.S. Energy Information Administration's Annual Energy Outlook 2023; shares of U.S. PEV sales and MSRPs derived from the Argonne National Laboratory E-Drive Sales Database, shares of North American final assembly compiled from

[849] Internal Revenue Service, ''Topic G—Frequently Asked Questions About Qualified Commercial Clean Vehicles Credit,'' February 3, 2023. *https://www.irs.gov/newsroom/topic-g-frequently-asked-questions-about-qualified-commercial-clean-vehicles-credit.*

[850] Department of Energy, ''Estimating Federal Tax Incentives for Heavy Duty Electric Vehicle Infrastructure and for Acquiring Electric Vehicles Weighing Less Than 14,000 Pounds,'' Memorandum, March 11, 2024.

Wards Auto data by Oak Ridge National Laboratory, and public sources describing the establishment of new electric vehicle assembly lines collected by the Department of Energy; share of U.S. EV sales that meet the applicable percentages of critical minerals and battery components, estimated using expert analysis from several DOE offices considering several public and proprietary critical mineral and battery component supply chain datasets (including automaker-reported information to the U.S. Treasury and Internal Revenue Service tracking vehicles qualified for 30D as reported on *FuelEconomy.gov*); and share of U.S. PEV sales that exclude suppliers that are FEOCs (estimated by DOE using deliberative information during the pre-rulemaking phase of implementing the FEOC restriction in IRC 30D).[851] DOE was further informed by confidential discussions with OEMs regarding supplier plans held throughout 2023. Lease rates were estimated using the latest data available from J.D. Power for light-duty electric vehicles. Additional detail and references can be found in the memorandum document cited above.

We also received comment that there is no guarantee that the full value of the 30D/45W credits will be passed on to the vehicle buyer but instead could be captured as profit by the vehicle manufacturer. However, we project that manufacturers will choose to produce PEVs as a means to comply with the standards. In this situation, we believe that manufacturers will be incentivized to compete with one another on a pricing basis. If a vehicle OEM were to capture a large portion of the credit as additional profit, this would conflict with the manufacturer's ability to sell the vehicles, which manufacturers are motivated to do as one of the lowest cost pathways to meeting the standards. In this final rule analysis, EPA continues to apply the full estimated average value of the 30D/45W credit toward the purchase price seen by the consumer. The 30D/45W credit amount is modeled in OMEGA as a direct reduction to the consumer purchase costs,[852] and therefore has an influence on the shares of BEVs demanded by consumers within the model. The purchase incentive is assumed to be realized entirely by the consumer and does not impact the vehicle production costs for the producer.

However, EPA also acknowledges that the relative newness of the 30D and 45W credits, as well as the content requirements for 30D and outstanding Treasury guidance that has not been finalized at the time of this writing, contribute to uncertainty at the present time regarding the average combined credit value that will ultimately be realized across the fleet and across the diversity of future PEV models. For example, specific guidance has not been finalized on the transition rule for non-traceable battery materials and excluded entity provision under 30D.[853] We also note that DOE was unable to incorporate into its modeling several features of the 30D and 45W tax credits that may affect eligibility, and which have been specifically raised by some commenters, including modified adjusted gross income (MAGI) of future buyers, the possibility that the credit may exceed the tax liability of some future buyers, the effect of future trends in vehicle prices on average MSRPs over time, lower than expected receptiveness to leasing, or the effect of future inflation on MAGI. Commenters also raised concerns about U.S. manufacturers securing IRA-compliant content, particularly in light of outstanding final Treasury guidance that could affect details of 30D, and particularly in the near term (for example, uncertainty about qualifying sources of graphite, and more broadly which minerals or other inputs would ultimately fall under the transition rule).

EPA considers the DOE analysis to represent the best accounting of potential future 30D/45W credits that is possible at this time. However, to further respond to uncertainties raised by commenters, EPA has revised the DOE figures downward for use in the OMEGA compliance analysis in order to remain conservative with respect to these uncertainties. As shown in Table 72, for 2023 through 2030, EPA has discounted the DOE estimates by 25 percent, and then ramped up to the DOE estimate between 2030 and 2032.

EPA considers this to be a reasonable accounting for the possible effect of these uncertainties which are not precisely quantifiable at this time but are not likely to have a large effect. DOE states that the impacts of the 30D MAGI limit ''are likely to be limited,'' stating further that ''IRS tax statistics indicate that 9% of the 2022 tax filers would be MAGI-limited.'' Further, DOE expects that the buyers excluded on an income basis would largely coincide with lessees (who remain eligible to benefit from 45W) and with the modeled 20 percent of vehicles that receive no credit in the DOE analysis.[854] Similarly, we expect the effect of inflation on MSRP eligibility and the effect of limited tax liability to be small, as OEMs have considerable leeway to adjust MSRP (especially when a relatively small change can capture such a large credit), and EPA is aware of no specific data that indicates that new vehicle buyers are frequently unable to claim the full eligible credit due to limited or no tax liability. Since January 2024, buyers who take the 30D credit at the point of sale are not subject to a tax liability limitation.[855] According to auto industry analyst firm Cox Automotive, the average income of new car buyers in 2023 was $115,000,[856] and according to the IRS, average total income tax in tax year 2020 (the latest data available) for filers between $75,000 and $100,000 was $7,363 and for filers between $100,000 and $200,000 was $15,093.[857] [858]

After 2030, we gradually phase down the 25 percent discounting of the DOE figures, and rejoin the DOE-determined estimate of a combined $6,000 in 2032. This reflects likely trends in 30D and 45W over time, namely, decreasing uncertainty about material supply and diminished influence of 45W compared to 30D. Specifically, as time passes, uncertainty about mineral supply decreases; that is, vehicle eligibility for

[851] Forthcoming final FEOC criteria could lead to average credit values being higher or lower than projected through the Excluded Entities provision.

[852] As described in Chapter 4.1 of the RIA, the modeling of consumer demand for ICE and BEV vehicles considers purchase and ownership costs as components of a ''consumer generalized cost'' for the ICE and BEV options. The purchase cost reflects the vehicle purchase price and any assumed purchase incentives under 30D or 45W of the IRA.

[853] **Federal Register** Vol. 88, No. 231, p. 84098, ''Section 30 Excluded Entities,'' December 4, 2023.

[854] Department of Energy, ''Estimating Federal Tax Incentives for Heavy Duty Electric Vehicle Infrastructure and for Acquiring Electric Vehicles Weighing Less Than 14,000 Pounds,'' Memorandum, March 11, 2024.

[855] Internal Revenue Service, ''IRS updates frequently asked questions related to New, Previously Owned, and Qualified Commercial Clean Vehicle Credits,'' FS–2023–29, December 2023. ''The amount of the credit that the electing taxpayer elects to transfer to the eligible entity may exceed the electing taxpayer's regular tax liability for the taxable year in which the sale occurs, and the excess, if any, is not subject to recapture from the dealer or the buyer.''

[856] Cox Automotive, ''Cox Automotive's Car Buyer Journey Study Shows Satisfaction With Car Buying Improved in 2023 After Two Years of Declines,'' January 17, 2024. Accessed on March 5, 2024 at *https://www.coxautoinc.com/market-insights/2023-car-buyer-journey-study*.

[857] Internal Revenue Service, Publication 1304 (Rev. 11–2022), continuation of Table 3.3 on p. 219, dividing column 61 (total income tax, thousands) by column 60 (number of returns), for the rows ''$75,000 under $100,000'' and ''$100,000 under $200,000.''

[858] Internal Revenue Service, ''SOI Tax Stats—Individual Income Tax Returns Complete Report (Publication 1304),'' website, located at *https://www.irs.gov/statistics/soi-tax-stats-individual-income-tax-returns-complete-report-publication-1304*.

the 30D content requirements would be expected to increase as manufacturers increasingly have the lead time needed to maximize eligibility of their vehicles for 30D by securing 30D-compliant content and increasingly manufacturing in the U.S. EPA expects that sufficient lead time will have occurred by 2031 to 2032 to resolve many of the uncertainties acknowledged previously, for example, securing 30D-compliant graphite as well as other content. In addition, the relative influence of 45W compared to 30D would be expected to decline over time if, as generally expected, PEV prices also decline relative to ICE vehicles, because the amount of the 45W credit depends on the price differential between a PEV and a comparable ICE vehicle. DOE included an estimate of this effect in their analysis. Also, if 45W is having less influence over time, uncertainty about leasing rates is becoming less important as well.

TABLE 72—UPDATES TO 30D AND 45W CLEAN VEHICLE CREDIT IN OMEGA

Model year	NPRM	FRM	FRM % of maximum available credit
2023	$3,750	$2,925	39
2024	4,000	3,225	43
2025	4,250	3,300	44
2026	4,500	3,300	44
2027	4,750	3,600	48
2028	5,000	3,750	50
2029	5,250	3,900	52
2030	5,500	4,125	55
2031	5,750	5,075	68
2032	6,000	6,000	80
2033	0	0	

After furthering considering the DOE analysis in light of comments on this topic, EPA concludes these updated values are responsive to the comments and represent a conservative but reasonable estimate of the average effective impact of 30D and 45W on PEV acquisition cost by consumers across the PEV fleet, reflecting current uncertainties. Over time, we expect that the impact of 30D and 45W will become more evident as additional data is collected by industry observers and may well turn out to be higher. Because our discounted estimates are conservative, we did not discount the DOE estimates in our low battery cost sensitivity case. Although 30D/45W does not directly factor into battery manufacturing cost, it does impact PEV cost as seen by the consumer and this sensitivity is intended to show a case in which PEV cost is generally more optimistic than in the central case. We note that many commenters supported our NPRM assumptions for 30D/45W, which were very close to the DOE estimates, and we continue to consider those values to represent another reasonable possibility for a future outcome although we have chosen to use lower and more conservative values in the central case. In addition, we conducted additional sensitivity analysis regarding the IRA tax credit assumptions in a memo to the docket.[859]

EPA also considered potential impacts on battery manufacturing cost that might result from the battery durability and warranty requirements described in sections III.G.2 and III.G.3 of this preamble. We received comments stating the position that the existence of durability and warranty requirements would increase the cost of PEV batteries, and that we should account for this increased cost. However, commenters did not provide supporting data regarding cost increases that might result from these requirements. Because the durability minimum performance requirement and the minimum battery warranty are similar to currently observed industry practices regarding durability performance and warranty terms, EPA continues to expect that these requirements will not result in a significant increase in battery manufacturing costs.

In the proposal, EPA also updated the non-battery powertrain costs that were used to determine the direct manufacturing cost of electrified powertrains. We referred to a variety of industry and academic sources, focusing primarily on teardowns of components and vehicles conducted by leading engineering firms. These included the 2017 teardown of the Chevy Bolt conducted by Munro and Associates for UBS;[860] a 2018 teardown of several electrified vehicle components conducted by Ricardo for the California Air Resources Board;[861] a set of commercial teardown reports published in 2019 and 2020 by Munro & Associates;[862] [863] [864] [865] [866] [867] and the 2021 NAS Phase 3 report.[868] Throughout the process of compiling the results of these studies, we collaborated with technical experts from the California Air Resources Board and NHTSA.

In the proposal, we described a new full-vehicle teardown study comparing a gasoline-fueled VW Tiguan to the battery-electric VW ID.4, conducted for

[859] U.S. EPA. 2024. Sensitivity Analysis of IRA Tax Credit Assumptions, Memorandum to Docket EPA–HQ–OAR–2022–0829, March 13, 2024. EPA considered the costs and lead time associated with this and other sensitivity analyses as part of our consideration of the feasibility and appropriateness of this rule, and as we explain in section V.B of the preamble, we find that the final standards are feasible and the costs of this rule are reasonable.

[860] UBS AG, ''Q-Series: UBS Evidence Lab Electric Car Teardown—Disruption Ahead?'' UBS Evidence Lab, May 18, 2017.

[861] California Air Resources Board, ''Advanced Strong Hybrid and Plug-In Hybrid Engineering Evaluation and Cost Analysis,'' CARB Agreement 15CAR018, prepared for CARB and California EPA by Munro & Associates, Inc. and Ricardo Strategic Consulting, April 21, 2017.

[862] Munro and Associates, ''Twelve Motor Side-by-Side Analysis,'' provided November 2020.

[863] Munro and Associates, ''6 Inverter Side-by-Side Analysis,'' provided January 2021.

[864] Munro and Associates, ''3 Inverter Side-by-Side Analysis,'' provided November 2020.

[865] Munro and Associates, ''BMW i3 Cost Analysis,'' dated January 2016, provided November 2020.

[866] Munro and Associates, ''2020 Tesla Model Y Cost Analysis,'' provided November 2020.

[867] Munro and Associates, ''2017 Tesla Model 3 Cost Analysis,'' dated 2018, provided November 12, 2020.

[868] National Academies of Sciences, Engineering, and Medicine 2021. ''Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy 2025–2035''. Washington, DC: The National Academies Press. *https://doi.org/10.17226/26092*.

EPA by FEV of America.[869] The study was designed to compare the manufacturing cost and assembly labor requirements for two comparable vehicles, one an ICE vehicle and one a BEV, both of which were built on respective dedicated-ICE[870] and dedicated-BEV[871] platforms by the same manufacturer. The teardown applies a bill-of-materials approach to both vehicles and derives cost and assembly labor estimates for each component. An additional task under this work assignment was for FEV to review the non-battery electric powertrain costs EPA had described in Chapter 2.6.1 of the DRIA, with respect to the cost values used and the method of scaling these costs across different vehicle performance characteristics and vehicle classes, and to suggest alternative values or scalings where applicable. More details about the goals of the teardown study can be found in RIA Chapter 2.5.2.2.3. The complete teardown report, the associated bill-of-materials data worksheets, and the FEV review of non-battery costs and scaling were available in the docket during the comment period[872 873] and updated report material has been posted since.[874]

We also indicated in the proposal that we may rely on the information from this work for the final rule. For example, we indicated that component costs for the BEV and ICE vehicle might be used to support or update our battery or non-battery costs for electrified vehicles, or our costs for ICE vehicles; assembly labor data might be used to further inform the employment analysis; and any other qualitative or quantitative information that could be drawn from the report might be used in the analysis.

The project report was delivered to EPA in February 2023 and underwent a contractor-managed peer review process that has now been completed.[875]

Concurrently with this contracted teardown project, EPA also contracted FEV to conduct a scaling exercise to develop up-to-date powertrain cost curves that could be used as inputs to OMEGA, using not only the teardown results of this project but also teardown results from FEV's extensive database of previous teardowns it has conducted for a wide variety of vehicles and components. As a result of that effort, we have updated our powertrain costs, including the non-battery technologies used in BEV, PHEV, and HEV powertrains. Chapter 2.6.1 of the RIA presents all of those updated powertrain cost curves. In general, the updated cost curves result in lower powertrain costs for nearly all powertrain technologies, with ICE powertrain costs being reduced somewhat more than those for electrified powertrains. As a result, the incremental costs when moving from ICE-only to any electrified powertrain have increased somewhat since the NPRM. Importantly, the scaling effort provided ICE, HEV, PHEV, and BEV powertrain costs that were generated using the same methodology. We consider the updated costs to represent the strongest and most up to date data available.

Some commenters encouraged EPA to conduct a teardown analysis of a relatively long-range PHEV, or to conduct a comparative analysis on PHEV and BEV costs with involvement of stakeholders such as car and truck makers. It was also noted that a PHEV may not need as strong a chassis as a BEV due to the lighter weight of the battery, and that this savings should be accounted for in PHEV cost. Given the time frame of the analysis, it was not possible to conduct a new teardown analysis of a long-range PHEV. Given the scope of the FEV teardown and the similarity of electrical components between the BEV that was analyzed and a long-range PHEV, it is unlikely that the results of a teardown of a long-range PHEV would provide significantly different costs estimates. While it may be possible that a PHEV could have less structural content owing to the smaller size and weight of the battery, it is unlikely that such cost savings could be generalized across the entire class of vehicles from the analysis of a single vehicle. For these reasons we did not conduct these additional analyses.

More discussion of the technical basis for the non-battery electrified vehicle cost estimates used in the final rule analysis may be found in RIA Chapter 2.

3. Analysis of Power Sector Emissions

As PEVs are anticipated to represent a significant share of the future U.S. light- and medium-duty vehicle fleet, EPA has continued to develop approaches to estimate the upstream emissions (*i.e.,* from electricity generation and transmission) of increased PEV charging demand as part of the assessment of the standards.[876] For this final rule, electric generation was modeled utilizing ''EPA's Power Sector Modeling Platform Post-IRA 2022 Reference Case using the Integrated Planing Model (IPM)'' in a similar manner to the analysis for the proposal.[877] IPM provides projections of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints represented within 67 regions of the 48 contiguous U.S.

As with the analysis for the proposal, charge demand from scenarios modeled within the OMEGA compliance model were regionalized into the 67 IPM regions using the EVI–X modeling suite of electric vehicle charging infrastructure analysis tools developed by the National Renewable Energy Laboratory (NREL) combined with a PEV likely adopter model. Chapter 5 of the RIA contains a detailed description of the analysis of PEV charging demand, electric generation and the resulting emissions and cost for different projected vehicle electrification scenarios. One update made within the power sector analysis for the final rule was the inclusion of heavy-duty charge demand based on an interim scenario developed from the Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3 Proposed Rule.[878] We combined this heavy-duty power sector demand together with demand for charging light- and medium-duty PEVs to improve forecasting of both electricity rates and power sector emissions factors used within the analysis of costs and benefits for the final rule.

Power sector modeling results of generation and grid mix from 2030 to 2050 and CO_2 emissions from 2028 to 2050 for the contiguous United States (CONUS) are shown in Figure 26. Power sector CO_2 emissions for the final rule are compared to a No Action case in Figure 27. Power sector modeling results are summarized in more detail

[869] FEV Consulting Inc., ''Cost and Technology Evaluation, Conventional Powertrain Vehicle Compared to an Electrified Powertrain Vehicle, Same Vehicle Class and OEM,'' prepared for Environmental Protection Agency, EPA Contract No. 68HERC19D00008, February 2023.

[870] VW MQB A2 (''Modularer Querbaukasten'' or ''Modular Transversal Toolkit'', version A2) global vehicle platform.

[871] VW MEB (''Modularer E-Antriebs Baukasten'' or ''modular electric-drive toolkit) global vehicle platform.

[872] Memo to Docket ID No. EPA–HQ–OAR–2022–0829, titled ''Cost and Technology Evaluation, Conventional Powertrain Vehicle Compared to an Electrified Powertrain Vehicle, Same Vehicle Class and OEM.''

[873] Memo to Docket ID No. EPA–HQ–OAR–2022–0829, titled ''EV Non-Battery Cost Review by FEV.''

[874] Memo to Docket ID No. EPA–HQ–OAR–2022–0829, titled ''FEV Cost and Technology Evaluation.''

[875] Memo to Docket ID No. EPA–HQ–OAR–2022–0829, titled ''External Peer Review of Cost and Technology Evaluation, Conventional Powertrain Vehicle Compared to an Electrified Powertrain Vehicle, Same Vehicle Class and OEM.''

[876] EPA also estimates certain upstream emissions associated with gasoline and diesel fuel production. See RIA Chapter 7.2.

[877] *https://www.epa.gov/power-sector-modeling/post-ira-2022-reference-case.*

[878] 88 FR 25926, April 27, 2023.

within Chapter 5 of the RIA. The results show significant continued year-over-year growth in both total generation and the use of renewables for electric generation (Figure 26) and year-over-year reductions in CO_2 emissions (Figure 27). Relative to a No Action case, the final light- and medium-duty standards are anticipated to increase generation by less than 1 percent in 2030 and by approximately 7.6 percent by 2050 relative to no action. When combined with anticipated demand from heavy-duty applications, generation is anticipated to increase by 11.6 percent relative to no action (Figure 26). The impact of the light- and medium-duty standards combined together with the anticipated impacts due to heavy-duty on EGU emissions are shown in Figure 27 through Figure 30. EGU emissions of NO_X (Figure 28), SO_2 (Figure 29), $PM_{2.5}$ (Figure 30) and other emissions followed similar general trends to the CO_2 emissions results. Emissions trend downwards year over year through 2050 for both the no action and the policy case analyses. The policy case (final standards) analysis showed an approximately 13.4 percent increase in EGU CO_2 emissions in 2050 for the light- and medium-duty final rule when combined with anticipated heavy-duty standards. An increase of 8.8 percent in EGU CO_2 emissions in 2050 is estimated for light- and medium-duty vehicle charging alone. Note that the increased CO_2 emissions from EGUs are more than offset by reductions in tailpipe emissions from the projected vehicle fleet under the final standards. Criteria pollutant emissions from EGUs follow similar trends to those of the EGU CO_2 emissions, with similar year-over-year emissions declines for both the policy case and no action power sector modeling, and with small increases in EGU emissions for the policy case relative to no action. Again, it should be noted that this represents EGU emissions only and does not include emissions reductions from vehicle tailpipe or refinery emissions. Additional details on EGU emissions from our power sector modeling are summarized in Chapter 5.2.3 of the RIA. Combined impacts of EGU and other upstream emissions are summarized in Chapter 9 of the RIA.

Power sector modeling results showed that the increased use of renewables will largely displace coal and (to a lesser extent) natural gas EGUs and will primarily be driven by provisions of the IRA. By 2035, power sector modeling results also showed that non-hydroelectric renewables (primarily wind and solar) will be the largest source of electric generation (approximately 45 percent of total generation), and would account for more than 75 percent of generation by 2050. This displacement of coal EGUs by renewables was also the primary factor in the year-over-year reductions in CO_2, NO_X, SO_2, $PM_{2.5}$, and other EGU emissions. Impacts on EGU GHG and criteria pollutant emissions due to grid-related IRA provisions were substantially larger than the impact of increased electricity demand due to projected increased electrification of light- and medium-duty vehicles under this rule and anticipated electricity demand under the proposed heavy-duty standards. As EGU emissions continue to decrease between 2028 and 2050 due to increasing use of renewables, the power sector GHG and criteria pollutant emissions associated with light- and medium-duty vehicle operation will continue to decrease, even as the number and proportion of electric vehicles increase over that timeframe.

Power sector modeling also showed a significant increase in the use of batteries for grid storage, which is expected to be increasingly important for generation, transmission and distribution of electricity. When modeling PEV charge demand for both the final rule and for a No Action case, grid battery storage capacity increased from approximately zero capacity in 2020 to approximately 53 GW in 2030 and 150 GW in 2050, representing the equivalent of approximately 105 GWh and 326 GWh of annual generation, respectively. The increase in grid battery storage was primarily due to modeling of incentives under the IRA.

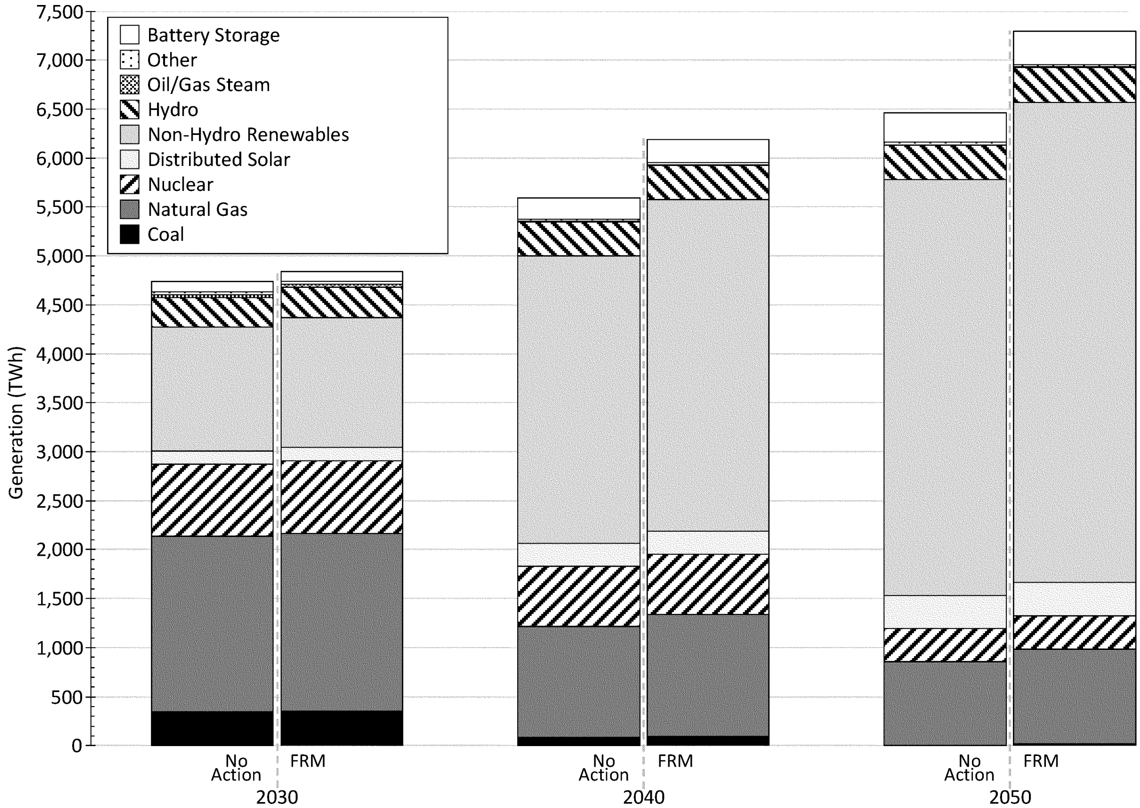

Figure 26: 2030–2050 Power Sector Generation and Grid Mix for the No Action Case (Left Side of Each Pair of Bars Representing Each Year) Compared to the Final Rule (Right Side of Each Pair of Bars)

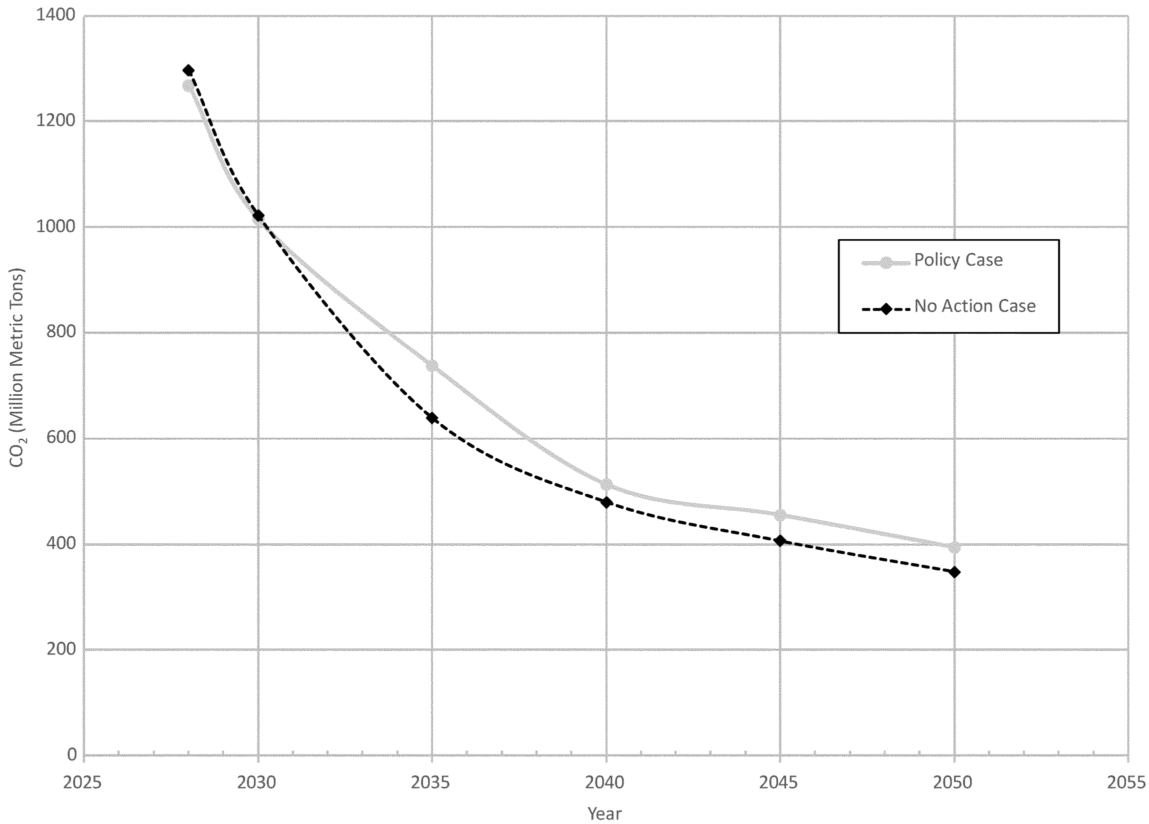

Figure 27: 2028 Through 2050 CONUS CO_2 Emissions From Electricity Generation for the Final Rule Policy Case (Gray Line) Compared to a No Action Case (Black Dashed Line)

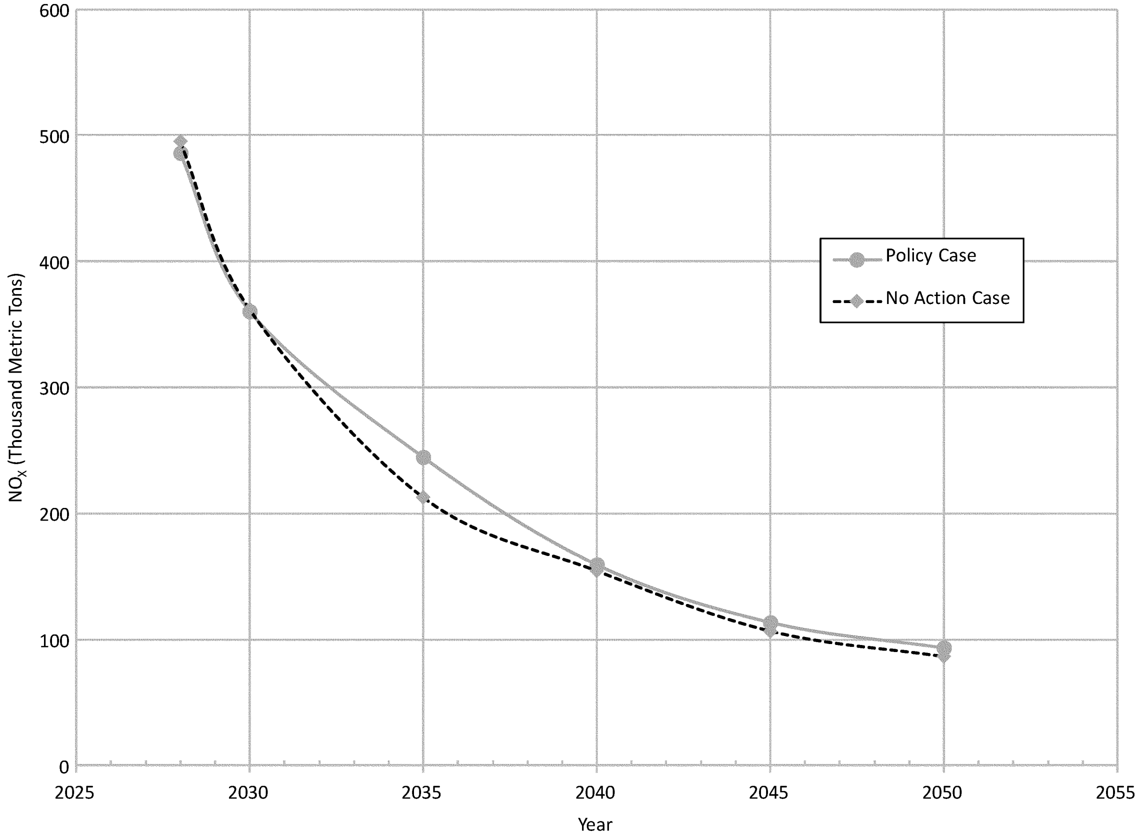

Figure 28: 2028 Through 2050 CONUS NO_X Emissions From Electricity Generation for the Final Rule Policy Case (Gray Line) Compared to a No Action Case (Black Dashed Line)

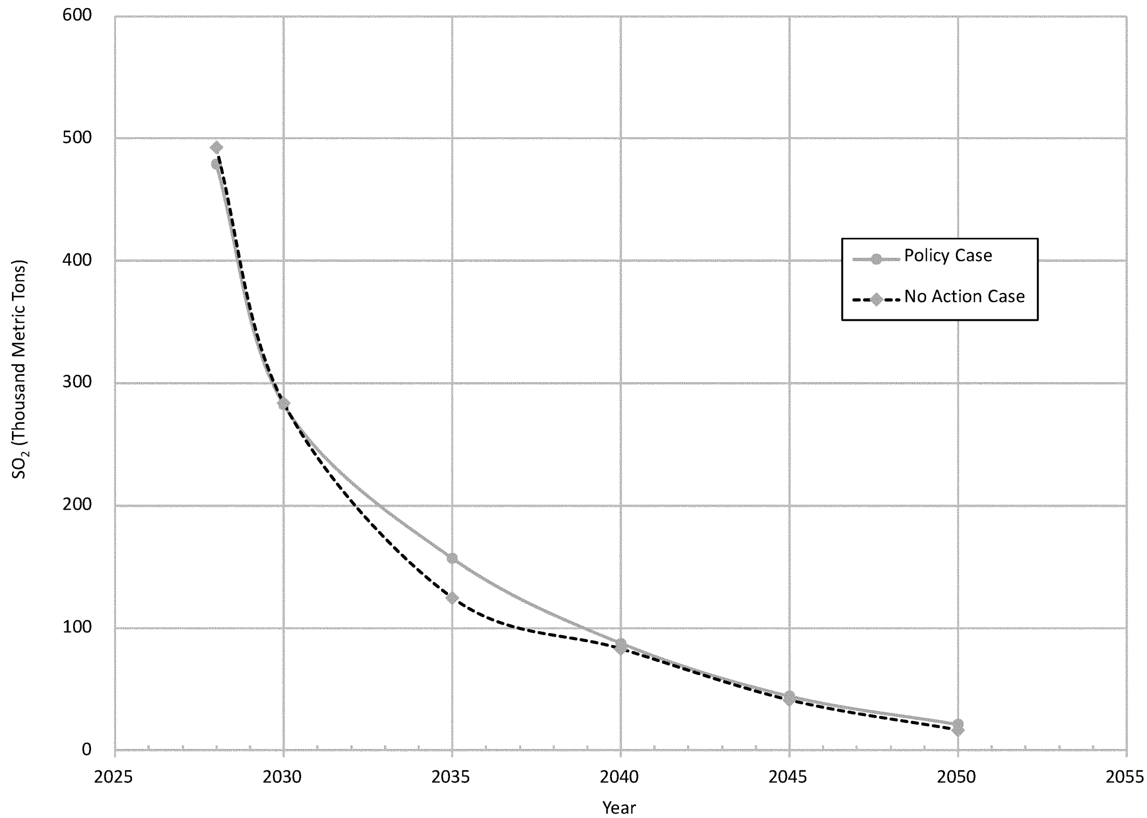

Figure 29: 2028 Through 2050 CONUS SO_2 Emissions From Electricity Generation for the Final Rule Policy Case (Gray Line) Compared to a No Action Case (Black Dashed Line)

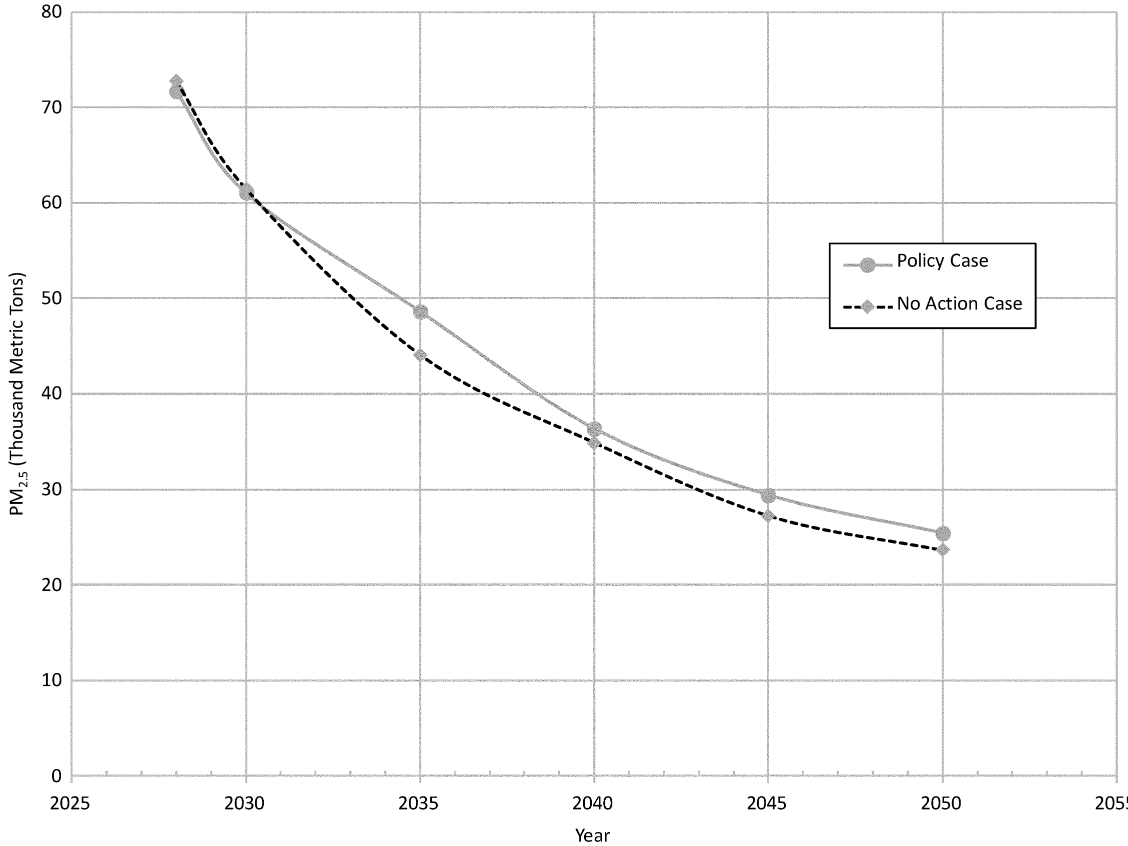

Figure 30: 2028 Through 2050 CONUS $PM_{2.5}$ Emissions From Electricity Generation for the Final Rule Policy Case (Gray Line) Compared to a No Action Case (Black Dashed Line)

4. PEV Charging Infrastructure Considerations

We received many comments regarding future charging infrastructure needs. Vehicle manufacturers, dealers, and representatives of the fuels industry, among others, raised concerns stating that charging infrastructure is inadequate today and that the pace of deployment is not on track to meet levels needed if the proposed standards are finalized. Commenters noted particular challenges for those who can't charge at home, as well as for rural areas. Manufacturers and others said customers won't buy PEVs if reliable charging infrastructure is not available. While they recognized the importance of the BIL and the IRA in supporting buildout of charging infrastructure, commenters expressed concerns that far more funding would be needed with some commenters characterizing BIL funds as a 'good downpayment'. We also received comments from states, non-governmental organizations, electrification groups, electric vehicle manufacturers, and utilities highlighting the many public and private investments in charging infrastructure that have been announced or are already underway, along with a new analysis submitted by EDF.[879] The analysis found that, taken together, these investments are putting us on track to meet public charging infrastructure needed in 2030 if the proposed standards were finalized. Several commenters noted that EPA finalizing stringent standards would provide certainty to vehicle manufacturers, charging equipment providers, and others, and would spur further investments in charging infrastructure.

As an initial matter, EPA notes that it anticipates automakers will employ a wide variety of control technologies, applied to ICE, hybrid, and electric powertrains, to meet the final standards and will continue to offer a diverse variety of vehicles for the duration of these standards and beyond. For example, under our central case modeling (which is only one estimate of a possible compliance path for the industry), in MY 2032, 29 percent of new vehicle sales would be non-hybrid ICE vehicles (with an additional 3 percent hybrid vehicles).[880] We anticipate that the flexibilities offered by the final rule will enable manufacturers who choose to meet the final rule through producing more PEVs to deploy PEVs in areas and at volumes that meet consumer demand. At the same time, EPA agrees that continued expansion of reliable charging infrastructure is important for higher rates of PEV adoption.

Public charging has been growing rapidly in the past few years. There are over 60,000 charging stations in the U.S. today with more than 160,000 electric vehicle supply equipment (EVSE) ports.[881] [882] This is more than double the number of public EVSE ports as of the

[879] Environmental Defense Fund and WSP, ''U.S. Public Electric Vehicle (EV) Charging Infrastructure Deployment Industry Investment Briefing,'' July 2023. Accessed December 18, 2023, at: *https://www.edf.org/sites/default/files/2023-07/WSP%20US%20Public%20EV%20Charging%20Infrastrcuture%20Deployment%20July%202023.pdf.*

[880] These figures include both advanced (21%) and base (8%) ICE vehicles, strong (2%) and mild (1%) hybrids.

[881] As described in RIA Chapter 5.3, each station may have one or more EVSE ports that provide electricity to a vehicle. The number of vehicles that can simultaneously charge at the station is equal to the number of EVSE ports.

[882] U.S. DOE Alternative Fuels Data Center, ''U.S. Public Electric Vehicle Charging Infrastructure.'' Accessed January 10, 2023, at *https://afdc.energy.gov/data/10972.* U.S. DOE Alternative Fuels Data Center, ''Alternative Fueling Station Locator.'' Accessed January 10, 2024, at *https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC.*

end of 2019.[883] Estimates for future infrastructure needs vary widely in the literature based on assumptions about driving and charging behavior, residential charging access, and the mix of EVSE by power levels, among other factors. A recent national assessment by NREL (Wood et al. 2023) estimated that to support 33 million PEVs in 2030, about 1.25 million public EVSE ports (including 182,000 DC fast charging (DCFC) ports) would be needed, along with 26.8 million private ports (most at single family homes, but also at multi-family homes and workplaces).[884] That yields a ratio of one public EVSE port needed per 26 PEVs. This fits well within a range of other recent studies examining public infrastructure needs. An ICCT report looking across a dozen studies published between 2018 to 2021 found that two-thirds of the estimates (including its own) fell between 20 and 40 PEVs per public EVSE port.[885] A new report conducted by ICF for the Coordinating Research Council, which assessed infrastructure needs for the level of PEV adoption in the proposed rule, found one public EVSE port would be needed for every 34 light-duty PEVs.[886] There was approximately one public EVSE port for every 26 PEVs on the road as of the second quarter of 2023,[887] suggesting public charging infrastructure is generally keeping pace with PEV adoption. For additional discussion on this topic, see RIA Chapter 5 and RTC section 17.

We agree with commenters that keeping up with charging needs as PEV adoption grows will require continued investments in charging infrastructure. The NREL study discussed above estimated that between $31 billion and $55 billion would be needed by 2030 for public charging infrastructure, noting that $24 billion in investments from public and private sources had already been announced as of March 2023.[888] The White House estimates that as of January 2024 total investments to expand the U.S. charging network had grown to over $25 billion.[889] Considering 2030 is still six years away, and that (as commenters noted) the standards themselves will spur additional investments, charging infrastructure investments in the U.S. appear to be on track to support the PEV adoption anticipated under the final standards. Furthermore, as described below, there are many public and private parties investing in charging infrastructure, including federal, state and local governments, automakers, utilities, charging companies, and retailers among others. These parties are already responding to the market that is developing for infrastructure, and we see no reason to believe they won't continue to meet infrastructure demand as the PEV market grows.

The Bipartisan Infrastructure Law (BIL) provides up to $7.5 billion over five years to build out a national PEV charging network.[890] Two-thirds of this funding is for the National Electric Vehicle Infrastructure (NEVI) Formula Program with the remaining $2.5 billion for the Charging and Fueling Infrastructure (CFI) Discretionary Grant Program. Both programs are administered under the Federal Highway Administration with support from the Joint Office of Energy and Transportation (JOET). The first phase of NEVI funding—a formula program for states—was launched in 2022 with initial plans for all 50 states, DC, and Puerto Rico approved in September 2023.[891] In total, the initial $1.5 billion of investments in the first round will help deploy or expand charging infrastructure on about 75,000 miles of highway.[892] Ohio was the first state to open a NEVI-funded station near Columbus in December 2023.[893] New York and Pennsylvania followed with stations in Kingston[894] and Pittston, respectively.[895] Another 30 states are soliciting proposals and making awards.[896] An additional $885 million is available for state plans in FY 2024.[897] In September 2023, JOET announced that up to $100 million in NEVI funding would available to increase reliability of the existing charging infrastructure network with funds going to repair or replace EVSE ports.[898] This will complement efforts of the National Charging Experience (ChargeX) Consortium. Launched in May 2023 by JOET and led by U.S. DOE labs, the ChargeX Consortium will develop solutions and identify best practices for common problems related to the consumer experience, *e.g.,* payment processing and user interface, vehicle-charger communication, and diagnostic data sharing.[899] Relatedly, in January 2024, JOET announced $46.5 million in federal funding to support 30 projects to increase charging access, reliability, resiliency, and workforce development.[900] This includes projects

[883] Ibid.

[884] Wood et al., ''The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Infrastructure,'' 2023. Accessed December 18, 2023, at *https://driveelectric.gov/files/2030-charging-network.pdf.*

[885] Bauer et al., ''Charging Up America: Assessing the Growing Need for U.S. Charging Infrastructure through 2030,'' 2021. Accessed November 5, 2023, at *https://theicct.org/wp-content/uploads/2021/12/charging-up-america-jul2021.pdf.* Note: The full range of studies spanned 12 to 129 PEVs per public charger though all but two were between 20 and 56.

[886] Coordinating Research Council, ''Assess the Battery Re-charging and Hydrogen Re-fueling Infrastructure Needs, Costs, and Timelines Required to Support Regulatory Requirements for Light-, Medium-, and Heavy-Duty Zero Emission Vehicles,'' September 2023. Accessed December 18, 2023, at *https://crcao.org/wp-content/uploads/2023/09/CRC_Infrastructure_Assessment_Report_ICF_09282023_Final-Report.pdf.* (*Note:* The study assessed infrastructure needs associated with ZEV adoption in the proposed rule, the proposed Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles-Phase 3, as well as California policies including Advanced Clean Cars II rule.)

[887] Brown, A. et al., ''Electric Vehicle Charging Infrastructure Trends from the Alternative Fueling Station Locator: Third Quarter 2023,'' 2024. Accessed March 10, 2024, at: *https://www.nrel.gov/docs/fy24osti/88223.pdf. Note:* Estimated from approximately 4.16 million EVs and 160,000 public EVSE ports.

[888] Wood et al., ''The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Infrastructure,'' 2023. Accessed December 18, 2023, at *https://driveelectric.gov/files/2030-charging-network.pdf.*

[889] The White House, ''FACT SHEET: Biden-Harris Administration Announces New Actions to Cut Electric Vehicle Costs for Americans and Continue Building Out a Convenient, Reliable, Made-in-America EV Charging Network'', January 19, 2024. Accessed at *https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/19/fact-sheet-biden-harris-administration-announces-new-actions-to-cut-electric-vehicle-costs-for-americans-and-continue-building-out-a-convenient-reliable-made-in-america-ev-charging-network/.*

[890] Enacted as the Infrastructure Investment and Jobs Act, Public Law 117–58. 2021. Accessed January 10, 2023, at *https://www.congress.gov/bill/117th-congress/house-bill/3684.*

[891] U.S. DOT, FHWA, ''Historic Step: All Fifty States Plus DC and Puerto Rico Greenlit to Move EV Charging Networks Forward, Covering 75,000 Miles of Highway,'' September 27, 2022. Accessed January 10, 2023, at *https://highways.dot.gov/newsroom/historic-step-all-fifty-states-plus-dc-and-puerto-rico-greenlit-move-ev-charging-networks.*

[892] Ibid.

[893] JOET, ''First Public EV Charging Station Funded by NEVI Open in America,'' December 13, 2023. Accessed December 18, 2023, at: *https://driveelectric.gov/news/first-nevi-funded-stations-open.*

[894] JOET, ''New York Continues NEVI Charging Station Momentum,'' December 15, 2023. Accessed December 18, 2023, at: *https://driveelectric.gov/news/new-york-NEVI-charging-station-momentum.*

[895] JOET, ''Pennsylvania Continues Shift Toward Thriving Electric Transportation Sector,'' January 23, 2024. Accessed February 24, 2024, at *https://driveelectric.gov/news/new-pennsylvania-nevi-station.*

[896] JOET, ''2024 Q1 NEVI Progress Update,'' February 16, 2024. Accessed February 24, 2024, at: *https://driveelectric.gov/news/nevi-update-q1.*

[897] JOET, ''State Plans for Electric Vehicle Charging.'' 2023. Accessed December 18, 2023, at: *https://driveelectric.gov/state-plans.*

[898] JOET, ''Biden-Harris Administration to Invest $100 Million for EV Charger Reliability,'' September 2023. Accessed December 18, 2023, at: *https://driveelectric.gov/news/ev-reliability-funding-opportunity.*

[899] JOET, ''Joint Office Announces National Charging Experience Consortium,'' May 18, 2023. Accessed March 12, 2024, at: *https://driveelectric.gov/news/chargex-consortium.*

[900] JOET, ''New Funding Enhances EV Charging Resiliency, Reliability, Equity, and Workforce

Continued

to increase the commercial capacity for testing and certification of high-power electric vehicle chargers, which will accelerate the deployment of interoperable, safe, and efficient electric vehicle and charger systems.[901] Also in January 2024, over $600 million in grants under the CFI Program was announced to deploy PEV charging and alternative fueling infrastructure in communities and along corridors in 22 states.[902] This first round of CFI grants is expected to fund about 7,500 EVSE ports.

Ensuring equitable access to charging is one of the stated goals of these infrastructure funds. Accordingly, FHWA instructed states to incorporate public engagement in their planning process for the NEVI Formula Program, including reaching out to Tribes and rural, underserved, and disadvantaged communities.[903] Both the formula funding and discretionary grant program are subject to the Justice40 Initiative target that 40 percent of the overall benefits of certain covered federal investments go to disadvantaged communities. Other programs with funding authorizations under the BIL that could be used in part to support charging infrastructure installations include the Congestion Mitigation & Air Quality Improvement Program, National Highway Performance Program, and Surface Transportation Block Grant Program among others.[904]

The Inflation Reduction Act (IRA), signed into law on August 16, 2022, will also help reduce the costs for deploying infrastructure.[905] The IRA extends the Internal Revenue Code 30C Alternative Fuel Refueling Property Tax Credit (section 13404) through Dec 31, 2032, with modifications. Under the new provisions, residents in low-income or non-urban areas, representing around two-thirds of Americans, are eligible for a 30 percent credit for the cost of installing residential charging equipment up to a $1,000 cap.[906] Businesses, including existing charging and fueling stations, are eligible for up to 30 percent of the costs associated with purchasing and installing charging equipment in these areas (subject to a $100,000 cap per item) if prevailing wage and apprenticeship requirements are met, and up to 6 percent otherwise.[907] ANL estimates that nearly three-quarters of existing gas stations are located in census tracts that qualify for the 30C tax credit, suggesting that a similarly high share of future charging stations could qualify as charging infrastructure buildout continues to expand across the country.[908] [909]

States, utilities, charging network providers, and others are also investing in and supporting PEV charging infrastructure deployment. California announced plans to invest $1.9 billion in state funds through 2027 for charging and hydrogen refueling infrastructure serving light-, medium-, and heavy-duty vehicles (and related activities), which it estimates could support 40,000 new EVSE ports.[910] The New York Power Authority is investing $250 million to support up to 400 DCFC stations.[911] Several states including New Jersey and Utah offer partial rebates for residential, workplace, or public charging while others such as Georgia and DC offer tax credits.[912] Other programs will increase charging access at multi-unit dwellings. For example, the municipal utility in Burlington, Vermont, in partnership with EVmatch, offers rebates for EVSE installations at these properties with an additional $300 incentive provided if owners make charging equipment available for public use during the day to further extend charging access.[913] The NC Clean Energy Technology Center identified more than 200 actions taken across 38 states and DC related to providing financial incentives for electric vehicles and/or charging infrastructure in 2022, a four-fold increase over the number of actions in 2017.[914] The Edison Electric Institute estimates that electric companies are investing $5.2 billion in infrastructure and other transportation electrification efforts in 35 states and the District of Columbia.[915] And over 60 electric companies and cooperatives serving customers in 48 states and the District of Columbia have joined together to advance fast charging through the National Electric Highway Coalition.[916]

In July 2023, seven automakers—BMW, GM, Honda, Hyundai, Kia, Mercedes-Benz, and Stellantis—announced that they would jointly deploy 30,000 EVSE ports in North

Development,'' January 19, 2024. Accessed February 24, 2024, at: *https://driveelectric.gov/news/workforce-development-ev-projects*.

[901] JOET, ''FY23 Ride and Drive FOA DE–FOA–0002881.'' Accessed February 25, 2024, at: *https://driveelectric.gov/files/ride-and-drive-foa.pdf*.

[902] JOET, ''Biden-Harris Administration Bolsters Electric Vehicle Future with More than $600 Million in New Funding,'' January 11, 2024, *https://driveelectric.gov/news/new-cfi-funding*.

[903] U.S. DOT, FHWA, ''The National Electric Vehicle Infrastructure (NEVI) Formula Program Guidance.'' February 10. Accessed January 10, 2023. *https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/90d_nevi_formula_program_guidance.pdf*.

[904] Ibid.

[905] Inflation Reduction Act of 2022, Public Law 117–169, 2022. Accessed December 2, 2022, at *https://www.congress.gov/117/bills/hr5376/BILLS-117hr5376enr.pdf*.

[906] The White House, ''FACT SHEET: Biden-Harris Administration Announces New Actions to Cut Electric Vehicle Costs for Americans and Continue Building Out a Convenient, Reliable, Made-in-America EV Charging Network,'' January 19, 2024. Accessed February 24, 2024, at: *https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/19/fact-sheet-biden-harris-administration-announces-new-actions-to-cut-electric-vehicle-costs-for-americans-and-continue-building-out-a-convenient-reliable-made-in-america-ev-charging-network/*.

[907] According to the Department of Energy, the IRS's ''good faith effort'' clause applicable to the apprenticeship requirement suggests that businesses will generally be able to meet it and take advantage of the full 30 percent tax credit, if otherwise eligible. See U.S. DOE, ''Estimating Federal Tax Incentives for Heavy Duty Electric Vehicle Infrastructure and for Acquiring Electric Vehicles Weighing Less Than 14,000 Pounds,'' Memorandum, March 2024.

[908] ANL's assessment found that 60 percent of existing DCFC stations and 51 percent of public L2 stations are located in qualifying census tracts, but notes that current PEV owners are more likely to live in urban areas compared to the overall light-duty vehicle population. As PEV adoption continues to expand and infrastructure corridors are built out, more charging station will be needed in low-income and non-urban census tracts where the 30C tax credit can help reduce capital costs for station developers.

[909] Gohlke, David, Zhou, Yan, and Wu, Xinyi. 2024. ''Refueling Infrastructure Deployment in Low-Income and Non-Urban Communities''. United States. Accessed March 12, 2024, at: *https://www.osti.gov/servlets/purl/2318956*.

[910] California Energy Commission, ''CEC Approves $1.9 Billion Plan to Expand Zero-Emission Transportation Infrastructure, February 14, 2024. Accessed March 10, 2024, at: *https://www.energy.ca.gov/news/2024-02/cec-approves-19-billion-plan-expand-zero-emission-transportation-infrastructure*.

[911] New York Power Authority, ''EVolve NY's Mission: A Fast Electric Charging Station Near You,'' 2023. Accessed December 18, 2023, at *https://evolveny.nypa.gov/about-evolve-new-york*.

[912] Details on eligibility, qualifying expenses, and rebate or tax credit amounts vary by state. See DOE Alternative Fuels Data Center, State Laws and Incentives. Accessed January 11, 2023, at *https://afdc.energy.gov/laws/state*.

[913] Darya Oreizi, ''Burlington Electric Department Launches New Program with EVmatch to Expand EV Charging at Multi-family Properties'' September 30, 2022. Available at: *https://evmatch.com/blog/burlington-electric-department-launches-new-program-with-evmatch-to-expand-ev-charging-at-multi-family-properties/#:~:text=Burlington%20Electric%20Department%20(BED)%20recently,stations%20at%20multi%2Dfamily%20properties*.

[914] Apadula, E. et al., ''50 States of Electric Vehicles Q4 2022 Quarterly Report & 2022 Annual Review Executive Summary,'' February 2023, NC Clean Energy Technology Center. Accessed March 8, 2023, at *https://nccleantech.ncsu.edu/wp-content/uploads/2023/02/Q4-22_EV_execsummary_Final.pdf*. *Note:* Includes actions by states and investor-owned utilities.

[915] EEI, ''Electric Transportation Biannual State Regulatory Update,'' December 2023. Accessed December 18, 2023, at: *https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Electric-Transportation/ET-Biannual-State-Regulatory-Update.pdf*. *Note:* The $5.2 billion total reflects approved filings for infrastructure deployments and other customer programs to advance transportation electrification.

[916] EEI, ''Issues & Policy: National Electric Highway Coalition''. Accessed January 11, 2023, at *https://www.eei.org/issues-and-policy/national-electric-highway-coalition*.

America.[917] GM is also partnering with charging provider EVgo to deploy over 2,700 DCFC ports [918] and charging provider FLO to deploy as many as 40,000 Level 2 ports (with a focus on deployments in rural areas).[919] Ford has agreements with several charging providers to make it easier for their customers to charge and pay across different networks [920] and plans to install publicly accessible DCFC ports at many of its dealerships.[921] Mercedes-Benz recently announced that it is planning to build 2,500 charging points in North America by 2027.[922] Tesla has its own network with nearly 24,000 DCFC ports and nearly 10,000 L2 ports in the United States.[923] Tesla announced that by 2024, 7,500 or more existing and new ports (including 3,500 DCFC) would be open to all PEVs, and that it would double the size of its DCFC network.[924] All major auto manufacturers have announced that they will offer the NACS standard developed by Tesla on future production models in order to access the Tesla network.[925] [926] Auto manufacturers are also providing support to customers. Volkswagen, Hyundai, and Kia all offer customers complimentary charging at Electrify America's public charging stations (subject to time limits or caps) in conjunction with the purchase of select new EV models.[927]

Other charging networks are also expanding. Francis Energy, which has fewer than 1,000 EVSE ports today,[928] aims to deploy over 50,000 by the end of the decade.[929] Electrify America, a subsidiary of VW that is implementing the $2 billion investment required as part of a 2016 Clean Air Act settlement,[930] plans to more than double its network size [931] to 10,000 fast charging ports across 1,800 U.S. and Canadian stations by 2026. This is supported in part by a $450 million investment from Siemens and Volkswagen Group.[932] Blink plans to invest over $60 million to grow its network over the next decade.[933] Charging companies are also partnering with major retailers, restaurants, and other businesses to make charging available to customers and the public. For example, EVgo is deploying DCFC at certain Meijer locations, CBL properties, and Wawa. Volta is installing DCFC and L2 ports at select Giant Food, Kroger, and Stop and Shop stores, while ChargePoint and Volvo Cars are partnering with Starbucks to make charging available at select Starbucks locations.[934] Walmart recently announced plans to expand their network of DCFCs from fewer than 300 locations to thousands of Walmart and Sam's Club facilities by 2030.[935] Other efforts will expand charging access along major highways, including at up to 500 Pilot and Flying J travel centers (through a partnership between Pilot, GM, and EVgo) and 200 TravelCenters of America and Petro locations (through a partnership between TravelCenters of America and Electrify America).[936] BP plans to invest $1 billion toward charging infrastructure by the end of the decade, including through a partnership to provide charging at various Hertz locations across the country that could support rental and ridesharing vehicles, taxis, and the general public.[937] About forty companies have announced over $500 million of investments in U.S. facilities to construct charging equipment, with planned domestic production capacity of more than 1,000,000 chargers (including 60,000 DCFCs) annually.[938] [939]

We assess the infrastructure needs and the associated costs for this final

[917] Camila Domonoske, ''Big carmakers unite to build a charging network and reassure reluctant EV buyers.'' July 2023, NPR. Accessed December 18, 2023, at: *https://www.npr.org/2023/07/26/1190188838/ev-chargers-network-range-anxiety-bmw-gm-honda-hyundai-kia-mercedes-stellantis.*

[918] GM, ''To Put 'Everybody In' an Electric Vehicle, GM introduces Ultium Charge 360,'' Accessed January 11, 2023, at *https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/apr/0428-ultium-charge-360.html.*

[919] Peter Valdes-Dapena, ''GM to put thousands of electric vehicle chargers in rural America,'' December 7, 2022, *https://www.cnn.com/2022/12/07/business/gm-chargers/index.html.*

[920] Ford, ''Ford Introduces North America's Largest Electric Vehicle Charging Network, Helping Customers Confidently Switch to an All-Electric Lifestyle,'' October 17, 2019. Accessed January 11, 2023, at *https://media.ford.com/content/fordmedia/fna/us/en/news/2019/10/17/ford-introduces-north-americas-largest-electric-vehicle-charting-network.html.*

[921] JOET, ''Private Sector Continues to Play Key Part in Accelerating Buildout of EV Charging Networks,'' February 15, 2023. Accessed March 6, 2023, at *https://driveelectric.gov/news/#private-investment.*

[922] Reuters, ''Mercedes to launch vehicle-charging network, starting in North America,'' January 6, 2023. Accessed January 11, 2023, at *https://www.reuters.com/business/autos-transportation/mercedes-launch-vehicle-charging-network-starting-north-america-2023-01-05/.*

[923] U.S. DOE Alternative Fuels Data Center, ''Alternative Fueling Station Locator.'' Accessed January 10, 2024, at *https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC.*

[924] The White House, ''Fact Sheet: Biden-Harris Administration Announces New Standards and Major Progress for a Made-in-America National Network of EV Chargers,'' February 15, 2023. Available at: *https://www.whitehouse.gov/briefing-room/statements-releases/2023/02/15/fact-sheet-biden-harris-administration-announces-new-standards-and-major-progress-for-a-made-in-america-national-network-of-electric-vehicle-chargers.*

[925] Reuters, ''More automakers plug into Tesla's EV charging network,'' Nov 1, 2023. Available at: *https://www.reuters.com/business/autos-transportation/more-automakers-plug-into-teslas-ev-charging-network-2023-10-05.*

[926] Wired, ''Tesla Wins EV Charing! Now What?'' February 12, 2024. Accessed on March 12, 2024, at: *https://www.wired.com/story/tesla-wins-ev-charging-now-what.*

[927] Details of complimentary charging and eligible vehicle models vary by auto manufacturer. See: *https://www.vw.com/en/models/id-4.html, https://www.hyundaiusa.com/us/en/electrified/charging*, and *https://owners.kia.com/content/owners/en/kia-electrify.html.*

[928] DOE, Alternative Fuels Data Center, ''Electric Vehicle Charging Station Locations''. Accessed March 6, 2023, at *https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC.*

[929] JOET, ''Private Sector Continues to Play Key Part in Accelerating Buildout of EV Charging Networks,'' February 15, 2023. Accessed March 6, 2023, at *https://driveelectric.gov/news/#private-investment.*

[930] EPA, ''Volkswagen Clean Air Act Civil Settlement,'' 2023. Accessed December 18, 2023, at: *https://www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement#investment. Note:* The $2 billion investment is for charging or hydrogen refueling infrastructure as well as other activities to advance ZEVs, *e.g.,* education and public outreach.

[931] DOE, Alternative Fuels Data Center, ''Electric Vehicle Charging Station Locations''. Accessed March 6, 2023, at *https://afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC.*

[932] Electrify America, ''Electrify America Raises $450 Million—Siemens Becomes a Minority Shareholder; Company Intensifies Commitment to Rapid Deployment of Ultra-Fast Charging,'' June 28, 2022, *https://media.electrifyamerica.com/en-us/releases/190.*

[933] JOET, ''Private Sector Continues to Play Key Part in Accelerating Buildout of EV Charging Networks,'' February 15, 2023. Accessed March 6, 2023, at *https://driveelectric.gov/news/#private-investment.*

[934] Ibid.

[935] Walmart, ''Leading the Charge: Walmart Announces Plan to Expand Electric Vehicle Charging Network,'' April 6, 2023. Accessed December 18, 2023, at: *https://www.wptv.com/walmart-plans-an-expansion-of-its-electric-vehicle-charging-services#:~:text=As%20part%20of%20a%20new,fast%20chargers%20at%20its%20stores.*

[936] JOET, ''Private Sector Continues to Play Key Part in Accelerating Buildout of EV Charging Networks,'' February 15, 2023. Accessed March 6, 2023, at *https://driveelectric.gov/news/#private-investment.*

[937] BP, ''bp plans to invest $1 billion in EV charging across US by 2030, helping to meet demand from Hertz's expanding EV rentals,'' February 15, 2023, *https://www.bp.com/en_us/united-states/home/news/press-releases/bp-plans-to-invest-1-billion-in-ev-charging-across-us-by-2030-helping-to-meet-demand-from-hertzs-expanding-ev-rentals.html.*

[938] DOE, ''Building America's Clean Energy Future,'' January 11, 2024. Accessed February 24, 2024, at *https://www.energy.gov/invest. Note:* investment and production capacity totals include only those available in public announcements, as reported by DOE, and may not be comprehensive.

[939] U.S. Department of Energy, Vehicle Technologies Office, ''FOTW #1314, October 30, 2023: Manufacturers Have Announced Investments of Over $500 million in More Than 40 American-Made Electric Vehicle Charger Plants.'' Available online: *https://www.energy.gov/eere/vehicles/articles/fotw-1314-october-30-2023-manufacturers-have-announced-investments-over-500.*

rulemaking from 2027 to 2055.[940] We start with estimates of electricity demand for the PEV penetration levels under the Final rule compared to those in the No Action case using the methodology described in section IV.C.3 of this preamble. A suite of NREL models is used to characterize the quantity and mix of EVSE ports that could meet this demand, including EVI-Pro to simulate charging demand from typical daily travel, EVI-RoadTrip to simulate demand from long-distance travel, and EVI-OnDemand to simulate demand from ride-hailing applications. EVSE ports are broken out by charging location (home, depot, work, or public) and by charging type and power level: AC Level 1 (L1), AC Level 2 (L2), and DC fast charging with a maximum power of 150 kW, 250 kW, or 350 kW (DC–150, DC–250, and DC–350). We anticipate that the highest number of ports will be needed at homes, growing from under 16 million in 2027 to over 77 million in 2055 under the final standards. This is followed by public charging, estimated to grow from under 600,000 ports to over 7.8 million total EVSE ports in that timeframe. The majority of these are L2 ports with only about 685,000 DCFC ports estimated to be needed by 2055. Depot and workplace charging needs also increase to over 3.7 million and about 5.8 million EVSE ports in 2055, respectively.[941] Similar patterns are observed in the No Action case though fewer total ports are needed than under the Final rule due to the lower anticipated PEV demand. Figure 31 illustrates the growth in charging network size needed under the final rule and in the No Action case over select years.[942] Most of the additional EVSE ports needed to serve PEVs in the final rulemaking appear after 2030, allowing years of lead time to build out an appropriate charging network.

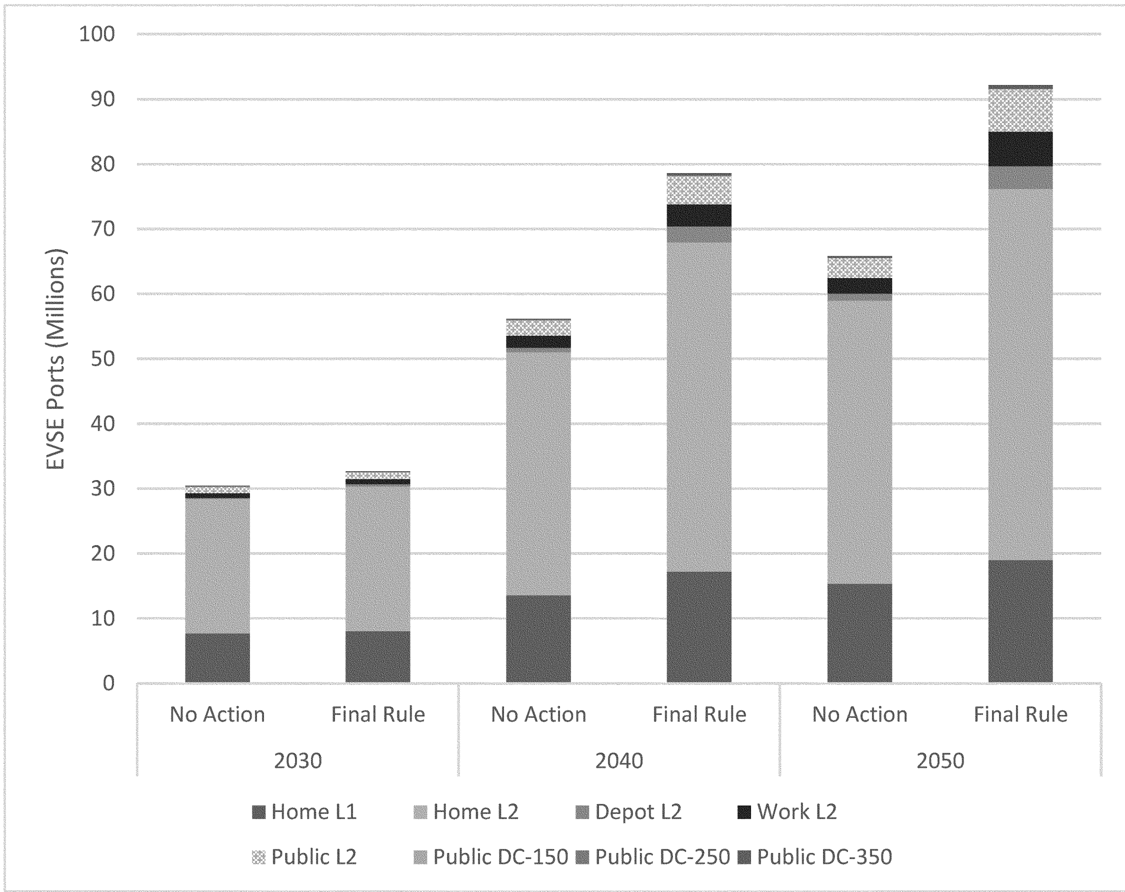

Figure 31: EVSE Port Counts by Charging Location and Type for the No Action Case (Left Side of Each Pair of Bars) and the Final Rule (Right Side of Each Pair of Bars) for Select Years.

[940] The Final rule and No Action cases used throughout the PEV charging infrastructure cost analysis were based on a preliminary analysis compared to the final compliance modeling. While annual PEV charging demand is generally higher in the compliance scenarios relative to those in the preliminary analysis (with annual differences of between plus and minus five percent), cumulative electricity consumption associated with PEV charging from 2027 to 2055 in the Final rule compliance scenario is only four percent higher for the action case (the final standards) and one percent higher in the No Action case, compared to the preliminary analysis used to assess PEV charging infrastructure needs and costs.

[941] The number of EVSE ports needed to meet a given level of electricity demand will vary based on assumptions about the mix of charging ports, charging preferences, vehicle characteristics, and other factors. See RIA Chapter 5 for a more detailed description of the assumptions underlying the EVSE port counts shown here.

[942] See RIA Chapter 5 for figures showing estimated port counts for each year from 2027 to 2055.

We estimate the costs to deploy the number of EVSE ports needed each year (2027–2055) to achieve the modeled network sizes for the Final rule and No Action case.[943] There are many factors that can impact equipment and installation costs, including whether a charging unit has multiple EVSE ports, how many ports are installed per site, as well as regional differences. Costs also vary in the literature. For the proposal, we sourced costs for each EVSE port from several studies and we requested comment on any additional estimates we should consider. Several commenters flagged that our overall EVSE cost estimates were lower than those in NREL's national charging network assessment (Wood et al. 2023),[944] which was published after the NPRM. For the final rule analysis, we have updated our assumed upfront hardware and installation costs for work and public EVSE ports to align with Wood et al. 2023. Costs for home and depot charging are assigned as follows. PEVs typically come with a charging cord that can be used for L1 charging by plugging it into a standard 120 V outlet, and, in some cases, for L2 charging by plugging into a 240 V outlet. We include the cost for this cord as part of the vehicle costs described in RIA Chapter 2, and therefore we do not include it here. Consistent with our NPRM analysis, we make the simplifying assumption that PEV owners opting for L1 home charging already have access to a 120 V outlet and therefore do not incur installation costs and that half of those in single-family homes opt to use the charging cord for L2 home charging while the other half purchase and install a wall-mounted or other Level 2 charging unit.[945] Costs for other home L2 charging are assigned assuming it serves both residents of multi-family housing as well as PEV owners without access to dedicated off-street parking who may use curbside or other neighborhood EVSE ports. Lastly, depot L2 charging applies to medium-duty PEVs [946] and reflects charging at their home base (*i.e.,* the location they are regularly parked when not in use). For some PEVs, this could be at a dedicated depot for commercial fleets whereas other medium-duty PEVs could be parked overnight and charged at the owner's home. Table 73 shows our final assumed costs per EVSE port.

TABLE 73—COSTS (HARDWARE AND INSTALLATION) PER EVSE PORT
[2022 Dollars]

Single-family home		Other home	Depot	Work	Public			
L1	L2	L2	L2	L2	L2	DC–150	DC–250	DC–350
$0	$1,280	$5,620	$6,150	$7,500	$7,500	$154,200	$193,450	$232,700

See RIA Chapter 5 for a more complete discussion of this analysis including low and high sensitivities not shown here. The final PEV charging infrastructure costs are presented in section VIII of this preamble.

5. Electric Grid Impacts

EPA acknowledges that there may be additional infrastructure needs and costs beyond those associated with charging equipment itself. As vehicle electrification load increases, alongside other new loads from data centers, industry, and building electrification, the grid will accommodate higher loads, which may require generation, transmission, and distribution system upgrades and additions. Our examination of the record, informed by our consultations with DOE, FERC, and other power sector stakeholders, is that the final standards of this rule, whether considered separately or in combination with the Phase 3 HD vehicle standards and upcoming power sector rules, are unlikely to adversely affect the reliability of the electric grid, and widespread adoption of PEVs could have significant benefits for the electric power system.[947] We also find that managed charging can reduce the impact of PEVs on the grid, innovative charging solutions can accelerate the integration of PEV loads, and the grid can be upgraded to accommodate increased loads from the transportation as well as other sectors. Further, we find that the final rule provides regulatory certainty to support increasing development of supporting electricity infrastructure as well as increasing adoption of strategies to mitigate infrastructure demands, such as managed charging and other innovative tools we describe later in this section.

In the balance of this section, we first provide an overview of the electric power system and grid reliability. We then discuss the impacts of this rule on generation. We find that the final rule, together with the Heavy-Duty Phase 3 GHG Proposed Rule, are associated with modest increases in electricity demand. We also conducted an analysis of resource adequacy, which is an important metric in North American Electric Reliability Corporation's (NERC) long-term reliability assessments. We find that the final rule, together with the HD Phase 3 Rule as well as other EPA rules that regulate the EGU sector, are unlikely to adversely affect resource adequacy. We then discuss transmission and find that the need for new transmission lines

[943] We assume a 15-year equipment lifetime for EVSE ports. We did not estimate costs for EVSE maintenance or repair though we note that this may be able to extend equipment lifetimes. See discussion in RIA Chapter 5.

[944] Wood et al., ''The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Infrastructure,'' 2023. Accessed December 18, 2023, at *https://driveelectric.gov/files/2030-charging-network.pdf.*

[945] For Level 2 single-family home charging, some PEV owners may opt to simply install or upgrade to a 240 V outlet for use with a charging cord while others may choose to purchase or install a wall-mounted or other Level 2 charging unit. We assume an even split for the costs shown in Table 8. Consistent with the proposal, residential L2 EVSE costs are estimated from costs in an ICCT study: Nicholas, Michael, ''Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas,'' 2019. Accessed March 11, 2024, at: *https://theicct.org/wp-content/uploads/2021/06/ICCT_EV_Charging_Cost_20190813.pdf.*

[946] Charging infrastructure needs for medium-duty PEVs were not simulated for the NPRM due to timing constraints, and therefore depot charging and other projected medium-duty PEV demands are new additions for this analysis.

[947] Many utility sector commenters supported EPA's assessment. See, *e.g.,* Comments of the Energy Strategy Coalition (''Members of this coalition are already engaging in long-term planning to meet the increased demand for electricity attributable to vehicle electrification, and the LMDV Proposal will provide a regulatory backstop supporting further investments in electrification and grid reliability. Demand for electricity will increase under both the LMDV Proposal and the recently-proposed Phase 3 Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles . . . but the electricity grid is capable of planning for and accommodating such demand growth and has previously experienced periods of significant and sustained growth.''); Comments of Edison Electric Institute.

associated with this rule and the HD Phase 3 rule between now and 2050 is projected to be very small, approximately one percent or less of transmission, and that nearly all of the additional buildout overlaps with existing transmission line right of ways. We find that this increase can reasonably be managed by the utility sector and project that transmission capacity will not constrain the increased demand for electricity associated with the final rule. Finally, we discuss our assessment of expected distribution system infrastructure needs. Our assessment is based on our own analysis as well as a state-of-the-art DOE Transportation Electrification Impacts Study (TEIS) conducted for this rulemaking and the HD Phase 3 Rule. We find that the final rule and the HD Phase 3 Rule are associated with a 3% increase in annual distribution investments, a modest increase that utilities can capably manage. The assessment also quantifies the significant benefits of basic managed charging practices applied to increasing PEV use. Based on the TEIS, EPA also quantified the impact on retail electric prices associated with the rule, concluding that there is no difference in retail electricity prices in 2030 and an increase of 2.5 percent in 2055, principally due to distribution-related costs.[948] Overall, we find that these relatively modest cost increases for distribution build out and the associated electricity price increases are reasonable.

i. Overview of the Electric Power System and Grid Reliability

The National Academy of Engineering ranks electrification as ''the greatest engineering achievement of the 20th century.'' [949] Comprised of approximately 11,000 utility-scale electric power plants,[950] 697,000 circuit-miles of power lines (240,000 miles of which are high-voltage transmission lines), 21,500 substations,[951] 5.5 million miles of low-voltage distribution lines,[952] 180 million power poles,[953] and serving 400 million consumers across North America,[954] the U.S. electric power sector is considered ''the world's biggest machine.'' [955]

Operating on a ''just in time'' basis, it is comprised of three basic components: generation, transmission, and distribution systems. While the forms of generation have varied—primarily from coal-fired sources in the mid-2000s to renewable sources supplemented with natural gas-fired generation, at present—the components of the system which deliver electricity remain the same. These components are the transmission and distribution systems, which have over time increased in size and reliability to accommodate the overall economic growth of the U.S. as well as the electricity demand associated with air conditioning, data centers, building electrification, cryptocurrency mining, and now vehicle electrification.

The electric power system in the U.S. has historically been a very reliable system,[956] with utilities, system planners, and reliability coordinators working together to ensure an efficient and reliable grid with adequate resources for supply to meet demand at all times, and we anticipate that this will continue in the future under these standards.

Power interruptions caused by extreme weather are the most-commonly reported, naturally-occurring factors affecting grid reliability, with the frequency of these severe weather events increasing significantly over the past twenty years due to climate change.[957] Conversely, decreasing emissions of greenhouse gases can be expected to help reduce future extreme weather events, which would serve to reduce the risks for electric power sector reliability. Extreme weather events include snowstorms, hurricanes, and wildfires. These power interruptions have significant impact on economic activity, with associated costs in the U.S. estimated to be $44 billion annually.[958] By requiring significant reductions in GHGs from new motor vehicles, this rule mitigates the harmful impacts of climate change, including the increased incidence of extreme weather events that affect grid reliability.

The average duration of annual electric power interruptions in the U.S., approximately two hours, decreased slightly from 2013 to 2021, when extreme weather events associated with climate change are excluded from reliability statistics. When extreme weather events associated with climate change are not excluded from reliability statistics, the national average length of annual electric power interruptions increased to about seven hours.[959]

Around 93 percent of all power interruptions in the U.S. occur at the distribution-level, with the remaining fraction of interruptions occurring at the transmission- and generation-levels.[960] [961] As new PEV models continue to enter the U.S. market, they are demonstrating increasing capability for use as distributed grid energy resources. As of January 2024, manufacturers have introduced, or plan to introduce, 24 MYs 2024–2025 PEVs with bidirectional charging capable of supporting two to three days of residential electricity consumption. These PEVs have capability to discharge power on the order of 10 kW to residential loads or limited commercial loads. Such a capability could be used to provide limited backup power to service stations providing petroleum

[948] These figures compare the action case with basic managed charging relative to the no action with unmanaged charging.

[949] National Academy of Engineering. 2003. Greatest Engineering Achievement of the 20th Century. (*http://www.greatachievements.org/*).

[950] U.S. EPA. 2024. Electric Power Sector Basics. (*https://www.epa.gov/power-sector/electric-power-sector-basics#:~:text=Discover%20programs,How%20Is%20Electricity%20Used%3F,miles%20of%20high%20voltage%20lines*).

[951] U.S. DOE. 2017. Transforming the Nation's Electricity System: The Second Installment of the QER. Quadrennial Energy Review. (*https://www.energy.gov/sites/prod/files/2017/02/f34/Appendix--Electricity%20System%20Overview.pdf*).

[952] U.S. DOE. 2024. U.S. Department of Energy Announces $34 Million to Improve the Reliability, Resiliency, and Security of America's Power Grid. (*https://arpa-e.energy.gov/news-and-media/press-releases/us-department-energy-announces-34-million-improve-reliability#:~:text=The%20electric%20power%20distribution%20system,in%20the%20country%20each%20year*).

[953] Warwick WM, Hardy TD, Hoffman MG, Homer JS. 2016. Electricity Distribution System Baseline Report (PNNL–25178). Richland,WA: Pacific Northwest National-Laboratory.

[954] Independent Electricity System Operator (2020). The World's Largest Machine: The North American Power Grid. (*https://www.ieso.ca/en/Powering-Tomorrow/2020/The-Worlds-Largest-Machine-The-North-American-Power-Grid#:~:text=The%20North%20American%20power%20grid%20is%20a%20vast%2C%20interconnected%20network,%E2%80%9Cthe%20world's%20largest%20machine.%E2%80%9D*).

[955] U.S. DOE. 2017. Keeping an Eye on the World's Largest Machine: How Measurements are Modernizing the Electric Grid. Richland,WA: Pacific Northwest National-Laboratory. (*https://www.pnnl.gov/events/keeping-eye-worlds-largest-machine-how-measurements-are-modernizing-electric-grid*).

[956] NREL, '' Explained: Reliability of the Current Power Grid'', NREL/FS–6A40–87297, January 2024 *https://www.nrel.gov/docs/fy24osti/87297.pdf*.

[957] DOE, Electric Disturbance Events (OE–417) Annual Summaries for 2000 to 2023, *https://www.oe.netl.doe.gov/OE417_annual_summary.aspx*.

[958] LaCommare, K. H., Eto, J. H., & Caswell, H. C. (2018, June). Distinguishing Among the Sources of Electric Service Interruptions. In 2018 IEEE International Conference on Probabilistic Methods Applied to Power Systems (PMAPS) (pp. 1–6). IEEE.

[959] EIA, U.S. electricity customers averaged seven hours of power interruptions in 2021, 2022, *https://www.eia.gov/todayinenergy/detail.php?id=54639#*.

[960] Eto, Joseph H, Kristina Hamachi LaCommare, Heidemarie C Caswell, and David Till. ''Distribution system versus bulk power system: identifying the source of electric service interruptions in the US.'' IET Generation, Transmission & Distribution 13.5 (2019) 717–723.

[961] Larsen, P. H., LaCommare, K. H., Eto, J. H., & Sweeney, J. L. (2015). Assessing changes in the reliability of the US electric power system.

fuels to emergency vehicles in response to a local disruption in electrical service.[962]

According to FERC, grid reliability is based on two key elements; [963]

• Reliable operation—A reliable power grid has the ability to withstand sudden electric system disturbances that can lead to blackouts.

• Resource adequacy—Generally speaking, resource adequacy is the ability of the electric system to meet the energy needs of electricity consumers. This means having sufficient generation to meet projected electric demand.

ii. Generation

We now turn to the impacts of this rule on generation and resource adequacy. As discussed in section IV.C.3 of the preamble and as part of our upstream analysis, we modeled changes to power generation due to the increased electricity demand anticipated under the final standards. Bulk generation and transmission system impacts are felt on a larger scale, and thus tend to reflect smoother load growth and be more predictable in nature. For a no action case, we project that generation will increase by 4.2% between 2028 and 2030 and by 36% between 2030 and 2050. Further, we project the additional generation needed to meet the projected demand of the light- and medium-duty PEVs under the final standards combined with our estimate of PEV demand from the Heavy-duty Phase 3 GHG proposed rule, to be relatively modest compared to a no action case, ranging from 0.93 percent in 2030 to approximately 12 percent in 2050 for both actions combined. Of that increased generation, approximately 84 percent in 2030 and approximately 66 percent in 2050 is due to light- and medium-duty PEVs, which are projected to represent approximately 0.78 percent and 7.6 percent of total U.S. generation in 2030 and 2050, respectively. Electric vehicle charging associated with the Action case (light- and medium-duty combined with heavy-duty) is expected to require 4 percent of the total electricity generated in 2030, which is slightly more than the increase in total U.S. electricity end-use consumption between 2021 and 2022.[964] This is also roughly equal to the combined latest U.S. annual electricity consumption estimates for data centers [965] and cryptocurrency mining operations,[966] both industries which have grown significantly in recent years and whose electricity demand the utility sector has capably managed.[967] EPA's assessment is that national power generation will continue to be sufficient as demand increases from electric vehicles associated with both this rule and the HD Phase 3 Rule.

Given the additional electricity demand associated with increasing adoption of electric vehicles, some commenters raised concerns that the additional demand associated with the rule could impact the reliability of the power grid.[968] To further assess the impacts of this rule on grid reliability and resource adequacy, we conducted an additional grid reliability assessment of the impacts of the rule and how projected outcomes under the rule compare with projected baseline outcomes in the presence of the IRA. Because we recognize that this rule is being developed contemporaneously with the Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3 proposed rule, which also is anticipated to increase demand for electricity, we analyzed the impacts of these two rules (the ''Vehicle Rules'') on the grid together. EPA also considered several recently proposed rules related to the grid that may directly impact the EGU sector (which we refer to as ''Power Sector Rules'' [969]).

Specifically, we considered whether the Vehicles Rules alone and combined with the Power Sector Rules would result in anticipated power grid changes such that they (1) respect and remain within the confines of key National Electric Reliability Corporation (NERC) assumptions,[970] (2) are consistent with historical trends and empirical data, and (3) are consistent with goals, planning efforts and Integrated Resource Plans (IRPs) of industry itself.[971] We demonstrate that the effects of EPA's vehicle and power sector rules do not preclude the industry from meeting NERC resource adequacy criteria or otherwise adversely affect resource adequacy. This demonstration includes explicit modeling of the impacts of the Vehicle Rules, an additional quantitative analysis of the cumulative impacts of the Vehicles Rules and the Power Sector Rules, as well as a review of the existing institutions that maintain

[962] Mulfati, Justin. dcBel, ''New year, new bidirectional cars: 2024 edition'' January 15, 2024. Accessed March 10, 2024. Available at: *https://www.dcbel.energy/blog/2024/01/15/new-year-new-bidirectional-cars-2024-edition/*.

[963] FERC, Reliability Explainer, August 16, 2023 *https://www.ferc.gov/reliability-explainer*.

[964] U.S. Energy Information Agency, Use of Electricity, December 18, 2023. *https://www.eia.gov/energyexplained/electricity/use-of-electricity.php#:~:text=Total%20U.S.%20electricity%20end%2Duse,3.2%25%20higher%20than%20in%202021.&text=In%202022%2C%20retail%20electricity%20sales,4.7%25%20higher%20than%20in%202021*.

[965] U.S. DOE Office of Energy Efficiency and Renewable Energy, Data Centers and Servers *https://www.energy.gov/eere/buildings/data-centers-and-servers*.

[966] U.S. Energy Information Agency, Tracking Electricity Consumption From U.S. Cryptocurrency Mining Operations, February 1, 2024, *https://www.eia.gov/todayinenergy/detail.php?id=61364#:~:text=Our%20preliminary%20estimates%20suggest%20that,2.3%25%20of%20U.S.%20electricity%20consumption.&text=This%20additional%20electricity%20use%20has,cost%2C%20reliability%2C%20and%20emissions*.

[967] As we noted at proposal, and as several commenters agreed, U.S. electric power utilities routinely upgrade the nation's electric power system to improve grid reliability and to meet new electric power demands. For example, when confronted with rapid adoption of air conditioners in the 1960s and 1970s, U.S. electric power utilities maintained reliability and met the new demand for electricity by planning and building upgrades to the electric power distribution system.

[968] EPA notes that manufacturers have a wide array of compliance options, as discussed in Section IV of the preamble. For example, manufacturers could produce significantly fewer BEVs than in the central case, or even no BEVs beyond the no action baseline. Were manufacturers to choose these compliance pathways, the increasing in electricity demand associated with the rule would be smaller.

[969] The recently proposed rules that we considered because they may impact the EGU sector (which we refer to as ''Power Sector Rules'') include: the proposed Existing and Proposed Supplemental Effluent Limitations Guidelines and Standards for the Steam Electric Power Generation Point Source Category (88 FR 18824) (''ELG Rule''), New Source Performance Standards for GHG Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired EGUs; Emission Guidelines for GHG emissions from Existing Fossil Fuel-Fired EGUs (88 FR 33240) (''111 EGU Rule''); and National Emissions Standards for Hazardous Air Pollutants: Coal-and Oil-Fired Electric Utility Steam Generating units Review of the Residual Risk and Technology Review (88 FR 24854) (''MATS RTR Rule''). EPA also considered all final rules affecting the EGU sector in the modeling for the Vehicle Rules.

[970] NERC was designated by FERC as the Electric Reliability Organization (ERO) in 2005 and, therefore, is responsible for establishing and enforcing mandatory reliability standards for the North American bulk power system. Resource Adequacy Primer for State Regulators, 2021, National Association of Regulatory Utility Commissioners (*https://pubs.naruc.org/pub/752088A2-1866-DAAC-99FB-6EB5FEA73042*).

[971] Although this final rule was developed generally contemporaneously with the HD Phase 3 rule, the two rulemakings are separate and distinct. Since the Phase 3 rule has not yet been finalized and was not complete as of the date of our analysis, we have been required to make certain assumptions for the purposes of this analysis to represent the results of the expected forthcoming Phase 3 rulemaking, which we believe are sufficiently accurate for purposes of this analysis. Our analysis of the proposed Power Sector Rules is based on the modeling conducted for proposals. We believe this analysis is a reasonable way of accounting for the cumulative impacts of our rules affecting the EGU sector, including the proposed Power Sector Rules, at this time. Our cumulative analysis of the Vehicles and Power Sector Rules supports this final rule, and it does not reopen any of the Power Sector Rules, which are the subject of separate agency proceedings. Consistent with past practice, as subsequent rules are finalized, EPA will perform additional power sector modeling that accounts for the cumulative impacts of the rule being finalized together with existing final rules at that time.

grid reliability and resource adequacy in the United States. We conclude that the Vehicles Rules, whether alone or combined with the Power Sector Rules, satisfy these criteria and are unlikely to adversely affect the power sector's ability to maintain resource adequacy or grid reliability.

Beginning with EPA's modeling of the Vehicle Rules, we used EPA's Integrated Planning Model (IPM), a model with built-in NERC resource adequacy constraints, to explicitly model the expected electric power sector impacts associated with the two vehicle rules. IPM is a state-of-the-art, peer-reviewed, multi-regional, dynamic, deterministic linear programming model of the contiguous U.S. electric power sector. It provides forecasts of least cost capacity expansion, electricity dispatch, and emissions control strategies while meeting energy demand and environmental, transmission, dispatch, and resource adequacy constraints. IPM modeling we conducted for the Vehicle Rules includes in the baseline all final rules that may directly impact the power sector, including the final Good Neighbor Plan for the 2015 Ozone National Ambient Air Quality Standards (NAAQS), 88 FR 36654.

EPA has used IPM for over two decades, including for prior successfully implemented rulemakings, to better understand power sector behavior under future business-as-usual conditions and to evaluate the economic and emissions impacts of prospective environmental policies. The model is designed to reflect electricity markets as accurately as possible. EPA uses the best available information from utilities, industry experts, gas and coal market experts, financial institutions, and government statistics as the basis for the detailed power sector modeling in IPM. The model documentation provides additional information on the assumptions discussed here as well as all other model assumptions and inputs. EPA relied on the same model platform at final as it did at proposal, but made substantial updates to reflect public comments. Of particular relevance, the model framework relies on resource adequacy-related constraints that come directly from NERC. This includes NERC target reserve margins for each region, NERC Electricity Supply & Demand load factors, and the availability of each generator to serve load across a given year as reported by the NERC Generating Availability Data System. Note that unit-level availability constraints in IPM are informed by the average planned/unplanned outage hours for NERC Generating Availability Data System. Therefore, the model projections for the Vehicle Rules are showing compliance pathways respecting these NERC resource adequacy criteria. These NERC resource adequacy criteria are standards by which FERC, NERC and the power sector industry judge that the grid is capable of meeting demand. Thus, we find that modeling results demonstrating that the grid will continue to operate within those resource adequacy criteria supports the conclusion that the rules will not have an adverse impact on resource adequacy, which is an essential element of grid reliability.

EPA also considered the cumulative impacts of the Vehicle Rules together with the Power Sector Rules, which as noted above are several recent proposed rules regulating the EGU sector. In a given rulemaking, EPA does not generally analyze the impacts of other proposed rulemakings, because those rules are, by definition, not final and do not bind any regulated entities, and because the agency does not want to prejudge separate and ongoing rulemaking processes. However, some commenters on this rule expressed concern regarding the cumulative impacts of these rules when finalized, claiming that the agency's failure to analyze the cumulative impacts of the Vehicle Rules and its EGU-sector related rules rendered this rule arbitrary and capricious. In particular, commenters argued that renewable energy could not come online quickly enough to make up for generation lost due to fossil sources that may retire, and that this together the increasing demand associated with the Vehicle Rules would adversely affect resource adequacy and grid reliability. EPA conducted additional analysis of these cumulative impacts in response to these comments. Our analysis finds that the cumulative impacts of the Vehicle Rules and Power Sector Rules is associated with changes to the electric grid that are well within the range of fleet conditions that respect resource adequacy, as projected by multiple, highly respected peer-reviewed models. In other words, taking into consideration a wide range of potential impacts on the power sector as a result of the IRA and Power Sector Rules (including the potential for much higher variable renewable generation), as well the potential for increased demand for electricity from both this rule and the Phase 3 Heavy Duty GHG rule, EPA found that the Vehicle Rules and proposed Power Sector Rules are not expected to adversely affect resource adequacy and that EPA's rules will not inhibit the industry from its responsibility to maintain a grid capable of meeting demand without disruption.

Finally, we note the numerous are existing and well-established institutional guardrails at the federal- and state-level, as well as non-governmental organizations, which we expect to continue to maintain resource adequacy and grid reliability. These well-established institutions—including the Federal Energy Regulatory Commission (FERC), state Public Service Commissions (PSC), Public Utility Commissions (PUC), and state energy offices, as well as NERC and Regional Transmission Organization (RTO) and Independent System Operator (ISO)—have been in place for decades, during which time they have ensured the resource adequacy and reliability of the electric power sector. As such, we expect these institutions will continue to ensure that the electric power sector is safe and reliable, and that utilities will proactively plan for electric load growth associated with all future electricity demand, including those increases due to our final rule. We also expect that utilities will continue to collaborate with EGU owners to ensure that any EGU retirements will occur in an orderly and coordinated manner. We also note that EPA's proposed Power Sector rules include built-in flexibilities that accommodate a variety of compliance pathways and timing pathways, all of which helps to ensure the resource adequacy and grid reliability of the electric power system.[972] In sum, the power sector analysis conducted in support of this rule indicates that the Vehicle Rules, whether alone or combined with the Power Sector Rules, are unlikely to affect the power sector's ability to maintain resource adequacy and grid reliability.[973]

iii. Transmission

The transmission system is another component of the electric power system with unique grid reliability attributes. The need for new transmission lines associated with the final rule and the HD Phase 3 Rule between now and 2050 is projected to be very small, approximately one percent or less of transmission. Nearly all of the projected new transmission builds appear to overlap with pre-existing transmission

[972] As noted above, EPA is not prejudging the outcome of any of the Power Sector Rules.

[973] See RIA Chapter 5; ''Resource Adequacy Analysis Final Rule Technical Memorandum for Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles, and Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3,'' available in the docket for this rulemaking.

line right of ways (ROW), which makes the permitting process simpler. Approximately 41-percent of the potential new transmission line builds projected by IPM have already been independently publicly proposed by developers. The agency finds that the utility sector can reasonably manage this very limited need for additional transmission.[974]

We also find that, the federal government has a role in improving transmission system planning,[975] and there are a myriad of programs and efforts underway that will help support transmission improvements to the grid and provide reliability benefits. While there is congestion and delays in transmission buildout, utilities and other actors have other ways to improve reliability, by deploying Grid Enhancing Technologies (GET) and Storage As Transmission Asset (SATA).

For example, two 230-kV transmission lines used by PPL Electric Utilities, in Pennsylvania, were found to be approaching their maximum transmission capacity in 2020. As a result, the utility paid more than $60 million in congestion fees in the winters of 2021–2022 and 2022–2023. Rather than rebuilding or reconductoring the two transmission lines, which would have cost tens of millions of dollars, the utility spent under $300 thousand installing dynamic line rating (DLR) sensors, which helped the utility to rebalance each of the two transmission lines and allowed them to reliably carry an additional 18 percent of power.[976]

DOE recently announced several programs and projects aimed at helping to alleviate the interconnection queue backlog, including the Grid Resilience and Innovation Partnerships (GRIP) program, with $10.5 billion in Bipartisan Infrastructure Law funding to develop and deploy Grid Enhancing Technologies (GET); and the Interconnection Innovation e-Xchange (i2X), which aims to increase data access and transparency, improve process and timing, promote economic efficiency, and maintain grid reliability.[977] [978] [979] [980] [981] [982] GRIP (among other DOE funding programs) also provides funding to build new transmission lines to unlock new clean generation sources.[983] FERC has issued various orders to address interconnection queue backlogs, improve certainty, and prevent undue discrimination for new technologies.[984] [985] FERC Order 2023 provides generator interconnection procedures and agreements to address interconnection queue backlogs, improve certainty, and prevent undue discrimination for new technologies.

The capacity of existing electric power transmission lines can be increased by a process known as reconductoring, in which existing transmission lines, typically with steel cores, are replaced with higher capacity composite conductors. Since the process makes use of existing transmission towers, it typically does not require additional rights of way. As such, new generation capacity can be rapidly added, which serves to improve resource adequacy. For example, American Electric Power, a Texas-based transmission utility, replaced the aging conventional conductors of a 240 miles transmission line with advanced composite core conductors from 2012–2015.[986] The reconductoring resulted in an approximate doubling of the previous transmission line capacity and was accomplished while the 345-kilovolt transmission lines remained energized.[987]

Energy storage projects can also be used to help to reduce transmission line congestion and are seen as alternatives to transmission line construction in some cases.[988] [989] These projects, known as Storage As Transmission Asset (SATA),[990] can help to reduce transmission line congestion, have smaller footprints, have shorter development, permitting, and construction times, and can be added incrementally, as required. Examples of SATA projects include the ERCOT Presidio Project,[991] a 4 MW battery system that improves power quality and reducing momentary outages due to voltage fluctuations, the APS Punkin Center,[992] a 2 MW, 8 MWh battery system deployed in place of upgrading 20 miles of transmission and distribution lines, the National Grid Nantucket Project,[993] a 6 MW, 48 MWh battery system installed on Nantucket Island, MA, as a contingency to undersea electric supply cables, and the Oakland Clean Energy Initiative Projects,[994] a 43.25 MW, 173 MWh energy storage project to replace fossil generation in the Bay area.

Through such efforts, the interconnection queues can be reduced in length, transmission capacity on existing transmission lines can be increased, additional generation assets

[974] See RIA Chapter 5.2.7.

[975] FERC regulates interstate regional transmission planning and is currently finalizing a major rule to improve transmission planning. The rule would require that transmission operators do long term planning and would require transmission providers to work with states to develop a cost allocation formula, among other changes. The primary goal of the FERC rule is to align with long-term needs, rather than focusing on short-term projects, which may lack capacity required to address future transmission needs.

[976] PPL's Dynamic Line Ratings Implementation: *https://www.energypa.org/wp-content/uploads/2023/04/Dynamic-Line-Ratings-H-Lehmann-E-Rosenberger.pdf*.

[977] Abboud, A. W., Gentle, J. P., Bukowski, E. E., Culler, M. J., Meng, J. P., & Morash, S. (2022). A Guide to Case Studies of Grid Enhancing Technologies (No. INL/MIS–22–69711–Rev000). Idaho National Laboratory (INL), Idaho Falls, ID (United States).

[978] DOE, Grid Deployment Office, Grid Resilience and Innovation Partnerships (GRIP) Program, *https://www.energy.gov/gdo/grid-resilience-and-innovation-partnerships-grip-program*.

[979] Federal Energy Regulatory Commission, Implementation of Dynamic Line Ratings, Docket No. AD22–5–000 (February 24, 2022), *https://www.federalregister.gov/documents/2022/02/24/2022-03911/implementation-of-dynamic-line-ratings*.

[980] DOE, Dynamic Line Rating, 2019, *https://www.energy.gov/oe/articles/dynamic-line-rating-report-congress-june-2019*.

[981] DOE, Advanced Transmission Technologies, 2020, *https://www.energy.gov/oe/articles/advanced-transmission-technologies-report*.

[982] DOE, About the Interconnection Innovation e-Xchange (i2X), 2024, *https://www.energy.gov/eere/i2x/about-interconnection-innovation-e-xchange-i2x*.

[983] DOE, 2024. Grid Resilience Utility and Industry Grants. *https://www.energy.gov/gdo/grid-resilience-and-innovation-partnerships-grip-program-projects*.

[984] Federal Energy Regulatory Commission, Improvements to Generator Interconnection Procedures and Agreements, Docket No. RM22–14–000; Order No. 2023 (July 28, 2023), *https://www.ferc.gov/media/e-1-order-2023-rm22-14-000*.

[985] *https://www.ferc.gov/news-events/news/staff-presentation-improvements-generator-interconnection-procedures-and*.

[986] Energized Reconductor Project in the Lower Rio Grande Valley of Texas (*https://www.aeptransmission.com/texas/RGVConductor/*).

[987] American Electric Power—Energized Reconductoring Project in the Lower Rio Grande Valley *https://www.quantaenergized.com/project/574*.

[988] Federal Energy Regulatory Commission, Managing Transmission Line Ratings, Docket No. RM20–16–000; Order No. 881 (December 16, 2021), *https://www.ferc.gov/media/e-1-rm20-16-000*.

[989] Federal Energy Regulatory Commission, Staff Presentation Final Order Regarding Managing Transmission Line Ratings FERC Order 881 (December 16, 2021), *https://www.ferc.gov/news-events/news/staff-presentation-final-order-regarding-managing-transmission-line-ratings*.

[990] Nguyen, T. A., & Byrne, R. H. (2020). Evaluation of Energy Storage As A Transmission Asset (No. SAND2020–9928C). Sandia National Lab.(SNL–NM), Albuquerque, NM (United States).

[991] *http://www.ettexas.com/Content/documents/NaSBatteryOverview.pdf*.

[992] *https://www.aps.com/-/media/APS/APSCOM–PDFs/About/Our-Company/Doing-business-with-us/Resource-Planning-and-Management/APS_IRP_2023_PUBLIC.ashx?la=en&hash=B0B8ED59F4698FE246386F3CD118DEC8*.

[993] Balducci, P. J., Alam, M. J. E., McDermott, T. E., Fotedar, V., Ma, X., Wu, D., . . . & Ganguli, S. (2019). Nantucket island energy storage system assessment (No. PNNL–28941). Pacific Northwest National Lab. (PNNL), Richland, WA (United States), *https://energystorage.pnnl.gov/pdf/PNNL-28941.pdf*.

[994] *https://www.pgecurrents.com/articles/2799-pg-e-proposes-two-energy-storage-projects-oakland-clean-energy-initiative-cpuc*.

can be brought online, and electricity generated by existing assets will be curtailed less often. These factors help to improve overall grid reliability. We conclude that it is reasonable to anticipate that transmission capacity will not constrain the increased demand for electricity projected in our central case modeling.

iv. Distribution

We next discuss distribution infrastructure. We acknowledge that increases in electric vehicle charging associated with the final rule are likely to require additional distribution infrastructure. We first review the literature regarding and tools to support distribution needs associated with PEV charging, and then we discuss the TEIS, which specifically analyzes the distribution needs associated with this rule and the HD Phase 3 Rule.

Numerous tools are available to address and mitigate anticipated distribution needs, including managed charging, time-of-use (TOU) electric rates, distributed energy resources (DERs), Power Control Systems (PCS), and others, which are discussed in greater detail below. New technologies and solutions exist and are emerging to ensure that new charging stations can be connected to the grid as quickly as possible, without adversely affecting grid reliability. Utility hosting capacity maps are one tool available that developers can use to identify faster and lower cost locations to connect new EV chargers. These maps can help charging station developers identify locations where there is excess available grid capacity. Hosting capacity maps provide greater transparency into the ability of the distribution grid to host additional distributed energy resources (DERs) such as BEV charging. In addition, hosting capacity maps can identify where DERs can alleviate or aggravate grid constraints. Hosting capacity is commonly defined as the additional injection or withdrawal of electric power up to the limits where individual grid assets exceed their power ratings or where a voltage violation would occur. Hosting capacity maps, analyzed and created by the utility that owns the distribution system, are usually color-coded lines or surface diagrams overlayed on geographic maps, representing the conditions on the grid at the time when the map is published or updated. The analysis is based on power flow simulations of the distribution circuits given specific customers' load profiles supplied by the electric circuit and the grid asset data as managed by the utility. The hosting capacity is highly location specific. A DOE review found that utilities have published 39 hosting capacity maps in 24 states and the District of Columbia.[995]

Hosting capacity maps can help direct new EV charger deployment to less constrained portions of the grid, giving utilities more lead time to make distribution system upgrades. In tandem, new technologies and power control protocols are helping connect new EV loads faster even where there are grid capacity constraints. One approach is for utilities to make non-firm capacity available immediately as they construct distribution system upgrades. Southern California Edison, a large electric utility in California, proposed a pilot to allow faster connection of new EV loads in constrained areas by deploying Power Control Systems (PCS).[996] In addition to the anticipated build out of charging infrastructure and electric distribution grids, innovative charging solutions implemented by electric utilities have further reduced lead times.

Plans like Southern California Edison's (SCE) to use load constraint management systems (LCMS),[997] which limits power that is available for EV charging based upon capacity limits of the distribution system, to connect new EV loads faster in constrained sections of the grid are being bolstered by new standards for load control technologies. UL, an organization that develops standards for the electronics industry, published the UL 3141 Outline of Investigation (OOI) for Power Control Systems (PCS) in January 2024.[998] Manufacturers can now use this standard for developing devices that utilities can use to limit the energy consumption of BEVs. The OOI identifies five potential functions for PCS. One of these functions is to serve as a Power Import Limit (PIL) or Power Export Limit (PEL). In these use cases, the PCS controls the flow of power between a local electric power system (local EPS, most often the building wiring on a single premises) and a broader area electric power system (area EPS, most often the utility's system). Critically, the standardized PIL function will enable the interconnection of new BEV charging stations faster by leveraging the flexibility of BEVs to charge in coordination with other loads at the premise. With this standard in place and manufacturer completion of conforming products, utilities will have a clear technological framework available to use in load control programs that accelerate charging infrastructure deployment for their customers.

In addition to the flexible interconnection enabled by PCS, technologies including battery or generation backed charging and mobile charging can facilitate rapid charging deployment, even before utility connections can be upgraded. Mobile chargers can be deployed immediately because they do not require an on-site grid connection. They can be used as a temporary solution to bring additional charging infrastructure to locations before a stationary, grid-connected charger can be deployed. Mobile chargers can also help bring charging infrastructure to locations where traditional charger deployments can be more difficult, such as at multi-unit dwellings.[999]

Battery-integrated charging is a promising solution to deploy DCFC quickly and inexpensively in relatively constrained areas of the grid. These chargers draw power from the grid slowly throughout the day and use a battery to store that power and then use it to charge EVs at much faster rates. A recent Argonne National Laboratory analysis found that battery-integrated DCFC results in either lower or similar levelized costs relative to non-battery-integrated DCFC in regions across the

[995] DOE, "U.S. Atlas of Electric Distribution System Hosting Capacity Maps," times to deploying BEVs. Available online: *https://www.energy.gov/eere/us-atlas-electric-distribution-system-hosting-capacity-maps*.

[996] In California, Southern California Edison (SCE) proposed a two-year Automated Load Control Management Systems (LCMS) Pilot. The program would use third-party owned LCMS equipment approved by SCE to accelerate the connection of new loads, including new EVSE, while "SCE completes necessary upgrades in areas with capacity constraints."1 SCE would use the LCMS to require new customers to limit consumption during periods when the system is more constrained, while providing those customers access to the distribution system sooner than would otherwise be possible. Once SCE completes required grid upgrades, the LCMS limits will be removed, and participating customers will gain unrestricted distribution service. SCE hopes to evaluate the extent to which LCMS can be used to "support distribution reliability and safety, reduce grid upgrade costs, and reduce delays to customers obtaining interconnection and utility power service."1 SCE states that prior CPUC decisions have expressed clear support for this technology and SCE is commencing the LCMS Pilot immediately. This program was approved by CPUC in January 2024.

[997] Load Constraint Management Systems (LCMS) allow EV chargers to temporarily connect to distribution systems in capacity constrained areas by simultaneously managing the time of charging in such a manner that accommodates other electricity demands before electric utilities can install permanent distribution system upgrades.

[998] UL Standards and Engagement. January 11, 2024. UL 3141: Outline of Investigation for Power Control Systems. *https://www.shopulstandards.com/ProductDetail.aspx?productId=UL3141_1_O_20240111*.

[999] *https://www.bloomberg.com/news/articles/2023-11-04/these-electric-vehicle-chargers-will-come-to-you.*

country, while accelerating deployment.[1000] Battery-integrated chargers save money both upfront on grid distribution upgrade costs as well as during operation by reducing the cost of utility demand charges based on maximum site load. Avoiding distribution grid upgrades also reduces the risk of interconnection-related delays, and thus speeds deployment. The study found that in California, battery-integration can reduce peak power demand of DCFC station by 60–90 percent. Battery-integrated chargers are already being deployed across the US. In several states, NEVI funding has been used to deploy battery-integrated DCFC, including chargers made by Freewire and Jule.[1001]

Additional innovative charging solutions will further accelerate charging deployment by optimizing the use of chargers that have already been installed. Technologies are emerging to make the most of existing charging infrastructure. Other companies are working on facilitating the sharing of chargers between more drivers. One company, EVMatch, developed a software platform for sharing, reserving, and renting EV charging stations, which can allow owners of charging stations to earn additional revenue while making their chargers available to more EV drivers to maximize the benefit of each deployed charger. EVMatch is also rolling out a new product called the EVMatch adapter in partnership with Argonne National Laboratory. The EVMatch adapter is a smart charging adapter that can turn any Level 1 or 2 EVSE into a smart charger that can remotely monitor and control charging to enable even more efficient utilization of existing chargers.[1002] Innovative charging models like these can be efficient ways to increase charging access for EVs with a smaller amount of physical infrastructure.[1003]

It is not uncommon for the electric power system to have additional, unutilized generation capacity at various times throughout a given day. In a manner akin to load constraint management systems (discussed above), grid operators can utilize this previously untapped generation capacity by shifting the charging of electric vehicles to times where excess underutilized generation capacity exists and/or shift electric vehicle charging away from times where generation capacity is less prevalent, without affecting the utility of electric vehicles. This allows the grid operators to more effectively use existing electric power system resources, which decreases overall operative costs for all ratepayers. Prior research efforts [1004] [1005] [1006] have capitalized on the mismatch between electric generation capacity and demand by demonstrating the ability to shift up to 20 percent of electric vehicle charging load demand from times of the day in which electricity supply is less-plentiful and/or more-expensive to other times of the day, when electricity supply is more-plentiful and/or less-expensive.[1007] Conversely, the research efforts also demonstrated the ability to increase electric vehicle charging loads by up to 30 percent in a given hour of the day. By more effectively utilizing existing electric power system assets, managed electric vehicle charging can also help to further reduce overall electricity costs by allowing for the deferral of electric power system upgrades, with deferment potential of between 5 and 15 years over the 2021–2050 period.[1008] While such deferrals reduce immediate capital expenditures for electric power system operators, they also extend the functional lifespan of these assets, provide electric utility planners with additional time to consider cost-effective planning options, and help to mitigate supply chain shortages for electric power system components.

Integration of electric vehicle charging into the power grid, by means of vehicle-to-grid software and systems that allow management of vehicle charging time and rate, has been found to create value for electric vehicle drivers, electric grid operators, and ratepayers.[1009] The ability to shift and curtail electric power by managing EV charging is a feature that can improve grid operations and, therefore, grid reliability. Management of PEV charging can reduce overall costs to utility ratepayers by delaying electric utility customer rate increases associated with equipment upgrades and may allow utilities to use electric vehicle charging as a resource to manage intermittent renewables. When PEVs charge during hours when existing grid infrastructure is underutilized, they can put downward pressure on all customers' electric rates by spreading fixed grid investment costs across greater electricity sales.[1010] The development of new electric utility tariffs, including those for submetering for electric vehicles, will also help to facilitate the management of electric vehicle charging and can help to reduce PEV operating costs. When employed as distributed energy resources (DER), PEVs can help to defer and/or replace the need for specific transmission and distribution

[1000] Poudel, Sajag, Jeffrey Wang, Krishna Reddi, Amgad Elgowainy, Joann Zhou. 2024. Innovative Charging Solutions for Deploying the National Charging Network: Technoeconomic Analysis. Argonne National Laboratory.

[1001] Batter-integrated chargers from Freewire and Jule have been selected for NEVI funding in Alaska, Colorado, Kentucky, Texas, and Utah. For Freewire's announcements, see *https://www.linkedin.com/posts/freewiretech_nevi-program-freewire-technologies-activity-7148020388294184961-2CNA*. For Jule's announcements, see *https://www.julepower.com/resources/spotlight*.

[1002] Jeff Chenoweth, ''The EVmatch Adapter Will Transform And Unify The Way You Monitor And Control Level 2 EV Chargers.'' March 2, 2023. Available at: *https://evmatch.com/blog/the-evmatch-adapter-will-transform-and-unify-the-way-you-monitor-and-control-level-2-ev-chargers.* Jason D. Harper, ''Electric Vehicle Smart Charge Adapter TCF (ANL)''. July 7, 2021. Available at: *https://www.energy.gov/sites/default/files/2021-07/elt271_harper_2021_p_5-17_908am_KF_ML.pdf*.

[1003] Argonne National Laboratory, 2024. Innovative Charging Solutions for Deploying the National Charging Network: Technoeconomic Analysis.

[1004] Kintner-Meyer, M., Davis, S., Sridhar, S., Bhatnagar, D., Mahserejian, S., & Ghosal, M. (2020). Electric vehicles at scale-phase I analysis: High EV adoption impacts on the western US power grid (No. PNNL–29894).

[1005] Pless, Shanti, Amy Allen, Lissa Myers, David Goldwasser, Andrew Meintz, Ben Polly, and Stephen Frank. 2020. Integrating Electric Vehicle Charging Infrastructure into Commercial Buildings and Mixed-Use Communities: Design, Modeling, and Control Optimization Opportunities; Preprint. Golden, CO: National Renewable Energy Laboratory. NREL/CP–5500–77438. *https://www.nrel.gov/docs/fy20osti/77438.pdf*.

[1006] Satchwell, A., Carvallo, J. P., Cappers, P., Milford, J., & Eshraghi, H. (2023). Quantifying the Financial Impacts of Electric Vehicles on Utility Ratepayers and Shareholders.

[1007] Lipman, Timothy, Alissa Harrington, and Adam Langton. 2021. Total Charge Management of Electric Vehicles. California Energy Commission. Publication Number: CEC–500–2021–055.

[1008] Kintner-Meyer, M. C., Sridhar, S., Holland, C., Singhal, A., Wolf, K. E., Larimer, C. J., . . . & Murali, R. E. (2022). Electric Vehicles at Scale-Phase II-Distribution Systems Analysis (No. PNNL–32460). Pacific Northwest National Lab. (PNNL), Richland, WA (United States).

[1009] Chhaya, S., et al., ''Distribution System Constrained Vehicle-to-Grid Services for Improved Grid Stability and Reliability; Publication Number: CEC–500–2019–027, 2019. Accessed December 13, 2022 at *https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-027.pdf*.

[1010] Satchwell, A., Carvallo, J. P., Cappers, P., Milford, J., & Eshraghi, H. (2023). Quantifying the Financial Impacts of Electric Vehicles on Utility Ratepayers and Shareholders; Jones, et al. ''The Future of Transportation Electrification.'' 2018. For more information on how EVs might lower electricity rates, see Frost, Jason, Melissa Whited, and Avi Allison. ''Electric Vehicles Are Driving Electric Rates Down.'' Synapse Energy Economics, Inc. June 2019 *https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf*, Electric Vehicles Are Driving Rates Down for All Customer Update Dec 2023 (*synapse-energy.com*); California Public Utilities Commission, Electricity Vehicles Rates and Cost of Fueling *https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification/electricity-rates-and-cost-of-fueling#:~:text=Electric%20Rates%20for%20EV%20Drivers,at%20a%20more%20reasonable%20price*.

system equipment upgrades. Recently, NREL found that a vehicle-to-grid control strategy which lowered an EV battery's average state of charge when parked—while ensuring it was fully recharged in anticipation of the driver's next need—could extend the life of the battery if continued over time.[1011] Similarly, a study by Environment and Climate Change Canada, NRC Canada and Transport Canada also found no significant different in usable battery energy between a vehicle that was used for bidirectional V2G and one that was not, and identified an improved SOC profile resulting from V2G activity as a possible factor.[1012] Application programming interfaces have been developed by industry in partnership with ANL to manage the exchange of energy services contracts, enabling the dispatch of PEVs and other distributed energy resources in to utility planning and operations territory-wide or within a specific section of the distribution grid.[1013] Further, automakers including BMW, Ford, and Honda developed a joint venture that promises to enable their EV customers to earn financial savings from managed charging and energy-sharing services.[1014] See section IV.C.5.ii of this preamble for a discussion of DERs and their potential benefits.

Managed EV charging provides several benefits to vehicle owners, rate payers that do not operate electric vehicles, and the operators of the electric power system, including lower costs and longer lifespans for electric power system assets. Managed electric vehicle charging, when coupled with time-of-use (TOU) electric rates, can help to further reduce already low refueling costs of EVs by allowing vehicle operators to charge when electric rates are most advantageous. Since low electricity costs coincide with surpluses of electricity, such charging reduces the overall costs of electricity generation and delivery to all electricity rate payers, not just those charging electric vehicles. Researchers at the Lawrence Berkeley National Laboratory (LBNL) identified 136 active or approved EV-specific TOU electric utility rates for U.S. investor-owned utilities in 37 states and the District of Columbia.[1015] Of the 136 active or approved EV-specific TOU electric utility rates, 54 rates are for residential customers, 48 rates are for commercial customers, 27 rates are for utility-owned facilities, four rates are for fleet operators, and the remaining three rates are for mixed facilities. In sum, our assessment of the literature and recent developments finds numerous tools to mitigate and address distribution related needs. We expect that uptake of these tools will likely vary and acknowledge that some are more readily available than others. But given the significant benefits associated with these tools and the rapid advances in their development, we expect that increasing deployment of such tools is very likely, particularly as PEV adoption increases, and the economic incentives associated with applying such tools on a widespread scale also increases.[1016]

To better understand the potential impacts of the final rule on the distribution system, EPA commissioned a study as part of an interagency agreement with the U.S. Department of Energy entitled the ''Transportation Electrification Impact Study'' (TEIS) to estimate the potential costs and benefits associated with electrical distribution system upgrades that may be incurred as a result of this final rule in addition to those of the Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3 Proposed Rule.[1017] These costs and benefits [1018] include new or replacement substations, underground and overhead distribution feeders, and service transformers, all in rural, suburban, and urban locations, as well as along freight corridors. To do so, our study builds upon the methodology developed by the California Public Utility Commission (CPUC) for their Electrification Impacts Study Part 1.[1019] The results of this study provide further support and confirmation for our findings in the proposed rule that grid reliability is not expected to be adversely affected by this rule and the HD Phase 3 Rule.[1020] Moreover, if PEV charging is managed (through available tools such as TOU tariffs and hosting capacity maps), there are likely to be net benefits from increased PEV penetration for all electric power system participants (including utilities and electricity consumers, whether they own PEVs or not).

In the TEIS study, aggregate distribution system-level costs and benefits were estimated for five states using parcel-level[1021] load profiles that were summed and applied to known utility infrastructure elements (*i.e.,* substations, distribution feeder lines, service transformers, etc.) and combined with utility-specific cost information. Using a full-scale distribution capacity expansion approach from the bottom (parcel-level) up to the substation level, the methodology employed identifies where and when the distribution grid will need capacity enhancements under certain policy and charging behavior scenarios consistent with this final rule.

Load profiles were analyzed using output from two analytical cases:

1. A no-action case that included modeling of electric vehicle provisions from the IRA within the OMEGA compliance model and compliance with 2023 and later GHG standards (86 FR 74434) with the addition of heavy-duty vehicle (Class 4–8) charge demand estimated for the California Advanced Clean Trucks (ACT) Program.

[1011] NREL. ''Electric Vehicles Play a Surprising Role in Supporting Grid Resiliency,'' October 12, 2023. Accessed November 5, 2024 at *https://www.nrel.gov/news/program/2023/evs-play-surprising-role-in-supporting-grid-resiliency.html.*

[1012] Lapointe, A. et al., ''Effects of Bi-directional Charging on the Battery Energy Capacity and Range of a 2018 Model Year Battery Electric Vehicle,'' 36th International Electric Vehicle Symposium and Exhibition (EVS36), June 11–14, 2023.

[1013] Evoke Systems. ''*https://www.prnewswire.com/news-releases/evoke-systems-announces-development-of-open-apis-for-managed-electric-vehicle-charging-301647906.html*,'' October 12, 2022. Accessed November 5, 2024 at *https://www.prnewswire.com/news-releases/evoke-systems-announces-development-of-open-apis-for-managed-electric-vehicle-charging-301647906.html.*

[1014] Honda, ''BMW, Ford and Honda Agree to Create ChargeScape, a New Company Focused on Optimizing Electric Vehicle Grid Services,'' September 12, 2023. Accessed February 5, 2024 at *https://www.prnewswire.com/news-releases/bmw-ford-and-honda-agree-to-create-chargescape-a-new-company-focused-on-optimizing-electric-vehicle-grid-services-301924860.html.*

[1015] Cappers, P., Satchwell, A., Brooks, C., & Kozel, S. (2023). A Snapshot of EV-Specific Rate Designs Among US Investor-Owned Electric Utilities. Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States).

[1016] In addition to the tools discussed that reduce the need for upgrades, there will be increased supply of grid components available for the situations in which some upgrades are still needed. Please refer to ''DOE Actions to Unlock Transformer and Grid Component Production'': *https://www.energy.gov/policy/articles/doe-actions-unlock-transformer-and-grid-component-production.*

[1017] National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Kevala Inc., and U.S. Department of Energy. Multi-State Transportation Electrification Impact Study: Preparing the Grid for Light-, Medium-, and Heavy-Duty Electric Vehicles. DOE/EE–2818, U.S. Department of Energy, 2024.

[1018] Benefits to non-EV owners include greater overall distribution system reliability, more-effective asset utilization, additional distribution system capacity, and decreasing retail electricity costs, but we have not attempted to monetize these benefits in our analysis.

[1019] California Public Utilities Commission, Order Instituting Rulemaking to Modernize the Electric Grid for a High Distributed Energy Resources Future, R.21–06–017 (July 2, 2021), *https://apps.cpuc.ca.gov/apex/f?p=401:56:0::NO:RP,57,RIR:P5_PROCEEDING_SELECT:R2106017.*

[1020] Grid reliability, broadly speaking, is dependent on sufficient and reliable generation, transmission and distribution. The TEIS study only addresses the question of potential reliability impacts on distribution, but we also address potential impacts on transmission and generation below.

[1021] ''Parcel-level'' in this context refers to buildings with street addresses.

2. A final rule policy case based upon Alternative 3 from the light- and medium-duty proposed rule with the addition of heavy-duty vehicle charge demand based on an interim scenario developed from the Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3 Proposed Rule (HDP3).

Of the scenarios modeled in IPM after the proposal, Alternative 3 is the closest scenario with respect to PEV charging demand to the final rule and represents the final rule within the power sector analysis. Alternative 3 differs from the finalized program by forecasting higher PEV sales in 2027–2031 than finalized, and thus higher PEV charging demand in earlier years and comparable PEV charging demand after 2032. Thus, power sector impacts on emissions and cost within the final rule analysis should be considered conservatively high estimates. The load profiles from light-, medium- and heavy-duty are distributed into IPM regions using NREL's EVI–X suite of models for light-duty, LDVs, MDVs, and heavy-duty buses; and using LBNL's HEVI–LOAD model for all other heavy-duty applications. The resulting premise-level load profiles were aggregated up to electric utility service territories. The system-level grid impacts and costs of electricity service were determined based upon the profiles. Additional scenarios were modeled to evaluate the impact of both unmanaged charging and managed charging. In the unmanaged case, the study assumes that EVs are charged immediately when the vehicle returns to a charger. In contrast, managed charging spreads the charging out more evenly over the period when the vehicle is parked at the charger; we note that the managed charging scenario evaluated only the most basic and readily available managed charging methods, a small subset of the numerous tools to address distribution needs that we reviewed in our earlier discussion. As a result, this study provides detailed modeling of potential impacts of these vehicles rules at the neighborhood level of electricity distribution.

This methodology is first applied to five states, which were selected based upon their diversity in urban/rural population, utility distribution grid composition, freight travel demands, and state EV policies. The selected states are California, Oklahoma, Illinois, Pennsylvania, and New York. The results from these five states are then extrapolated to the 67 IPM regions that we use to represent the remaining 48 contiguous states within our power sector analysis.

The TEIS national-level results found that the Action case, with managed charging, provides significant distribution system benefits relative to unmanaged charging both financially and in terms of the ability to defer necessary distribution system upgrades. The TEIS also found that the incremental grid upgrades needed in the Action cases relative to the No Action cases are manageable and that benefits outweigh costs.[1022] Such deferment, provided by managed charging, allows electric utilities to more effectively schedule and coordinate needed distribution system upgrades, while providing greater flexibility in accommodating potential supply chain shortfalls. The study also found that the Action case, with managed charging, requires significantly less electricity at peak times than the No Action case, illustrating the electricity system benefits of employing grid integration technologies and techniques. Note that the Action case assumes the limited usage of Distributed Energy Resources (DER) based on the TEIS, for example, vehicle to grid communication, which can delay vehicle charging to off-peak times or can stagger the scheduling of charge demand. Some implementations of DER also involve onsite generation of electricity using photovoltaic cells or distribution-level grid battery storage, however those were beyond the scope of the TEIS and were not included in our Action case analysis of the FRM at the distribution level. The TEIS provides further evidence that implementing smart placements of charging infrastructure where grid capacity is available and managed charging can more than offset the impact of additional EV load projected under this final rulemaking (and the HD Phase 3 rule) on the amount of distribution system investment that will be needed through 2032.

The study also found that the distribution costs associated with increasing demand from the Vehicle Rules were quite small relative to total distribution costs. Based on utility reports to the Federal Energy Regulatory Commission, data from electric co-ops, and extrapolation for the remaining utilities, the TEIS estimated that the national investment in distribution systems exceeded $60 billion annually as of 2021. A high-level approach for scaling the national distribution system investment to the five states under study was applied to estimate that $15 billion of distribution system investment occurred in 2021. Through 2032, the TEIS estimated that the incremental investment in distribution networks (to accommodate PEV growth due to EPA's rulemaking) as an additional $1.6 billion of grid investment for PEVs relative to a no action case when charging is managed and $2.3 billion when charging is unmanaged. Annualizing the latter number (reflecting unmanaged charging) between 2027 and 2032 results in an annual cost from the EPA light- and medium duty rule combined with the heavy-duty phase 3 proposed rule of $0.4 billion across the five states. Within the five states and extrapolated across the nation, this amounts to approximately 3% of existing annual distribution investments. We think this increase in distribution investment is modest and reasonable. Moreover, this value is conservative as it is inclusive of effects for both the light- and medium-duty vehicle standards and the heavy-duty Phase 3 proposed rule standards and so overstate the amount of grid investment associated with the final rule, and as it does not reflect managed charging. Given the very significant economic benefits of managed charging, we expect the market to adopt managed charging particularly under the influence of additional PEV adoption associated with the central case of the final rule, and that would further decrease the investment, to roughly $0.3 billion per year, or approximately 2% of annual distribution investments.

We also estimated the impact on retail electricity prices based on the TEIS. The TEIS results were extrapolated to all IPM regions in order to estimate impacts on electricity rates using the Retail Price Model (see RIA Chapter 5). We modeled retail electricity rates in the no action case with unmanaged charging compared to the action case with managed charging. We think this is a reasonable approach for the reason noted above: given the considerable economic benefits of managed charging, particularly in light of the increased PEV adoption associated with the central case of the final rule, there is an extremely strong economic incentive for market actors to adopt managed charging practices. Our analysis projects

[1022] Additionally, the TEIS found that: (1) the Action case would require an incremental 3% annual growth in charging infrastructure between 2027–2032 relative to the No Action case; (2) Incremental distribution grid investment needs represent approximately 3% of current annual utility investments in the distribution system for scenarios consistent with the EPA proposals; (3) Incremental distribution grid investment needs decrease by 30% with basic managed charging techniques, illustrating the potential for significant cost savings through optimizing PEV charging and other loads at the local level; (4) Benefits of vehicle electrification to consumers outweigh the estimated cost of charging infrastructure and grid upgrades in scenarios consistent with the EPA proposals.

that there is no difference in retail electricity prices in 2030 and the difference in 2055 is only 2.5 percent.[1023] We estimate that the 2.5 percent difference is primarily due to distribution-level costs. Note also that this is comparable to the 2–3% increase in distribution-level investments estimated for the 5 states within the TEIS noted above. The net cost of distribution-level upgrades are included within our analysis of costs and benefits for the final rule along with other grid-related costs modeled by IPM, and is reflected in electricity rates estimated using the Retail Price Model (see RIA Chapter 5).

A 2–3 percent increase in distribution system build out correlates to a small increase in manufacturing output so concerns regarding supply chain timing and cost are minimal. The total costs are modest both in and of themselves, as a percentage of grid investment even without considering mitigation strategies, and in terms of effect on electricity rates for users. EPA thus believes that the costs associated with distributive grid buildout attributable to the rule are reasonable.

Further discussion of the results of the TEIS study are included in the RIA Chapter 5.4.2., and additional details can be found in the TEIS report included in the docket for this final rule. Based on our review of the record, including the TEIS and other studies and public comments,[1024] and our consultations with DOE, we conclude that it is reasonable to anticipate the power sector can continue to manage and improve the electricity distribution system to support greater deployment of PEVs, such as those we model in our compliance pathways, and in fact the power sector may benefit from the increased deployment of PEVs.

6. Consumer Acceptance

EPA carefully considered acceptance of light-duty vehicle technologies, qualitatively and quantitatively, because we recognize that consumer acceptance is an important factor for any innovation and therefore relevant factor to the feasibility of PEVs as a significant emissions control strategy.[1025] When we speak of consumer acceptance, we mean consumer acceptance of ICE vehicles, HEVs, BEVs, and PHEVs. We define acceptance as a multifaceted, nonlinear process consisting of awareness, access, approval, and adoption.[1026] In other words, ''acceptance'' of a given vehicle technology, as we define it and model it, is not the same thing as ''purchase'' of a given vehicle technology. For example, high relative acceptance of BEVs may or may not result in BEV purchase. Relative acceptance of vehicle technologies influences the purchase outcome but does not necessarily determine the outcome. In the language of models, relative acceptance of vehicle technologies is an input (*i.e.,* a numeric parameter) and purchase behavior is an output (*i.e.,* projected market shares of vehicle technologies) that is based on acceptance as well as on other factors. Finally, we emphasize that in our discussion and representations of consumer acceptance of any one vehicle technology is only meaningful relative to other vehicle technologies. We represent consumer acceptance quantitatively in our modeling via parameterization of a logit model. The logit model is the most common example of a random utility discrete choice model and the dominant paradigm for modeling consumer demand. In this preamble section, we continue by focusing on consumer acceptance via a conceptual, non-numerical lens. See RIA Chapter 4.1 for an expanded presentation of consumer acceptance, the quantitative parameterization of consumer acceptance (*i.e.,* shareweights), and modeling framework for vehicle technology choice (*i.e.,* the logit model).

EPA recognized that an evidence-based definition and understanding of consumer acceptance of PEVs was an important consideration for this rulemaking. Thus, EPA in coordination with the Lawrence Berkeley National Laboratory (LBNL), conducted a comprehensive review of the scientific literature regarding consumer acceptance of PEVs. That effort culminated in a peer-reviewed report on PEV acceptance in which EPA and LBNL organize and summarize the enablers and obstacles of PEV acceptance evident from the scientific literature.[1027] The review concluded that ''there is no evidence to suggest anything immutable within consumers or inherent to PEVs that irremediably obstructs acceptance.'' More simply put, the enablers of PEV acceptance are external to the person. With the evolution of the environment in which people make decisions (*e.g.,* infrastructure, advertising, access) and advancements in technology and vehicle attributes (*e.g.,* range, body style, price), widespread acceptance of PEVs is very likely to follow.

Consumer Reports (CR) describes trends in PEV acceptance as a virtuous cycle in which consumer demand for PEVs will continue to grow. ''As automakers deliver more volume, economies of scale and intensified competition for customers will further feed cost declines, which will feed back into the cycle, and lead to increased EV demand.''[1028] Consumer Reports also argues that we have already observed this effect. ''This is because the barriers to EV adoption identified in CR's 2022 survey of BEV and low carbon fuels awareness are being addressed: purchase cost for EVs is declining, charging infrastructure is expanding, consumers are gaining more experience with EVs, and automakers are investing in new models and increased production.[1029] These trends tend to reinforce one another in a virtuous cycle to create even more demand for these vehicles.''[1030]

In other words, PEV acceptance enablers (and diminishing obstacles) are part of a positive and robust feedback loop. Growth in PEV adoption has already grown based on technology advancement alone,[1031] and is expected

[1023] We note that had we compared an unmanaged action scenario with an unmanaged no-action scenario, or a managed action scenario with a managed no-action scenario, we would expect only marginally different electricity rates, given that distribution costs are a very small part of total electricity costs.

[1024] We note that the Edison Electric Institute in its comments also supported the ability of the power sector to meet future anticipated needs, stating that ''[e]lectric companies can accommodate localized power needs at the pace of customer demand, provided appropriate customer engagement and enabling policies are in place''. Docket EPA–HQ–OAR–2022–0829–0708.

[1025] EPA focused on light-duty vehicle acceptance among non-commercial consumers. We acknowledge that light-duty, commercial consumers and medium-duty purchasers are likely to have purchase behavior that prioritize different criteria, for example, operating costs or other vehicle attributes.

[1026] EPA recognizes that others may not employ the same definitions of acceptance and adoption that we do. We did not apply our definitions when, for example, interpreting feedback received via public comments. However, these distinctions and discipline in adhering to these definitions are important to conceptual clarity of and modeling consumer processes (*e.g.,* decision making) and observable behavior (*e.g.,* purchase, sales, registration).

[1027] Jackman, D. K., K. S. Fujita (LBNL), H. C. Yang (LBNL), and M. Taylor (LBNL). Literature Review of U.S. Consumer Acceptance of New Personally Owned Light-Duty (LD) Plug-in Electric Vehicles (PEVs). U.S. Environmental Protection Agency, Washington, DC Available at: *https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=353465.*

[1028] EPA–HQ–OAR–2022–0829–0728, pp. 10–14.

[1029] Battery Electric Vehicles & Low Carbon Fuels Survey, Consumer Reports, April 2022, *https://article.images.consumerreports.org/image/upload/v1657127210/prod/content/dam/CRO-Images-2022/Cars/07July/2022_Consumer_Reports_BEV_and_LCF_Survey_Report.pdf.* Accessed on 02/23/2024.

[1030] EPA–HQ–OAR–2022–0829–0728, pp. 10–14.

[1031] Forsythe, Connor R., Kenneth T. Gillingham, Jeremy J. Michalek, and Kate S. Whitefoot. 2023. ''Technology advancement is driving electric vehicle adoption.'' PNAS 120 (23). doi:*https://doi.org/10.1073/pnas.2219396120.*

to continue to grow. The continued introduction of more PEV models, especially SUVs and pickups, has brought, and will continue to bring, more new vehicle buyers into the PEV market. PEV purchase incentives have led to more PEV purchases, a trend we expect will continue given the substantial additional incentives offered through the IRA. Easy, accessible residential charging has produced higher levels of PEV satisfaction; higher satisfaction correlates with more purchases.[1032] Forsythe et al. (2023) finds that ''with the assumed technological innovations, even if all purchase incentives were entirely phased out, BEVs could still have a market share of about 50 percent relative to combustion vehicles by 2030, based on consumer choice alone.'' In conclusion, the empirical evidence strongly suggests that while enablers can enhance each other, the absence of any one of these enablers does not appear to diminish the effect of the others. In short, the system does not have to be perfect for PEV acceptance to increase and expand.

EPA further substantiates these and other findings with additional observations of key enablers of PEV acceptance, namely increasing market presence, more model choices, expanding infrastructure, and decreasing costs to consumers.[1033] First, annual sales of light-duty PEVs in the U.S. have grown robustly and are expected to continue to grow. PEVs reached 9.8 percent of monthly sales in January 2024 and were 9.3 percent of all light-duty vehicle sales in 2023, up from 6.8 percent in 2022.[1034] This robust growth combined with vehicle manufacturers' plans to expand PEV production strongly suggests that PEV market share will continue to grow rapidly. Second, the number of PEV models available to consumers is increasing, meeting consumers demand for a variety of body styles and price points. Specifically, the number of BEV and PHEV models available for sale in the U.S. has increased from about 24 in MY 2015 to about 60 in MY 2021 and to over 180 in MY 2023, with offerings in a growing range of vehicle segments.[1035] Data from JD Power and Associates shows that MY 2023 BEVs and PHEVs are now available as sedans, sport utility vehicles, and pickup trucks. In addition, the greatest offering of PEVs is in the popular crossover/SUV segment.[1036] Third, the expansion of charging infrastructure has been keeping up with PEV adoption as discussed in section IV.C.4 of the preamble. This trend is widely expected to continue, particularly in light of very large public and private investments. Fourth, while the initial purchase price of BEVs is currently higher than for most ICE vehicles, the price difference is likely to narrow or become insignificant as the cost of batteries fall and PEV production rises in the coming years.[1037] Among the many studies that address cost parity, an emerging consensus suggests that purchase price parity is likely to be achievable by the mid-2020s for some vehicle segments and models.[1038] [1039] Specifically, the International Council on Clean Transportation (ICCT) projects that price parity with ICE vehicles will ''occur between 2024 and 2026 for 150- to 200-mile range BEVs, between 2027 and 2029 for 250- to 300-mile range BEVs, and between 2029 and 2033 for 350- to 400-mile range BEVs''[1040] The Environmental Defense Fund notes that ''most industry experts believe wide-spread price parity will happen around 2025.''[1041] Lastly, the Inflation Reduction Act provides a purchase incentive of up to $7,500 for eligible light-duty vehicles and buyers, which is expected to increase consumer uptake of zero emissions vehicle technology.[1042]

Recent research also further substantiates the conclusion that PEVs acceptance and adoption will continue to grow and expand. Foremost among those studies are the recent third-party projections of PEV market shares. EPA reviewed several recent reports and studies containing PEV projections, all of which include the impact of the IRA; none consider the impact of this rule. Altogether, these studies project PEV market share in a range from 42 to 68 percent of new vehicle sales in 2030. The mid-range projections of PEV sales from these studies, to which we compare our No Action case, range from 48 to 58 percent in 2030.[1043] [1044] [1045] [1046] [1047] [1048] In a recent report, LBNL challenges ''emergent rules of thumb regarding PEV acceptance'' (*e.g.,* wealthy, urban, male). Their work suggests that there is untapped demand among mainstream vehicle buyers that emerging conventional wisdom regarding who buys and who doesn't buy PEVs is

[1032] Hardman, S., and Tal, G., ''Understanding discontinuance among California's electric vehicle owners,'' Nature Energy, v.538 n.6, May 2021.

[1033] Jackman, D K, K S Fujita, H C Yang, and M Taylor. 2023. Literature Review of U.S. Consumer Acceptance of New Personally Owned Light-duty Plug-in Electric Vehicles. Washington, DC: U.S. Environmental Protection Agency.

[1034] Argonne National Laboratory, Energy Systems and Infrastructure Analysis. 2024. Light-duty Electric Drive Vehicles Monthly Sales Updates. *https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates*, accessed 02/21/2024.

[1035] Fueleconomy.gov, 2015 Fuel Economy Guide, 2021 Fuel Economy Guide, and 2023 Fuel Economy Guide.

[1036] Taylor, M., Fujita, K.S., Campbell N., 2024, ''The False Dichotomies of Plug-in Electric Vehicles,'' Lawrence Berkeley National Laboratory.

[1037] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022. ''This analysis does not consider the effect of any available state, local, or federal subsidies and tax incentives for electric vehicles and their charging infrastructure'' (page 30).

[1038] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022. ''This analysis does not consider the effect of any available state, local, or federal subsidies and tax incentives for electric vehicles and their charging infrastructure'' (page 30).

[1039] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer Commitments and Public Policy Initiatives Supporting Electric Mobility in the U.S. and Worldwide,'' September 2022. This report notes the Inflation Reduction Act (IRA), but estimates do not take into act effects of the IRA.

[1040] International Council on Clean Transportation, ''Assessment of Light-Duty Electric Vehicle Costs and Consumer Benefits in the United States in the 2022–2035 Time Frame,'' October 2022 (page iii). ''This analysis does not consider the effect of any available state, local, or federal subsidies and tax incentives for electric vehicles and their charging infrastructure'' (page 30).

[1041] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer Commitments and Public Policy Initiatives Supporting Electric Mobility in the U.S. and Worldwide,'' September 2022 (page 10). This report notes the Inflation Reduction Act (IRA), but estimates do not take into act effects of the IRA.

[1042] Slowik, P., Searle, S., Basma, H., Miller, J., Zhou, Y., Rodriguez, F., . . . Baldwin, S. (2023). Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States. The International Council on Clean Transportation. Retrieved October 26, 2023, from *https://energyinnovation.org/wp-content/uploads/2023/01/IRA-EV-assessment-white-paper-letter-v46.pdf*.

[1043] Cole, Cassandra, Michael Droste, Christopher Knittel, Shanjun Li, and James H. Stock. 2023. ''Policies for Electrifying the Light-Duty Fleet in the United States.'' AEA Papers and Proceedings 113: 316–322. doi:*https://doi.org/10.1257/pandp.20231063*.

[1044] IEA. 2023. ''Global EV Outlook 2023: Catching up with climate ambitions.'' International Energy Agency.

[1045] Forsythe, Connor R., Kenneth T. Gillingham, Jeremy J. Michalek, and Kate S. Whitefoot. 2023. ''Technology advancement is driving electric vehicle adoption.'' PNAS 120 (23). doi:*https://doi.org/10.1073/pnas.2219396120*.

[1046] Bloomberg NEF. 2023. ''Electric Vehicle Outlook 2023.''

[1047] U.S. Department of Energy, Office of Policy. 2023. ''Investing in American Energy: Significant Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Energy Economy and Emissions Reductions.''

[1048] Slowik, Peter, Stephanie Searle, Hussein Basma, Josh Miller, Yuanrong Zhou, Felipe Rodriguez, Claire Buysse, et al. 2023. ''Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States.'' International Council on Clean Transportation and Energy Innovation Policy & Technology LLC.

incorrect. For example, they note that early PEVs were not well-positioned to appeal to a large segment of the population. Most early EVs were hatchbacks, which represents a very small portion of overall US vehicle sales in a market where vehicle buyers tend to consider and purchase vehicles with the same body style (*e.g.,* many buyers only consider SUVs.[1049] In the hierarchy of purchase criteria, body style ranks very high among consumers, and tends to be a criterion they are unwilling to compromise.[1050] Thus, a consumer may not consider purchasing a PEV, even if they are interested in PEVs generally, when PEVs are not available in their preferred body style but will consider a PEV when a PEV is available in their preferred body style. All of the above supports our conclusions that considerable further growth in the US PEV market is not only possible, with additional investment and product offerings by automakers and others, but likely to occur.

Lastly, many individuals and institutions provided diverse comments on our proposed rule regarding consumer acceptance. Commenters expressed views about both access to and demand for PEVs, some noting individual/household characteristics, vehicle attributes, and/or system conditions affecting consumer acceptance of PEVs. For example, Consumer Reports identified substantial unmet demand among U.S. consumers, calculating that ''there are now approximately 45 EV-ready buyers for every EV being manufactured.''[1051] Individual commenters at the public hearings appear to have experienced this lack of access to PEVs firsthand, stating that despite intentions to purchase a plug-in electric vehicle, none were available for them to purchase. In a similar vein, commenters from the Carnegie Mellon University and Yale University ''present evidence that BEVs could constitute the majority or near-majority of cars and SUVs by 2030, given widespread BEV availability and technology trends.''[1052] In contrast, some commenters, such as Stellantis and Honda, asserted that estimates of PEV market growth in the proposed rule, were ''overly optimistic'' and did not appear to take into account that PEV adoption ''does require the owner to embrace a different approach'' and ''adapt their trip planning and driving behavior to allow for charging needs.''[1053] For example, Volkswagen Group of America expressed concerns about the absence of a ''prerequisite . . . comprehensive, interoperable and integrated charging infrastructure network across the U.S.''[1054] Relatedly, other commenters, including Nissan, Alliance for Automotive Innovation, Toyota, and National Automobile Dealers Association, suggested that PEVs could be out of reach for some consumers due to purchase price; the inconvenience, novelty, or expense of charging; or their belief that PEVs may not meet the needs of all consumers. In response to these and other comments, we were attentive to the timeframe, uncertainties, evidence, and studies associated with each comment.[1055] We considered all of the information provided by commenters. See RTC section 13.

Taking into account all of the above—EPA and LBNL's report on PEV acceptance, recent acceptance research, recent third party projections of PEV adoption, public comments, market trends, and analyses presented throughout this preamble and the RIA—we conclude that PEV acceptance is growing and will continue to grow rapidly for all body styles, particularly for vehicles likely to be used largely as passenger vehicles such as sedans, wagons, CUVs, and SUVs. Observed and expected PEV adoption and acceptance aligns well with patterns of adoption of innovations observed through history. Typically, sales of a new technology are low and increase slowly and unpredictably in what is called the innovator and early adopter stage. After the early adopter stage, adoption increases very quickly, with rapidly accelerating demand as the technology becomes mainstream. We expect PEV adoption and acceptance to follow the S-shaped behavior. See RIA Chapter 4.1.

We also conclude that our expectations for continued rapid growth in PEV acceptance are reasonable. The system of PEV growing acceptance enablers and diminishing obstacles is robust. PEV acceptance is responding to the evolution of the environment in which people make decisions (*e.g.,* increasing market presence, expanding infrastructure, advancements in technology, more model choices, decreasing costs to consumers, increasing familiarity). Exposure to and experience with PEVs lead to more PEV purchase which leads to more exposure and experience and so on. More PEV production leads to economies of scale that feed cost declines, more purchase, and more production. Recent research also further substantiates the conclusion that PEVs acceptance and adoption will continue to grow and expand. Foremost among those studies are the recent third-party projections of PEV market shares, with which EPA projections align. There appears to be little if any evidence contrary to our conclusions among researchers and commenters who recognize the interactions of time and network effects on the pace and acceleration of the diffusion of innovation. At this time, the evidence we have assessed indicates that over the next several years consumer interest in PEVs will yield significant increases in PEV adoption.

While we have emphasized PEVs and the relative growth in PEV acceptance here, we note that the acceptance and purchase of ICE vehicles, HEVs, PHEVs, and BEVs will persist throughout the timeframe of this rule. Therefore, in relative terms, we represent acceptance of all vehicle technologies. All of these technologies are well-represented in EPA's modeling and in demonstrated compliance pathways, as they are in third-party projections. For more information on LD vehicle consumer modeling and considerations, see RIA Chapter 4.

7. Supply Chain, Manufacturing, and Mineral Security Considerations

All new motor vehicles, including ICE vehicles and PEVs, require manufacturing inputs in the form of materials such as structural metals, plastics, electrical conductors, electronics and computer chips, and many other materials, minerals, and components that are produced both domestically and globally. These inputs rely to varying degrees on a highly interconnected global supply chain that includes mining and recycling operations, processing of mined or

[1049] Taylor, M., Fujita, K.S., and Campbell, N. 2024. Draft of ''The False Dichotomies of Plug-in Electric Vehicle Markets.'' Lawrence Berkeley National Laboratory.

[1050] Fujita, K.S., Yang, H–C, Taylor, M., Jackman, D. 2022. ''Green Light on Buying a Car: How Consumer Decision-Making Interacts with Environmental Attributes in the New Vehicle Purchase Process.'' Transportation Research Record: Journal of the Transportation Research Board, 2676:7. *https://doi.org/10.1177/03611981221082566*.

[1051] Harto, C. (2023). Excess Demand: The Looming Shortage. Retrieved November 29, 2023, from *https://advocacy.consumerreports.org/wp-content/uploads/2023/03/Excess-Demand-The-Looming-EV-Shortage.pdf.*

[1052] Forsythe, C. R., Gillingham, K. T., Michalek, J. J., & Whitefoot, K. S. (2023). Technology advancement is driving electric vehicle adoption. PNAS, 120(23). Retrieved November 29, 2023, from *https://www.pnas.org/doi/epdf/10.1073/pnas.2219396120.*

[1053] EPA–HQ–OAR–2022–0829–0678–0002 and EPA–HQ–OAR–2022–0829–0652–0049.

[1054] EPA–HQ–OAR–2022–0829–0669–003.

[1055] EPA–HQ–OAR–2022–0829–0594–0005, EPA–HQ–OAR–2022–0829–0701–0069, EPA–HQ–OAR–2022–0829–0620–0029, and EPA–HQ–OAR–2022–0829–0470–0001.

reclaimed materials into pure metals or chemical products, manufacture of vehicle components, and final assembly of vehicles.

Although the market share of PEVs in the U.S. is already rapidly growing, EPA recognizes that many manufacturers will likely produce additional PEVs as part of their chosen strategy to achieve the performance-based emissions standards, particularly after 2030. Compared to ICE vehicles, the electrified powertrain of PEVs commonly contains a greater proportion of conductive metals such as copper as well as certain minerals and mineral products that are used in the high-voltage battery. Accordingly, many of the public comments we received were related to the need to secure sources of these inputs to support increased manufacture of PEVs for the U.S. market.

First, it is important to view this issue from a holistic perspective that also considers the inputs currently required by ICE vehicles. Compared to PEVs, ICE vehicles rely to a greater degree on certain inputs, most notably refined crude oil products such as gasoline or diesel. Historically, supply and price fluctuations of crude oil products have periodically created significant risks, costs, and uncertainties for the U.S. economy and for national security, and continue to pose them today. Manufacture of ICE vehicles also relies on critical minerals (for example, platinum group metals) used in emission control catalysts. EPA thus has many years of experience in assessing the availability of critical minerals as part of our assessment of feasibility of standards taking into consideration available technologies, cost, and lead time. The critical minerals used in emission control catalysts of ICE products, such as cerium, palladium, platinum, and rhodium,[1056] historically have posed uncertainty and risk regarding their reliable supply. For example, platinum, which has historically been recognized as a precious metal, was the dominant platinum group metal used in early catalysts.[1057] Platinum group metals were understood to be costly and potentially scarce in advance of emission control standards of the 1970s that were premised on use of those minerals for catalyst control of pollutants.[1058] [1059] In the 1990s, concerns were similarly raised about possible shortages of palladium resulting from the Tier 2 standards, yet the supply chain adjusted to this need as well.[1060] Although manufacturers have engineered emission control systems to reduce the amount of these minerals that are needed, they continue to be scarce and costly today, and continue to be largely sourced from countries with which the U.S. does not have free trade agreements. For example, South Africa and Russia continue to be dominant suppliers of these metals as they were in the 1970s, and U.S. relations with both countries have periodically been strained. In this sense, the need for a secure supply chain for the inputs required for PEV production is similar to that which continues to be important for ICE vehicle production.

The PEV supply chain consists of several activity stages including upstream, midstream, and downstream, which includes end of life. In this discussion, upstream refers to extraction of raw materials from mining activities. Midstream refers to additional processing of raw materials into battery-grade materials, production of electrode active materials (EAM), production of other battery components (*i.e.,* electrolyte, foils, and separators), and electrode and cell manufacturing. Downstream refers to production of battery modules, and packs from battery cells. End of life refers to recovery and processing of used batteries for reuse or recycling.[1061] Global demand for zero-emission vehicles has already led to rapidly growing demand for capacity in each of these areas and subsequent buildout of this capacity across the world.

The value of developing a robust and secure supply chain that includes these activities and the products they create has accordingly received broad attention in the industry and is a key theme of comments we have received. The primary considerations here are (a) the capability of global and domestic supply chains to support U.S. manufacturing of batteries and other PEV components, (b) the availability of critical minerals as manufacturing inputs, and (c) the possibility that sourcing of these items from other countries, to the extent it occurs, might pose a threat to national security. In this section, EPA considers how these factors relate to the feasibility of producing the PEVs that manufacturers may choose to produce to comply with the standards.

As in the proposal, we continue to note several key themes that contribute to our conclusion that the proposed standards are appropriate with respect to these issues. First, we note that, to the extent that minerals, battery components, and battery cells are sourced from outside of the U.S., it is not because the products cannot be produced in the U.S., but because other countries have already invested in developing a supply chain for their production, while the U.S. has begun doing so more recently. The rapid growth in domestic demand for automotive lithium-ion batteries that is already taking place is driving the development of a supply chain for these products that includes development of domestic sources as well as a rapid buildout of production capacity in countries with which the U.S. has good relations, including countries with free-trade agreements (FTAs), long-established trade allies and other economic allies.[1062] For example (as described and cited later in this section), U.S. manufacturers are increasingly seeking out secure, reliable, and geographically proximate supplies of batteries, cells, and the minerals and materials needed to build them; this is also necessary to remain competitive in the global automotive market where electrification is proceeding rapidly. As a result, a large number of new U.S. battery, cell, and component manufacturing facilities have recently been announced or are already under

[1056] Department of Energy, ''Critical Materials Assessment,'' July 2023.

[1057] Hageluken, C., ''Markets for the Catalyst Metals Platinum, Palladium and Rhodium,'' Metall, v60, pp. 31–42, January 2006.

[1058] For example, in floor debate over the Clean Air Act of 1970, Senator Griffin opposed the vehicle emissions standards because the vehicle that had been shown capable of meeting the standards used platinum-based catalytic converters and ''[a]side from the very high cost of the platinum in the exhaust system, the fact is that there is now a worldwide shortage of platinum and it is totally impractical to contemplate use in production line cars of large quantities of this precious material. . . .'' Environmental Policy Division of the Congressional Research Service Volume 1, 93d Cong., 2d Sess., A Legislative History of the Clean Air Amendments of 1970 at 307 (Comm. Print 1974).

[1059] Further, in debate over both the 1977 and 1990 amendments to the Clean Air Act, some members of Congress supported relaxing NO_X controls from motor vehicles due to concerns over foreign control of rhodium supplies, but Congress rejected those efforts. See 136 Cong. Rec. 5102–04 (1990); 123 Cong. Rec. 18173–74 (1977).

[1060] U.S. EPA, Tier 2 Report to Congress, EPA420–R–98–008, July 1998, p. E–13.

[1061] Rocky Mountain Institute, ''The EV Battery Supply Chain Explained,'' May 5, 2023. Accessed on May 15, 2023 at *https://rmi.org/the-ev-battery-supply-chain-explained.*

[1062] Here we use the term ''economic allies'' to refer to countries that are not covered nations and do not have a free-trade agreement (FTA) with the U.S., but which are party to other economic agreements or defense treaties. Economic agreements include the Minerals Security Partnership (MSP), Critical Minerals Agreement (CMA), Trade and Investment Framework Agreement (TIFA), bilateral investment treaties (BITs), or other international initiatives as described in Figure 18, ''U.S. government international initiatives to secure battery minerals and materials.''

construction. Many automakers, suppliers, startups, and related industries have already recognized the need for increased domestic and ''friendshored'' production capacity as a business opportunity, and are investing in building out various aspects of the supply chain domestically as well. Second, Congress and the Administration have taken significant steps to accelerate this activity by funding, facilitating, and otherwise promoting the rapid growth of U.S. and allied supply chains for these products through the Inflation Reduction Act (IRA), the Bipartisan Infrastructure Law (BIL), and numerous Executive Branch initiatives. Recent and ongoing announcements of investment and construction activity stimulated by these measures indicate that they are having a strong impact on development of the domestic supply chain, as illustrated by recent analysis from Argonne National Laboratory and the Department of Energy. Finally, to the extent that minerals are imported to the U.S. as constituents of vehicles, batteries, or cells, or for vehicle or battery production in the U.S., they largely remain in the U.S. and over the long term have the potential to be reclaimed through recycling, reducing the need for new materials from either domestic or foreign sources. In this updated analysis for the final rule, we examine these themes again in light of the public comments and additional data that has become available since the proposal.

We received a large number of comments on our analysis of critical minerals, battery and mineral production capacity, and mineral security. Some common themes were: that the proposal did not adequately address critical minerals or battery manufacturing; that we should account for all critical minerals rather than lithium only; that the proposal did not adequately address the risk associated with uncertain availability of critical minerals in the future; and that the timeline and/or degree of BEV penetration anticipated by the proposal cannot be supported by available minerals and/or growth in domestic supplies or battery manufacturing. It was also suggested that the rapid growth in demand stemming from the rule would result in undue reliance on nations with which the U.S. does not have good trade relations, increased reliance on imports in general, and/or encourage environmentally or socially unsound sourcing practices. Some commenters felt that the discussion of national security in the proposal was not sufficient, pointing again to concerns about vulnerabilities resulting from a dependence on imported minerals and materials in order to manufacture vehicles or support the infrastructure they require.[1063]

Another frequent theme of the comments was a perception of uncertainty and risk, in reference to the question of whether or not critical mineral prices and availability will stabilize in the near term or even the long term. Some commenters also suggested that this uncertainty might be addressed by a stringency adjustment mechanism, in which progress in domestic sourcing of critical minerals, battery components, and other inputs to the supply chain would be monitored and the stringency of the standards adjusted if progress underperforms expectations. Commenters also cited the need for permitting reform and streamlining, as permitting is a major factor in the lead time necessary to develop new mineral sources. It was also suggested that the desire to source from responsible vendors that support Environmental, Social, and Governance (ESG) goals could increase the cost of purchased minerals by encouraging use of higher-cost domestic supplies. It was also suggested that BEVs are not an efficient use of these limited resources, and the goals of the standards could be more effectively met with HEVs and PHEVs, which require less critical mineral content and impose less demand on infrastructure, reducing the level of risk associated with all of these issues.

For this final rule we considered the public comments carefully. We have provided detailed responses to comments relating to critical minerals, the supply chain, and mineral security in section 15 of the RTC. We also continued our ongoing consultation with industry and government agency sources (including the Department of Energy (DOE) and National Labs, the Department of State, the U.S. Geological Survey (USGS), and several analysis firms) to collect information on production capacity forecasts, price forecasts, global mineral markets, and related topics. Importantly, we also coordinated with DOE and NHTSA in their assessment of the outlook for supply chain development and critical mineral availability. The Department of Energy is well qualified for such research, as it routinely studies issues related to electric vehicles, development of the supply chain, and broad-scale issues relating to energy use and infrastructure, through its network of National Laboratories. DOE worked together with Argonne National Laboratory (ANL) beginning in 2022 to assess global critical minerals availability and North American battery components manufacturing, and coordinated with EPA to share the results of these analyses during much of 2023 and early 2024. In sections IV.C.7.i through IV.C.7.iv of this preamble, below, we review the main findings of this work, along with the additional information we have collected since the proposal. As in the proposal, we have considered the totality of information in the public record in reaching our conclusions regarding the influence of future manufacturing capacity, critical minerals, and mineral security on the feasibility of the final standards.

In EPA's view, many of the concerns stated by commenters about the supply chain, critical minerals, and mineral security were stated as part of a broader argument that the proposed standards were too stringent; that is, that the commenter believed that the standards should be weakened (or withdrawn entirely) because the supply chain or the availability of critical minerals could not support the amount of vehicle electrification that would result from the standards, or it would create a reliance on imported products that would threaten national security. As will be discussed in the following sections, our updated assessment of the evidence continues to support the conclusion that the standards are appropriate from the perspective of critical minerals availability, the battery supply chain, and mineral security. Further, given the economic and other factors that are contributing to continued development of a robust and secure supply chain, we find no persuasive evidence that the need to establish supply chains for critical minerals or components will adversely impact national security by creating a long-term dependence on imports of critical minerals or components from covered nations or associated suppliers. The current and projected availability of critical minerals and components from domestic production or trade with friendly countries, including countries with FTAs, countries participating in the Mineral Security Partnership (MSP),[1064] [1065] and other economic

[1063] While these latter concerns bear a resemblance to the issue of energy security, in the context of mineral or other inputs to vehicle manufacturing we refer to this topic as mineral security.

[1064] The Minerals Security Partnership (MSP) ''aims to accelerate the development of diverse and sustainable critical energy minerals supply chains through working with host governments and industry to facilitate targeted financial and diplomatic support for strategic projects along the allies, as well as the continued incentives for suppliers and manufacturers to develop sourcing options from these countries, provide a sufficient basis to conclude that these materials are likely to be available in sufficient quantities for vehicle manufacturers without undue reliance on covered nations or associated suppliers that could potentially raise national security concerns. Moreover, we expect that the standards will provide increased regulatory certainty for domestic production of batteries and critical minerals, and for creating domestic supply chains, which in turn has the potential to strengthen the global competitiveness of the U.S. in these areas. Our assessments are informed by extensive consultation with the Department of Energy, Argonne National Laboratory, and other government agencies that represent some of the strongest public sector expertise in these areas.

Regarding the adequacy of the supply chain in supporting the standards, EPA notes that it is a misconception to assume that the U.S. must establish a fully independent domestic supply chain for critical minerals or other inputs to PEV production in order to contemplate standards that may result in increased manufacture of PEVs. The supply chain that supports production of consumer products, including ICE vehicles, is highly interconnected across the world, and it has long been the norm that global supply chains are involved in providing many of the products that are commonly available in the U.S. market and that are used on a daily basis. As with almost any other product, the relevant standard is not complete domestic self-sufficiency, but rather a diversified supply chain that includes not only domestic production where possible and appropriate but also includes trade with FTA countries and other economic allies with whom the U.S. has good trade relations. As discussed later and further illustrated in Figure 38 of section IV.C.7.ii of this preamble, bilateral and multilateral trade agreements and other arrangements (such as defense agreements and various development and investment partnerships), either long-standing or more recently established, already exist with many countries, which greatly expands opportunities to develop a secure supply chain that reaches well beyond the borders of U.S.

EPA also notes that no analysis of future outcomes with regard to the supply chain, critical minerals, or mineral security can be absolutely certain. In general, in establishing appropriateness of standards, the Clean Air Act does not require that EPA must prove that every potential uncertainty associated with compliance with the standards must be eliminated a priori. It is well-established in case law that ''[i]n 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. Thus, EPA is not required to rebut all speculation that unspecified factors may hinder 'real world' emission control.'' [1066] Thus, it is not required, nor would it be reasonable to expect, that EPA prove sufficient production capacity already exists today for technologies or inputs that may be needed to comply with standards in the future, nor that all potential uncertainties that can be identified regarding the development of that capacity must be eliminated. In fact, past EPA rulemakings have often been technology-forcing, and so have led industry to develop and increase production of technologies for which critical inputs or production capacity were not fully developed and in place at the time. Some examples include standards in the 1970s that led to the widespread use of catalysts for emission control, the phase-down of lead in gasoline from the 1970s to the 1980s, reformulated gasoline in the 1990s, and the use of selective catalytic reduction (and diesel exhaust fluid), in the 2010s.

Accordingly, our analysis of the supply chain and critical minerals is oriented toward recognizing the steps that are needed to support the increased penetrations of PEVs we project in the compliance analysis, and showing that these needs are capable of being addressed in a manner consistent with meeting the standards during the time frame of the rule.

EPA has considered the public comments in total, and as described throughout these rulemaking documents, is finalizing standards that are less stringent than in the proposal, particularly in the early years of the program. In the public comments relating to supply chain, critical minerals, and mineral security, EPA finds no evidence that would lead it to conclude that a further reduction in the stringency of the standards is appropriate or necessary.

While commenters have presented information to further demonstrate the well-understood concept that currently operating supply capacity must grow in order to meet projected future demand, and have recited many of the uncertainties commonly associated with predicting this or any future response of supply to future demand, they have failed to provide specific evidence to support the implication that the demand resulting from the standards will not or cannot be met by industry in the time available. Commenters question whether market forces and government initiatives and incentives that are already underway will lead to sufficient supply to meet the standards, but do not show specifically why these activities should reasonably be expected to fail. Indeed, EPA has shown that the industry is working actively and effectively to increase supply and secure supply chains for needed materials; that government incentives and initiatives have been defined and are moving forward with intended effect; and that current price forecasts and investment outlooks for the time frame of the rule do not suggest that industry at large foresees a looming inability to meet the proposed standards, especially given that they have been publicly known for nearly a year and were more stringent than the final standards.

Although commenters imply that current circumstances or future unknowns amount to a constraint that will prevent industry from meeting the standards or would cause harm by doing so, they have not identified any specific alleged constraint or set of constraints with sufficient specificity that it would lead EPA to reasonably conclude that a reduction in stringency is necessary to address their concerns. Nor have commenters detailed and quantified any such constraint sufficiently that it could be translated into any specific degree of stringency reduction that commenters believe would address their concerns.

The presence of uncertainty is a common element in any forward-looking analysis, and is typically approached as a matter of risk assessment, including sensitivity analysis conducted around costs, compliance paths, or other key factors. Taken as a whole, our examination of the status and outlook for development of the supply chain, combined with the

value chain.'' MSP partners include Australia, Canada, Finland, France, Germany, India, Italy, Japan, Norway, the Republic of Korea, Sweden, the United Kingdom, the United States, and the European Union (represented by the European Commission). *https://www.state.gov/minerals-security-partnership.*

[1065] ''Minerals Security Partnership (MSP) Principles for Responsible Critical Mineral Supply Chains,'' *https://www.state.gov/wp-content/uploads/2023/02/MSP-Principles-for-Responsible-Critical-Mineral-Supply-Chains-Accessible.pdf.*

[1066] *NRDC* v. *EPA,* 655 F.2d 318, 333–34 (D.C. Cir. 1981).

robust set of sensitivity cases that we include in the updated analysis, explore the most significant risks and uncertainties surrounding the future development of these and other issues, and show that compliance with the final standards is possible under a broad range of reasonable scenarios. Included in these scenarios are alternative compliance pathways that would rely on fewer BEVs and more vehicles with ICEs across a range of electrification (including non-hybrid ICE vehicles, HEVs and PHEVs), which would significantly reduce the demand for battery production and critical minerals compared to the central case.

Section IV.C.7.i of the preamble provides a general review of how we considered supply chain and manufacturing considerations in this analysis, the sources we considered, and how we used this information in the analysis. Section IV.C.7.ii examines the issues surrounding availability of critical mineral inputs. Section IV.C.7.iii provides a high-level discussion of the security implications of increased demand for critical minerals and other materials used to manufacture electrified vehicles. Section IV.C.7.iv describes the role of battery and mineral recycling. Additional details on these aspects of the analysis may be found in RIA Chapter 3.1, including 3.1.5 where we describe how we used this information to develop modeling constraints on PEV penetration for the compliance analysis.

i. Production Capacity for Batteries and Battery Components

Major steps in manufacturing a PEV battery pack include manufacturing of battery cells and assembly of cells into modules that can be assembled into a battery pack. Inputs to cell manufacturing include electrode active materials (EAM), such as cathode and anode powders, as well as specialized products such as electrolytes, separators, binders, and similar materials. Depending on the level of vertical integration, a plant making cells might produce some of these inputs in-house or purchase them from a supplier. While other battery chemistries exist or are under development, this section focuses on supply chains for lithium-ion batteries given their wide use and likely predominance during the time frame of the rule.

In the proposal, we examined the outlook for U.S. and global battery manufacturing capacity for automotive lithium-ion batteries and compared it to our projection of U.S. battery demand under the proposed standards. We collected and reviewed a number of independent studies and forecasts, including numerous studies by analyst firms and various stakeholders, as well as a study of announced North American cell and battery manufacturing facilities compiled by Argonne National Laboratory. Our review of these studies included consideration of uncertainties of the sort that are common to any forward-looking analysis but did not identify any hard constraint that indicated that global or domestic battery manufacturing capacity would be insufficient to support battery demand under the proposed standards. The review indicated that the industry was already showing a rapidly growing and robust response to meet current and anticipated demand, that this activity was widely expected to continue, and that the level of North American manufacturing capacity that had been announced to date would be sufficient to meet the demand projected under the proposed standards. We assessed that battery manufacturing capacity was not likely to pose a limitation on the ability of auto manufacturers to meet the standards as proposed.

We received a variety of comments, some of which disagreed with our assessment and others which supported it. Among those that disagreed, some primary themes included: that we looked only at light-duty battery demand and not at other transportation or product sectors that use lithium-ion batteries, such as heavy-duty vehicles, stationary storage, and portable devices; that the projections of North American manufacturing capacity did not include sufficient ramp-up time; and that we should consider active material manufacturing in addition to cell manufacturing. The Alliance for Automotive Innovation included in its comments a BMI forecast that indicated a somewhat lower battery manufacturing capacity than that documented by ANL.

EPA appreciates and has carefully considered the substantive and detailed comments offered by the commenters. The additional information EPA has collected since the proposal, through these public comments and our continued research, informs many of the points raised by the commenters. Taken together, EPA does not find evidence that would change our previous assessment in the proposal that the outlook for U.S. battery production indicates that it is likely to be sufficient to support the standards.

One important factor in our assessment is a study of North American battery and cell manufacturing capacity performed by ANL, which updates an earlier version of the study that we cited in the proposal.[1067] The updated ANL study further reinforces our assessment of U.S. battery manufacturing capacity, showing that announced capacity has significantly increased since the prior study. EPA considers ANL's assessment through December 2023 to be thorough and up to date and notes that the BMI assessment cited in comments by the Alliance in July 2023 necessarily represents earlier information. The updated ANL projections estimate the period from announcement to beginning of production for each individual plant based on numerous factors, and uses a baseline estimate of 3 years from beginning of production to full scale operation, based on historical cell manufacturing data. ANL describes this as ''a modestly conservative estimate,'' acknowledging that plants could reach nominal capacity more quickly or more slowly. ANL has also specifically accounted for the intended use of the cells produced in these plants, finding as expected that the vast majority are expected to be used in light-duty automotive applications rather than heavy-duty, stationary or consumer product applications.

Some public commenters stated that we should include consideration of active material manufacturing. In response, EPA notes that the outlook for global cathode active material manufacturing capacity was considered in the proposal; later in this section we consider additional information regarding manufacturing for electrode active materials and other cell components.

[1067] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024. *https://publications.anl.gov/anlpubs/2024/03/187735.pdf*.

In addition, our updated compliance analysis projects a substantially lower demand for battery production than in the proposal. This is largely due to the effect of our higher battery cost inputs, which reduce the penetration of BEVs, the inclusion of PHEVs which use smaller batteries than BEVs, and updated BEV efficiency inputs. After including all of these updates, projected North American automotive battery production capacity continues to surpass projected demand (see the later discussion at Figure 36). Even if a shortfall were to occur, our higher battery cost sensitivity accounts for higher battery costs that might result, and as previously noted, alternative compliance pathways that place less demand on battery production would continue to exist.

Since the proposal, we have not found evidence to change our observation that U.S. PEV production to date has not been particularly reliant on foreign manufacture of batteries and cells, nor that increased PEV penetration must imply such a reliance. In the proposal we noted that about 57 percent of cells and 84 percent of assembled packs sold in the U.S. from 2010 to 2021 were manufactured in the U.S.[1068] [1069] Continued growth in U.S. BEV sales is dominated by manufacturers such as Tesla who largely use U.S. made batteries, and the large production capacity of announced U.S. plants under construction or planned also suggests that this will continue to be the case going forward.

We also continue to see evidence that global lithium-ion battery and cell production is growing rapidly and is likely to keep pace with increasing global demand. In the proposal we noted a 2021 report from Argonne National Laboratory (ANL)[1070] that examined the state of the global supply chain for electrified vehicles and included a comparison of recent projections of future global battery manufacturing capacity and projections of future global battery demand from various analysis firms out to 2030, as seen in Figure 32. The three most recent projections of capacity (from BNEF, Roland Berger, and S&P Global in 2020–2021) that were collected by ANL at that time exceeded the corresponding projections of demand by a significant margin in every year for which they were projected, suggesting that global battery manufacturing capacity was already responding strongly to increasing demand.

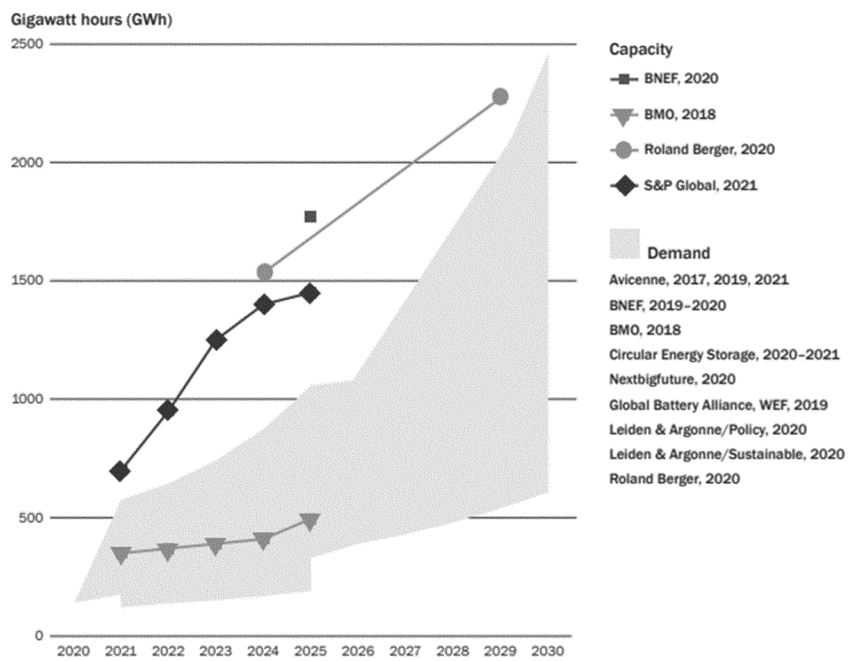

Figure 32: Future Global Li-ion Battery Demand and Production Capacity, 2020–2030 [1071] [1072]

[1068] Argonne National Laboratory, ''Lithium-Ion Battery Supply Chain for E-Drive Vehicles in the United States: 2010–2020,'' ANL/ESD–21/3, March 2021.

[1069] U.S. Department of Energy, ''Vehicle Technologies Office Transportation Analysis Fact of the Week #1278, Most Battery Cells and Battery Packs in Plug-in Vehicles Sold in the United States From 2010 to 2021 Were Domestically Produced,'' February 20, 2023.

[1070] Argonne National Laboratory, ''Lithium-Ion Battery Supply Chain for E-Drive Vehicles in the United States: 2010–2020,'' ANL/ESD–21/3, March 2021.

[1071] Argonne National Laboratory, ''Lithium-Ion Battery Supply Chain for E-Drive Vehicles in the United States: 2010–2020,'' ANL/ESD–21/3, March 2021.

[1072] Federal Consortium for Advanced Batteries, ''National Blueprint for Lithium Batteries 2021–2030,'' June 2021 (Figure 2). Available at *https://www.energy.gov/sites/default/files/2021-06/FCAB%20National%20Blueprint%20Lithium%20Batteries%200621_0.pdf*.

Since the proposal, we have not seen evidence that the general conclusion conveyed by Figure 32 has changed. More recent projections have become available that indicate that projections of future capacity have grown dramatically in only a short time. For example, in May 2023 the International Energy Agency (IEA) projected a global capacity of 3.97 TWh in 2025,[1073] more than twice the highest projection in Figure 32 of about 1.75 TWh for 2025 made by BNEF in 2020. IEA also projected 6.8 TWh for 2030,[1074] which is about triple the highest projection made for 2029 by Roland Berger in 2020. In December 2023, BNEF indicated that its projection of North American lithium-ion cell manufacturing nameplate capacity for 2030 was 76 percent higher than its projection for the same year in 2022, and attributed the increase in part to industry's response to IRA incentives including the 45X production tax credit. The same report indicated that global capacity could increase to as much as 7.4 TWh in 2025 if all project announcements that were public at the time were to be completed.[1075] The rate of increase of projections such as these strongly indicate that the capacity of both domestic and global battery production is increasing at a rapid pace that is much greater than anticipated only two to three years ago. Further, the IEA indicates that the 6.8 TWh global capacity projected for 2030 would be enough to cover global battery demand under its ''Net Zero'' scenario, and would cover nearly twice the demand implied by currently announced pledges across the world.[1076] The updated ANL study supports the continuation of this trend, finding projected battery cell production in MSP countries through 2035 (outside North America) to slightly exceed the sum in North America, with each reaching 1,300 GWh/year by 2030.

As described in section I.A.2 of this preamble, manufacturers are continuing to project high levels of electrification in their future fleets and are continuing to make very large investments toward making this possible, by increasing manufacturing capacity and securing sources and suppliers for critical minerals, materials, and components. Although some manufacturers, such as Toyota and Stellantis, have most recently signaled a potential interest in including a significant percentage of HEVs and PHEVs in their fleets, this remains consistent with our modeling as it represents a potential compliance path that may be attractive to manufacturers with substantial expertise or customer base that supports these products. Indeed, as we show below, manufacturers' choosing to produce more HEVs and PHEVs would decrease the need for batteries, battery components, and critical minerals, providing even further support for our conclusion that related supply issues are unlikely to constrain compliance with the final rule.

One analysis we cited in the proposal indicated that 37 of the world's automakers are planning to invest a total of almost $1.2 trillion by 2030 toward electrification,[1077] a large portion of which will be used for construction of manufacturing facilities for vehicles, battery cells and packs, and materials, supporting up to 5.8 terawatt-hours of battery production and 54 million electric vehicles per year globally.[1078] Similarly, an analysis by the Center for Automotive Research showed that a significant shift in North American investment is occurring toward electrification technologies, with $36 billion of about $38 billion in total automaker manufacturing facility investments announced in 2021 being slated for electrification-related manufacturing in North America, with a similar proportion and amount on track for 2022.[1079]

Since the proposal, ongoing work conducted by ANL examines the most recent developments in the growth of the supply chain and confirms continuation of this trend. As noted previously, ANL has continued tracking investments in battery and electric vehicle manufacturing to estimate growth of battery production in North America, based on press releases, financial disclosures, and news articles.[1080] ANL finds that since 2000, companies have announced over $150 billion in planned investments for battery production in the United States.[1081] In this context, battery production refers to the full chain of production including extraction of the raw minerals necessary to make batteries, processing into battery-grade materials, manufacturing of active materials and cell components, and production of battery cells and packs for end use. ANL finds that this investment has accelerated in recent years, with over $100 billion dollars of investment announced in the last two years alone.

The majority of the battery investments are for lithium-ion batteries, linked to the development and deployment of electric vehicles. Historically, many of these investments have been in traditional auto manufacturing locations in eastern North America, with many found in a band from Ontario through Michigan and other Great Lakes states, and then to newer vehicle assembly plants in the south, especially in Alabama, Tennessee, and South Carolina. The most prominent battery cell manufacturing investments have roughly followed this pattern.

We also noted in the proposal that the Department of Energy had in 2021 accounted for at least 13 new battery plants, most of which will include cell manufacturing, that were expected to become operational in the U.S. in the next few years.[1082] Among these, in partnership with SK Innovation, Ford is building three large new battery plants in Kentucky and Tennessee[1083] and a

[1073] International Energy Agency, ''Lithium-ion battery manufacturing capacity, 2022–2030,'' May 22, 2023. Accessed on February 22, 2024 at *https://www.iea.org/data-and-statistics/charts/lithium-ion-battery-manufacturing-capacity-2022-2030.*

[1074] International Energy Agency, ''Global EV Outlook 2023,'' p. 112, May 2023. Accessed on November 28, 2023 at *https://iea.blob.core.windows.net/assets/dacf14d2-eabc-498a-8263-9f97fd5dc327/GEVO2023.pdf.*

[1075] BloombergNEF, ''Zero-Emission Vehicles Factbook: A BloombergNEF special report prepared for COP28, December 2023, p. 30 and 40.

[1076] International Energy Agency, ''Global EV Outlook 2023,'' p. 122, May 2023. Accessed on November 28, 2023 at *https://iea.blob.core.windows.net/assets/dacf14d2-eabc-498a-8263-9f97fd5dc327/GEVO2023.pdf.*

[1077] Reuters, ''A Reuters analysis of 37 global automakers found that they plan to invest nearly $1.2 trillion in electric vehicles and batteries through 2030,'' October 21, 2022. Accessed on November 4, 2022 at *https://graphics.reuters.com/AUTOS-INVESTMENT/ELECTRIC/akpeqgzqypr/.*

[1078] Reuters, ''Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030,'' October 25, 2022. Accessed on November 4, 2022 at *https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/.*

[1079] Center for Automotive Research, ''Automakers Invest Billions in North American EV and Battery Manufacturing Facilities,'' July 21, 2022. Retrieved on November 10, 2022 at *https://www.cargroup.org/automakers-invest-billions-in-north-american-ev-and-battery-manufacturing-facilities/.*

[1080] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

[1081] This value is based upon public statements of investment. Not all manufacturing facility expansions include explicit information about the scale of the investment. Additionally, this value is based on ANL tracking of investments. While diligent effort has been paid to include existing facilities and older press releases, these historical announcements are more difficult to find, and so this data may be biased against older investments.

[1082] Department of Energy, Fact of the Week #1217, ''Thirteen New Electric Vehicle Battery Plants Are Planned in the U.S. Within the Next Five Years,'' December 20, 2021.

[1083] Ford Media Center, ''Ford to Lead America's Shift to Electric Vehicles with New Mega Campus in Tennessee and Twin Battery Plants in Kentucky; $11.4B Investment to Create 11,000 Jobs and Power New Lineup of Advanced EVs,'' Press Release, September 27, 2021.

fourth in Michigan.[1084] General Motors is partnering with LG Chem to build another three plants in Tennessee, Michigan, and Ohio, and considering another in Indiana. LG Chem has also announced plans for a cathode material production facility in Tennessee, said to be sufficient to supply 1.2 million high-performance electric vehicles per year by 2027.[1085] Panasonic, already partnering with Tesla for its factories in Texas and Nevada, is planning two new factories in Oklahoma and Kansas. Toyota plans to be operational with a plant in Greensboro, North Carolina in 2025, and Volkswagen in Chattanooga, Tennessee at about the same time. According to a May 2022 forecast by S&P Global, announcements such as these were expected to result in a U.S. annual manufacturing capacity of 382 GWh by 2025,[1086] or 580 GWh by 2027,[1087] up from roughly 60 GWh [1088] [1089] today.

As noted in the proposal, manufacturers continue to approach construction of new battery manufacturing plants as part of joint ventures with established cell suppliers, by which the OEM may secure a supply of cells, modules, or battery packs for its products and develop a chain of supply that will support their production needs.[1090] [1091] [1092] [1093] [1094] [1095] According to ANL, the largest portion of total forecast North American cell production capacity represents joint ventures of energy companies with automotive companies, while a similar amount represents cell suppliers without a formal joint venture, and the remaining group represent OEM ventures.[1096]

Overall, these investments are part of a pattern of rapidly increasing investment over the last three years that continues today. Figure 33 shows that cumulative announcements of investments in the battery supply chain have increased by a factor of six from about $25 billion three years ago to about $156 billion today.[1097] U.S. policy, including the BIL and the IRA, is likely to have driven much of this investment. As seen in the figure, cumulative investment announcements roughly doubled after the BIL (or IIJA) was enacted, and more than doubled again after the IRA was enacted. Additional announcements are likely as the rollout of funds and incentives from BIL and IRA continues. This aggressive investment in North American manufacturing is likely to play a strong role in minimizing risks of supply chain shocks and assuring U.S. manufacturing resilience.

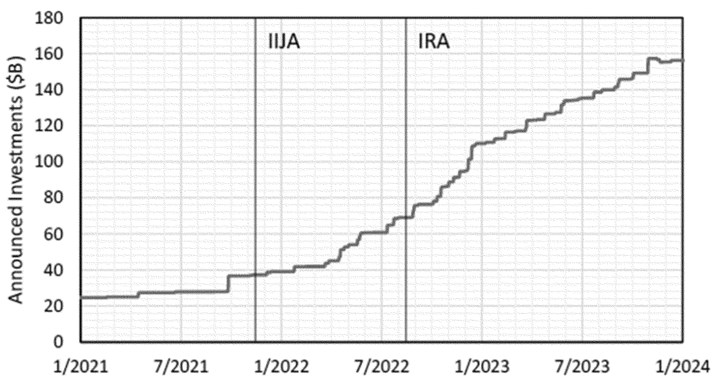

Figure 33: Evolution of Battery Supply Chain Investments in the U.S. Since 2021

[1084] Ford Media Center, ''Ford Taps Michigan for New LFP Battery Plant; New Battery Chemistry Offers Customers Value, Durability, Fast Charging, Creates 2,500 More New American Jobs,'' Press Release, February 13, 2023.

[1085] LG Chem, ''LG Chem to Establish Largest Cathode Plant in US for EV Batteries,'' Press Release, November 22, 2022.

[1086] S&P Global Market Intelligence, ''US ready for a battery factory boom, but now it needs to hold the charge,'' October 3, 2022. Accessed on November 22, 2022 at *https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-ready-for-a-battery-factory-boom-but-now-it-needs-to-hold-the-charge-72262329*.

[1087] S&P Global Mobility, ''Growth of Li-ion battery manufacturing capacity in key EV markets,'' May 20, 2022. Accessed on November 22, 2022 at *https://www.spglobal.com/mobility/en/research-analysis/growth-of-liion-battery-manufacturing-capacity.html*.

[1088] Federal Consortium for Advanced Batteries, ''National Blueprint for Lithium Batteries 2021–2030,'' June 2021. Available at *https://www.energy.gov/sites/default/files/2021-06/FCAB%20National%20Blueprint%20Lithium%20Batteries%200621_0.pdf*.

[1089] S&P Global Mobility, ''Growth of Li-ion battery manufacturing capacity in key EV markets,'' May 20, 2022. Accessed on November 22, 2022 at *https://www.spglobal.com/mobility/en/research-analysis/growth-of-liion-battery-manufacturing-capacity.html*.

[1090] Voelcker, J., ''Good News: Ford and GM Are Competing on EV Investments,'' Car and Driver, October 18, 2021. Accessed on December 9, 2021 at *https://www.caranddriver.com/features/a37930458/ford-gm-ev-investments/*.

[1091] Stellantis, ''Stellantis and LG Energy Solution to Form Joint Venture for Lithium-Ion Battery Production in North America,'' Press Release, October 18, 2021.

[1092] Toyota Motor Corporation, ''Toyota Charges into Electrified Future in the U.S. with 10-year, $3.4 billion Investment,'' Press Release, October 18, 2021.

[1093] Ford Motor Company, ''Ford to Lead America's Shift To Electric Vehicles With New Mega Campus in Tennessee and Twin Battery Plants in Kentucky; $11.4B Investment to Create 11,000 Jobs and Power New Lineup of Advanced EVs,'' Press Release, September 27, 2021.

[1094] General Motors Corporation, ''GM and LG Energy Solution Investing $2.3 Billion in 2nd Ultium Cells Manufacturing Plant in U.S.,'' Press Release, April 16, 2021.

[1095] Shepardson, D. and Lienert, P., ''GM eyes investments of more than $4 billion in Michigan EV plants,'' Reuters, December 10, 2021. Accessed on December 13, 2021 at *https://www.reuters.com/business/autos-transportation/gm-eyes-3-billion-investment-michigan-ev-plants-source-2021-12-10/*.

[1096] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

[1097] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

Even as these investment trends have continued, in the second half of 2023 some automakers announced changes to previously announced battery production plans. For example, in mid-2023, Ford paused construction of their recently announced battery plant in Marshall, Michigan [1098] (since restarted), and in November 2023 announced a reduction in the size of the plant from 50 GWh to 20 GWh.[1099] Tesla also announced a delay in construction of a battery plant in Mexico.[1100] [1101] We discussed the broader topic of changes to manufacturer investment and product plan outlooks in section I.A.2 of this preamble, and extending from our conclusion in that discussion, EPA does not consider these changes to indicate a meaningful slowdown or reversal of the U.S. or global battery production trends described here. Specific factors were active during the period when Ford made its announcement, such as the 2023 United Auto Workers strike,[1102] and an increase in inventories for light-duty vehicles of all types,[1103] which may be related to economic conditions such as high interest rates and higher transaction prices for all types of vehicles.[1104] [1105] [1106] Ford has since restarted construction.[1107] Tesla specifically cited economic conditions, and not a change in overall battery production plans, for its delay, while a delay in GM's Ultium plant in Tennessee was attributed to construction delays.[1108] Despite the delays by Ford and Tesla, others announced increased investments or accelerated timetables at the same time. For example, Toyota announced an $8 billion increase in investment in its North Carolina plant,[1109] and Hyundai accelerated construction of its Georgia plant.[1110] Given the unprecedented rate and size of recent investment activity in PEV technology, adjustments to previously announced plans would ordinarily be expected to occur, and to date have included both reductions and increases in investment amounts and pacing. The overall trend continues to be very large and rapid increases in domestic production of batteries and battery components.

The updated ANL analysis accounts not only for new announcements since the proposal, but also for recent reductions in scope, such as the reduction of the Ford plant's announced capacity. As seen in Figure 34, ANL indicates that overall projections for North American battery production capacity by 2030 have increased by a factor of about 10 over the last three years. The vertical axis shows the estimated North American production capacity for 2030, and the horizontal axis shows the date of company announcements. Expected capacity for 2030 increased from 300 GWh/year in December 2021 to 800 GWh/year by December 2022, and now stands at more than 1,300 GWh/year.

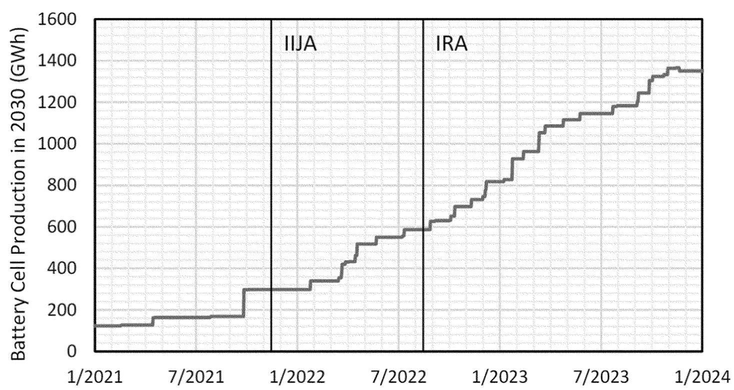

Figure 34: Evolution in Battery Cell Production Announcements in North America

[1098] Reuters, ''Ford pauses work on $3.5 bln battery plant in Michigan,'' September 25, 2023. Accessed on December 15, 2023 at *https://www.reuters.com/business/autos-transportation/ford-pauses-work-35-billion-battery-plant-michigan-2023-09-25*.

[1099] New York Times, ''Ford Resumes Work on E.V. Battery Plant in Michigan, at Reduced Scale,'' November 21, 2023. Accessed on December 15, 2023 at *https://www.nytimes.com/2023/11/21/business/ford-ev-battery-plant-michigan.html*.

[1100] Reuters, ''Mexico gives Tesla land-use permits for gigafactory, says state government,'' December 12, 2023. Accessed on February 14, 2024 at *https://www.reuters.com/business/autos-transportation/mexico-gives-tesla-land-use-permits-gigafactory-says-state-government-20231213*.

[1101] Mexico Now, ''Taxes and global economy stop Tesla plant in Nuevo Leon,'' October 23, 2023. Accessed on February 14, 2024 at *https://mexico-now.com/taxes-and-global-economy-stop-tesla-plant-in-nuevo-leon*.

[1102] CBS News, ''Ford resuming construction of Michigan EV battery plant delayed by strike, scaling back jobs,'' November 21, 2023. Accessed on December 15, 2023 at *https://www.cbsnews.com/detroit/news/ford-resuming-construction-of-michigan-ev-battery-plant-delayed-by-strike-scaling-back-jobs*.

[1103] National Automobile Dealers Association, ''NADA Market Beat,'' November 2023. Accessed on December 11, 2023 at *https://www.nada.org/nada/nada-headlines/nada-market-beat-new-light-vehicle-inventory-reaches-20-month-high*.

[1104] Reuters, ''More alarm bells sound on slowing demand for electric vehicles,'' October 25, 2023. Accessed on December 15, 2023 at *https://www.reuters.com/business/autos-transportation/more-alarm-bells-sound-slowing-demand-electric-vehicles-2023-10-25*.

[1105] CNBC, ''Sparse inventory drives prices for new, used vehicles higher,'' October 17, 2023. Accessed on December 15, 2023 at *https://www.cnbc.com/2023/10/17/sparse-inventory-drives-prices-for-new-used-cars-higher.html*.

[1106] San Diego Union-Tribune, ''Has enthusiasm for electric cars waned?,'' October 27, 2023. Accessed on December 15, 2023 at *https://www.sandiegouniontribune.com/business/story/2023-10-27/has-enthusiasm-for-electric-cars-waned*.

[1107] CBS News, ''Ford resuming construction of Michigan EV battery plant delayed by strike, scaling back jobs,'' November 21, 2023. Accessed on December 15, 2023 at *https://www.cbsnews.com/detroit/news/ford-resuming-construction-of-michigan-ev-battery-plant-delayed-by-strike-scaling-back-jobs*.

[1108] *InsideEVs.com*, ''GM's Ultium Cells Plant In Tennessee Delayed Until 2024 (Updated),'' October 28, 2023. Accessed on February 22, 2024 at *https://insideevs.com/news/693537/gm-ultium-cells-tennessee-plant-delayed-2024*.

[1109] Toyota Newsroom, ''Toyota Supercharges North Carolina Battery Plant with New $8 Billion Investment,'' Press Release, October 31, 2023. Available at *https://pressroom.toyota.com/toyota-supercharges-north-carolina-battery-plant-with-new-8-billion-investment*.

[1110] Ars Technica, ''Hyundai hurries to finish factory in Georgia to meet US EV demand,'' September 20, 2023. Accessed on February 23, 2024 at *https://arstechnica.com/cars/2023/09/hyundai-hurries-to-finish-factory-in-georgia-to-meet-us-ev-demand*.

As shown in Figure 35, this updated study illustrates the rapid recent growth in new plant announcements. Light-duty vehicle applications are the largest portion of announced and operating plants. These production estimates are based on new plant announcements and construction and include an estimate of time between announcement and initial production based on historical data, as described previously.[1111] Based on its assessment, ANL projected annual operating capacities by applying a 36 month linear ramp-up time from announced date of initial production to full-scale production. It is important to note that, as with all projections of future capacity, the apparent flattening of growth after 2030 is only an artifact of data availability, in that public announcements tend to extend only a limited period into the future. It does not indicate that investment past 2030 will slow or stop, as additional demand is likely to spur additional announcements just as it has for the earlier years.

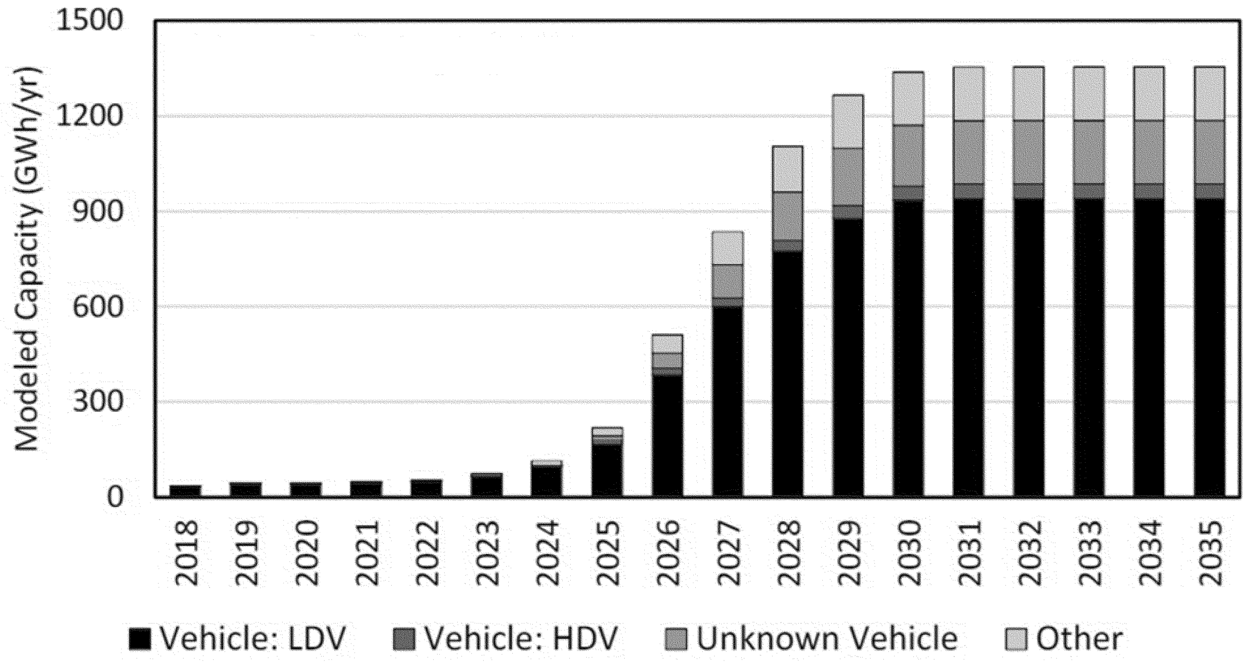

Figure 35: Modeled Lithium-Ion Cell Production Capacity in North America From 2018 to 2035 by Transportation Sector

Looking at cells dedicated specifically to light-duty vehicles, Figure 36 shows that in all years of the rule from 2027 to 2032, North American light-duty vehicle cell manufacturing is expected to be meet demand under all compliance scenarios EPA modeled.[1112] This accounting of projected battery manufacturing is particularly conservative because it excludes production designated for vehicles but for which the vehicle type was not specified, and also excludes rumored and conditional manufacturing capacity. The lines in Figure 36 show the projected GWh of battery production needed to support the PEV and HEV market under several cases of our analysis including the central case, No Action case, and two alternative pathways (Pathway B and C of the Executive Summary). It shows that in all years of the rule, the projected battery demand for U.S. electrified light- and medium-duty vehicles is well within projected operating North American battery cell production capacity for light-duty vehicles. As the bulk of these announcements are slated for automotive applications, it shows that already-announced North American battery manufacturing capacity is likely to be more than sufficient to meet battery demand under the rule.[1113] Although demand in the central case begins to approach projected capacity in 2032, this again is an artifact of the limited time frame of currently known supply announcements, as described previously.

[1111] Most announcements include initial production date, and some show assumed date for full-scale production. For plants without this information, DOE assumed 3 years from initial opening of the plant to full-scale production as default, based on historical growth of cell production plants. This may be overly conservative, as older plants did not have the rest of the battery infrastructure growing in tandem.

[1112] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

[1113] This finding also has implications for the ability of U.S. manufacturers to take advantage of the Inflation Reduction Act's Manufacturer Production Tax Credit (IRC 45X) of up to $45 per kWh for cells and modules produced in the United States. We address our updated assumptions for these incentives in section IV.C.2 of this preamble.

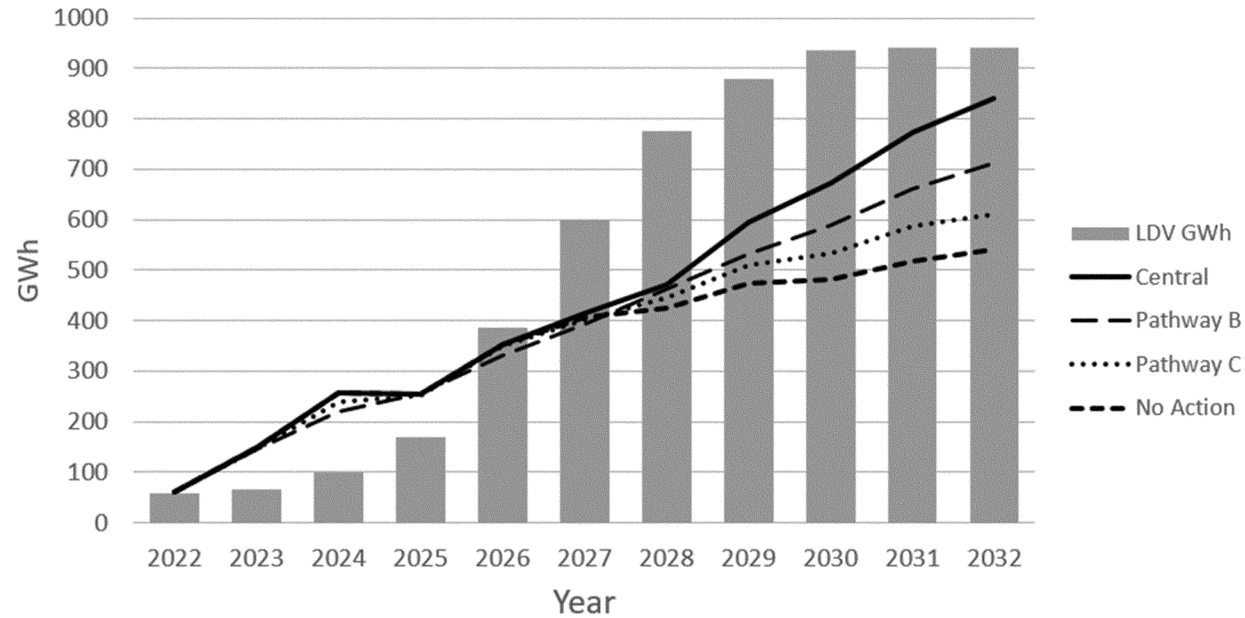

Figure 36: Planned North America Light-Duty Vehicle Cell Production Capacity Compared to Battery Demand Under Various Cases of the Analysis

The annual battery production required for the compliant fleet generated by OMEGA under our central case is 671 GWh in 2030, far less than the projected operating North American light-duty vehicle battery production capacity of 935 GWh projected for the same year in Figure 36 above. Demand reaches a maximum of 839 GWh in 2032, still less than projected capacity. These amounts compare to a maximum of about 540 GWh under the No Action case. Pathway B is a pathway with moderate penetration of HEVs and PHEVs (collectively called P/HEVs) in place of BEVs. Pathway C is a pathway in which no new BEV models are introduced beyond the No Action case, in which ICE, HEV and PHEV are more prevalent. Pathway C results in the lowest peak battery demand of 612 GWh in 2032. These latter cases show that compliance with the standards would continue to be possible even if critical mineral availability or manufacturing capacity were more constrained than current projections indicate.

Moving beyond battery and cell manufacturing, we now consider the outlook for North American manufacturing of electrode active materials and other cell components. Active materials include cathode and anode powders and electrolyte, for which critical minerals and precursor chemicals are important manufacturing inputs. Cell components include specialty products such as aluminum and copper current collector foils, electrode separators, and solvents and binders. In order to meet their projected operating capacities, the North American battery plants represented in Figure 36 above will either manufacture these materials on site or at another location, or purchase them from a supplier, or a combination of the two.

Significant production of many of these items is occurring in the U.S. For example, several large suppliers of batteries and cells, as well as major OEMs, are increasingly taking steps to secure domestically sourced raw minerals, active materials and cell components to supply their battery and cell manufacturing plants. Auto manufacturers are also moving to secure supplies of these items to support their production needs and partnerships. For example, Ford has moved to secure sources of raw materials for its battery needs;[1114] [1115] General Motors has signed similar supply chain agreements, for battery materials[1116] [1117] [1118] as well as for rare-earth metals for electric machines;[1119] and Tesla has also moved to secure a domestic lithium supply.[1120] Announcements in this general vein have been occurring regularly since the proposal and continue to provide evidence that the industry is continuing to actively pursue domestic sources of battery materials. In addition, the Inflation Reduction Act (IRA) and the Bipartisan Infrastructure Law (BIL) continue to provide significant support to accelerate these efforts to build out a U.S. supply chain for mineral, cell, battery component, and battery production.

In the 2024 ANL study of battery manufacturing,[1121] ANL quantitatively examined the outlook for North American production of these components, based on currently known company announcements to increase production in North America of anode active material (AAM), cathode active material (CAM), electrolyte, foils, and separators. ANL then compared the potential supply with anticipated demand for domestic battery production.

Unlike with battery cell manufacturing, ANL found that a gap currently exists between anticipated future domestic demand and currently operating and announced future U.S. manufacturing capacity for many of the constituent materials and cell

[1114] Green Car Congress, ''Ford sources battery capacity and raw materials for 600K EV annual run rate by late 2023, 2M by end of 2026; adding LFP,'' July 22, 2022.

[1115] Ford Motor Company, ''Ford Releases New Battery Capacity Plan, Raw Materials Details to Scale EVs; On Track to Ramp to 600K Run Rate by '23 and 2M+ by '26, Leveraging Global Relationships,'' Press Release, July 21, 2022.

[1116] Green Car Congress, ''GM signs major Li-ion supply chain agreements: CAM with LG Chem and lithium hydroxide with Livent,'' July 26, 2022.

[1117] Grzelewski, J., ''GM says it has enough EV battery raw materials to hit 2025 production target,'' The Detroit News, July 26, 2022.

[1118] Hall, K., ''GM announces new partnership for EV battery supply,'' The Detroit News, April 12, 2022.

[1119] Hawkins, A., ''General Motors makes moves to source rare earth metals for EV motors in North America,'' The Verge, December 9, 2021.

[1120] Piedmont Lithium, ''Piedmont Lithium Signs Sales Agreement With Tesla,'' Press Release, September 28, 2020.

[1121] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

components listed above. Based on currently known announcements, ANL finds that North American production can meet all of the North American demand for electrolyte, approximately half of the demand for electrode active materials, and about one quarter of the demand for separators and foils by the end of the decade. ANL notes that these estimates for North American production take ''a conservative view of future manufacturing announcements, only including sites which have been explicitly formally announced.'' [1122]

Again, as stated previously, the relevant standard is not complete domestic self-sufficiency but rather a diversified supply chain that includes not only domestic production where possible and appropriate but also includes trade with FTA countries as well as our many other economic allies with whom the U.S. has good trade relations. While it is likely that some of domestic demand for the battery components listed above will be satisfied through imports, allies and partners outside of North America are likely to be key suppliers.

ANL observes that manufacturing announcements for battery components often significantly lag those for battery cell manufacturing, and without growth in battery cell manufacturing creating demand for their products in the U.S., battery component manufacturers would have little reason to increase their manufacturing capacity in North America. Indeed, with any product, the mere identification of a gap between projected supply and projected demand does not by itself constitute a future shortage, and often represents the very signal that motivates new supply to be developed or expanded.

ANL also notes that past history suggests that the market often rapidly adapts in response to demand and industrial policies.[1123] Significantly, ANL does not conclude that the gap represents a hard constraint or that it cannot be significantly reduced or closed in the future, citing several factors that are likely to address the gap. These factors include the fact that increases in production capacity for these components tend to require less lead time than for cell production or mining operations. According to ANL, ''because of their shorter construction and permitting time, most battery components can be responsive to the demand arising from battery cell plants.'' Producers of these components are therefore more likely to be in a position to await clear demand signals, such as specific offtake agreements, before new projects or capacity expansions will be announced. That is, quoting the ANL study, companies ''may be waiting for certainty in demand from cell production or for availability of financing before publicly committing to building a manufacturing plant.'' Currently observed capacities for cell material and components production may therefore be more indicative of current offtake agreements and spot market demand than of production potential, and announcements of future capacity resulting from increased demand or offtake are likely to become known at a time much closer to the beginning of production. Plans may depend upon various other factors such as, for example, additional guidance on IRA provisions, or the progress of funding distributions. Many production plans have outstanding funding applications through the various DOE and other government funding and loan programs (described later), but have yet to be awarded or publicly announced. Some further capacity increases may occur despite the lack of a formal announcement at this time; for example, ANL identified an additional 590 GWh/year in nominal anode active material capacity that would arise by the end of the decade at facilities which are being planned or considered but have not yet been formally announced, which would close the supply-demand gap by 2032.

Further, domestic production for any of these materials and components could be significantly underestimated to the degree that any of the announced cell production facilities discussed previously are also planning to manufacture these components onsite. Announcements of cell manufacturing plants typically lack sufficient detail to determine the degree of vertical integration that might be planned, and these details often are not separately announced. EPA also notes that the overall scale of investment in cell and component manufacturing capacity across the industry suggests that the industry at large has confidence in being able to secure sufficient supplies of materials and components to operate these plants in a manner that returns their investment.

Importantly, as noted above, allies and partners outside of North America are likely to be integral to meeting domestic battery component demand. Some of the world leaders in production of cell materials and components are close allies of the U.S. and are likely to have a prominent role in filling the gap, as they do today. For example, Japan and South Korea are the second and third largest producers of electrode active materials,[1124] while South Korea is dominant in separator film [1125] and home to the largest manufacturer of copper foils which also is constructing capacity in the U.S.[1126] [1127]

For these and similar reasons EPA does not consider the apparent gap between projected domestic demand and projected North American supply of cells, components, and material inputs identified by ANL to be indicative of a constraint that would prevent announced U.S. battery cell manufacturing from operating as planned, with a combination of domestically produced materials and components and those acquired through trade with economic allies.

To the extent that content is imported from partner nations, it is important to note that this carries significance primarily for qualification of a vehicle for the IRC 30D clean vehicle credit or for concerns about U.S. reliance on imports, and does not constrain U.S. cell production for U.S. PEVs per se. The presence of imported content does not exclude any PEV from being sold in the U.S. market, nor does it prevent access to the similarly significant 45X cell and module production credit to manufacturers.[1128] Therefore, the ability for North American plants to operate at the capacities projected previously would not be constrained by any potential shortfall in domestic production of cell materials and components, but only by a shortfall in global production, if such a shortfall were to exist.

We now consider the outlook for global production of cell materials and components.[1129] Figure 37 repeats the chart that was provided in the proposal, showing projections prepared by Li-Bridge for DOE,[1130] and presented to the

[1122] Id. at p. 50.

[1123] Id.

[1124] Id.

[1125] Byun, H., ''Korea to dominate 75% of battery separator market by 2030: report,'' The Korea Herald, July 17, 2023. Accessed on March 1, 2024 at *https://www.koreaherald.com/view.php?ud=20230717000571*.

[1126] Kim, H., ''Hopes rise for Korean copper foil makers' gains under IRA,'' The Korea Economic Daily, August 10, 2023. Accessed on March 1, 2024 at *https://www.kedglobal.com/batteries/newsView/ked202308100025*.

[1127] Kim, J., ''SK Nexilis launches copper foil production in Malaysia,'' November 5, 2023. Accessed on March 1, 2024 at *https://www.kedglobal.com/batteries/newsView/ked202311050002*.

[1128] It is also relevant that imported mineral content eventually becomes feedstock for recycling, through which it becomes a domestic resource.

[1129] Our assumptions for access to 30D are described separately in section IV.C.2 of this preamble, and implications for mineral security are discussed in IV.C.7.iii.

[1130] Slides 6 and 7 of presentation by Li-Bridge to Federal Consortium for Advanced Batteries (FCAB), November 17, 2022.

Federal Consortium for Advanced Batteries (FCAB) [1131] in November 2022. These projections were largely derived by DOE from Benchmark Minerals Intelligence (BMI) projections, and indicated that global supplies of cathode active material (CAM) were expected to be sufficient through 2035.

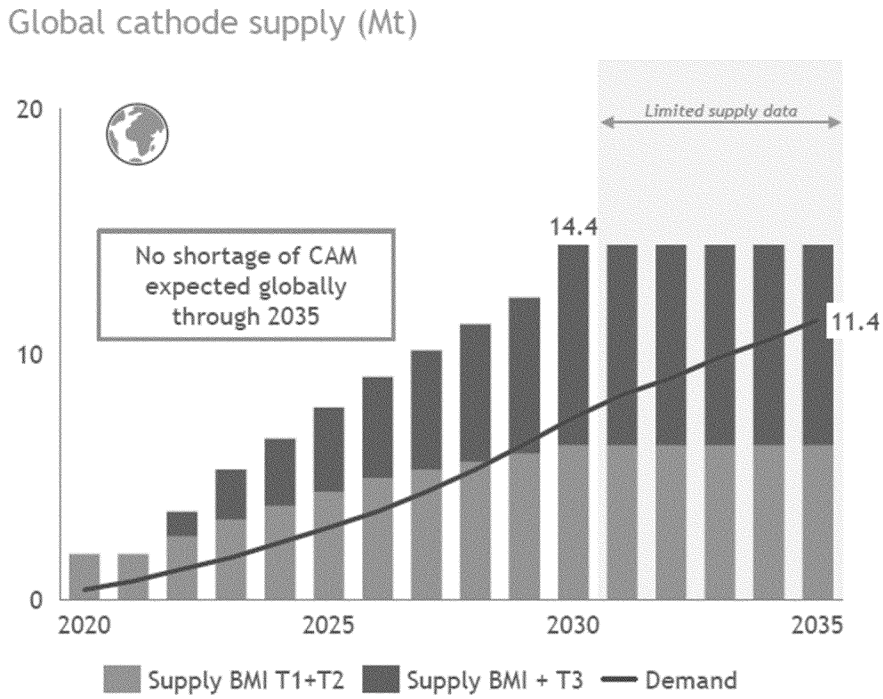

Figure 37: DOE Li-Bridge Assessment of Global CAM Supply and Demand

In the figure, the labels T1 and T2 represent supplies that BMI considers as having a track record of supplying these materials outside of China and within China, respectively. The label T3 represents supplies that BMI assessed as not having an established track record of production, and thus represent earlier stage efforts, such as for example, new entrants to the market that intend to supply anticipated demand but which may not have established offtake agreements.

To the degree that the Li-Bridge assessment of global demand begins to enter T3 supply in 2029, the same observation cited above applies, regarding the shorter notice typically provided by announcements that react to demonstration of demand. That is, in the period between now and 2029 it is likely that increases in demand will motivate increases in supply that would not be announced until much closer to 2029. The ability of production capacity for many cell materials and components to adjust relatively quickly to changes in anticipated demand suggests that these materials do not represent a constraint to PEV production in the global context any more than in the domestic context. Also, new cell component or active material plants tend to have shorter construction and permitting time than cell manufacturing plants.[1132]

As another factor promoting domestic capacity, the IRA offers sizeable incentives and other support for further development of domestic and North American manufacture of electrified vehicles and components. These incentives represent a significant dollar investment. At the time of passage of the IRA, the Joint Committee on Taxation estimated that $30.6 billion would be realized by manufacturers through the 45X Advanced Manufacturing Production Credit alone.[1133] Since the proposal, the Committee has significantly increased its estimates for IRA climate and clean energy incentives, due in part to higher expected utilization of 45X.[1134] Another $6.2 billion or more may be realized through expansion of the 48C Advanced Energy Project Credit, a 30 percent tax credit for investments in projects that reequip, expand, or establish certain energy manufacturing facilities.[1135] The IRC 30D Clean Vehicle Credit also indirectly incentivizes domestic manufacturing investments by offering a vehicle manufacturer's eligible retail customers up to $7,500 toward the purchase of PEVs that have a specified amount of critical mineral and battery component content manufactured in North America. Together, these provisions are continuing to motivate manufacturers to invest in the continued development of a North American supply chain, and already appear to have proven influential on the plans of manufacturers to procure domestic or North American mineral and component sources and to construct domestic manufacturing facilities to claim the benefits of the act.[1136] [1137]

[1131] *https://www.energy.gov/eere/vehicles/federal-consortium-advanced-batteries-fcab.*

[1132] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

[1133] Congressional Research Service, ''Tax Provisions in the Inflation Reduction Act of 2022 (H.R. 5376),'' August 10, 2022.

[1134] Obey, D., ''CBO Sees Higher IRA Costs From EV Credit Popularity, EPA Auto Rules,'' Inside EPA, February 9, 2024. Accessed on February 23, 2024 at *https://insideepa.com/daily-news/cbo-sees-higher-ira-costs-ev-credit-popularity-epa-auto-rules.*

[1135] Congressional Research Service, ''Tax Provisions in the Inflation Reduction Act of 2022 (H.R. 5376),'' August 10, 2022.

[1136] Subramanian, P., ''Why Honda's EV battery plant likely wouldn't happen without new climate credits,'' Yahoo Finance, August 29, 2022.

[1137] LG Chem, ''LG Chem to Establish Largest Cathode Plant in US for EV Batteries,'' Press Release, November 22, 2022.

In addition, funds continue to be awarded under the BIL, which provides for $7.9 billion to support development of the domestic supply chain for battery manufacturing, recycling, and critical minerals.[1138] Through this funding DOE is working to facilitate and support further development of the midstream and downstream supply chain, by identifying priorities and rapidly funding those areas through numerous programs and funding opportunities.[1139] [1140] [1141] Programs that include midstream and downstream in their scope include those administered by the Office of Manufacturing and Energy Supply Chains (MESC), which has allocated about $1.9 billion in funding out of an available $4.1 billion that is available for active material production, separator production, precursor materials production, and battery cell production.[1142] Across all stages of the supply chain, these programs are designed to have a large impact. According to a final report from the Department of Energy's Li-Bridge alliance,[1143] ''the U.S. industry can double its value-added share by 2030 (capturing an additional $17 billion in direct value-add annually and 40,000 jobs in 2030 from mining to cell manufacturing), dramatically increase U.S. national and economic security, and position itself on the path to a near-circular economy by 2050.'' [1144] The $7.9 billion provided by the BIL for U.S. battery supply chain projects [1145] represents a total of about $14 billion when industry cost matching is considered.[1146] [1147] Other recently announced projects will utilize another $40 billion in private funding.[1148] According to DOE's Li-Bridge alliance, the total of these commitments already represents more than half of the capital investment that Li-Bridge considers necessary for supply chain investment to 2030.[1149]

Further, the DOE Loan Programs Office continues to disburse substantial amounts of assistance through the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program and Title 17 Innovative Energy Loan Guarantee Program, which include midstream activities such as manufacturing of active materials, battery components and cells among their focus.[1150] These programs together comprise $110 billion of total available funds for loans and loan guarantees [1151] much of which is available to fund such projects.

Analyst sentiment largely agrees that the U.S. is taking the appropriate steps to secure its supply chain. According to BNEF, Canada and the United States rank first and third, respectively, in their Global Lithium-Ion Battery Supply Chain Ranking. This annual ranking rates 30 countries on their relative ''potential to build a secure, reliable, and sustainable lithium-ion battery supply chain''. BNEF credits ''clear policy commitment and implementation'' for North America's high position, including the effect of the IRA.[1152]

In consideration of this updated information on battery cell and cell component manufacturing, EPA has continued to identify the steps necessary to secure the supply of battery cells and cell materials and components needed to comply with the standards. EPA also notes rapidly growing evidence that the federal investments and initiatives under the IRA and BIL are continuing to build the domestic supply chain as intended, and indicate that the federal government is taking appropriate actions to support its development. It continues to be our assessment that the development of this supply chain is proceeding in a manner capable of supporting the future levels of PEV technology indicated in the scenarios of the compliance analysis, and is therefore unlikely to constrain manufacturers' ability to comply.

ii. Critical Minerals

Critical minerals include a large diversity of minerals and metals that are deemed to be essential to economic or national security of the U.S. and whose supply chain is potentially vulnerable to disruption.[1153] [1154] The Energy Act of 2020 defines a ''critical mineral'' as a non-fuel mineral or mineral material essential to the economic or national security of the United States and which has a supply chain vulnerable to disruption. The U.S. Geological Survey (USGS) lists 50 minerals as ''critical to the U.S. economy and national security.'' [1155] [1156] Risks to mineral availability may stem from geological scarcity, geopolitics, trade policy, or similar factors.[1157] Critical minerals range from relatively plentiful materials that are constrained primarily by production and refining capacity, such

[1138] Congressional Research Service, ''Energy and Minerals Provisions in the Infrastructure Investment and Jobs Act (Pub. L. 117–58)'', February 16, 2022. *https://crsreports.congress.gov/product/pdf/R/R47034*.

[1139] Department of Energy, Li-Bridge, ''Building a Robust and Resilient U.S. Lithium Battery Supply Chain,'' February 2023.

[1140] The White House, ''Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth,'' 100-Day Reviews under Executive Order 14017, June 2021.

[1141] Federal Consortium for Advanced Batteries, ''National Blueprint for Lithium Batteries 2021–2030,'' June 2021. Available at *https://www.energy.gov/sites/default/files/2021-06/FCAB%20National%20Blueprint%20Lithium%20Batteries%200621_0.pdf*.

[1142] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

[1143] *https://www.anl.gov/li-bridge*.

[1144] Department of Energy, Li-Bridge, ''Building a Robust and Resilient U.S. Lithium Battery Supply Chain,'' February 2023.

[1145] Congressional Research Service, ''Energy and Minerals Provisions in the Infrastructure Investment and Jobs Act (Pub. L. 117–58)'', February 16, 2022. *https://crsreports.congress.gov/product/pdf/R/R47034*.

[1146] Department of Energy, Li-Bridge, ''Building a Robust and Resilient U.S. Lithium Battery Supply Chain,'' February 2023 (p. 9).

[1147] Department of Energy, EERE Funding Opportunity Exchange, EERE Funding Opportunity Announcements. Accessed March 4, 2023 at *https://eere-exchange.energy.gov/Default.aspx#FoaId0596def9-c1cc-478d-aa4f-14b472864eba*.

[1148] Federal Reserve Bank of Dallas, ''Automakers' bold plans for electric vehicles spur U.S. battery boom,'' October 11, 2022. Accessed on March 4, 2023 at *https://www.dallasfed.org/research/economics/2022/1011*.

[1149] Department of Energy, Li-Bridge, ''Building a Robust and Resilient U.S. Lithium Battery Supply Chain,'' February 2023 (p. 9).

[1150] Department of Energy Loan Programs Office, ''Critical Materials Loans & Loan Guarantees,'' *https://www.energy.gov/sites/default/files/2021-06/DOE-LPO_Program_Handout_Critical_Materials_June2021_0.pdf*.

[1151] See Table 1 in Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024.

[1152] Bloomberg New Energy Finance (BNEF), ''China Drops to Second in BloombergNEF's Global Lithium-Ion Battery Supply Chain Ranking as Canada Comes Out on Top,'' February 5, 2024. Accessed on February 24, 2024 at *https://about.bnef.com/blog/china-drops-to-second-in-bloombergnefs-global-lithium-ion-battery-supply-chain-ranking-as-canada-comes-out-on-top*.

[1153] According to USGS, the Energy Act of 2020 defines a ''critical mineral'' as ''a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption.''

[1154] U.S. Geological Survey, ''U.S. Geological Survey Releases 2022 List of Critical Minerals,'' February 22, 2022. Available at: *https://www.usgs.gov/news/national-news-release/us-geological-survey-releases-2022-list-critical-minerals*.

[1155] Id.

[1156] The full list includes: Aluminum, antimony, arsenic, barite, beryllium, bismuth, cerium, cesium, chromium, cobalt, dysprosium, erbium, europium, fluorspar, gadolinium, gallium, germanium, graphite, hafnium, holmium, indium, iridium, lanthanum, lithium, lutetium, magnesium, manganese, neodymium, nickel, niobium, palladium, platinum, praseodymium, rhodium, rubidium, ruthenium, samarium, scandium, tantalum, tellurium, terbium, thulium, tin, titanium, tungsten, vanadium, ytterbium, yttrium, zinc, and zirconium.

[1157] International Energy Agency, ''The Role of Critical Minerals in Clean Energy Transitions,'' World Energy Outlook Special Report, Revised version. March 2022.

as aluminum, to those that are both relatively difficult to source and costly to process, such as the rare-earth metals that are used in magnets for permanent-magnet synchronous motors (PMSMs) and some semiconductor products. Extraction, processing, and recycling of minerals are key parts of the supply chain that affect the availability of minerals. For the purposes of this rule, we focus on a key set of minerals (lithium, cobalt, nickel, manganese, and graphite) commonly used in BEVs; their general availability impacts the production of battery cells and battery components.

As discussed in the opening paragraphs of section IV.C.7 of the preamble, certain critical minerals have long been essential to manufacturing both ICE vehicles and PEVs. Emission control catalysts for ICE vehicles utilize critical minerals including cerium, palladium, platinum, and rhodium, which (as described previously) were understood to be costly and potentially scarce in advance of emission control standards of the 1970s that were premised on use of those minerals for catalyst control of pollutants. These minerals are also required by PHEVs due to the presence of the ICE. Nickel-metal hydride batteries that have been used in many HEVs for over twenty years require significant amounts of nickel and rare-earth metals such as lanthanum. Critical minerals most important to lithium-ion battery production include lithium and graphite, and the cathode chemistries that are used in the majority of cells produced today also call for nickel, cobalt, and manganese. Aluminum is also used for cathode foils and in some cathode chemistries. Rare-earth metals are used in permanent-magnet electric machines, and include several elements such as dysprosium, neodymium, and samarium.

The battery cell manufacturing capacity discussed in the previous section will depend on the ability of manufacturers to secure the inputs necessary for battery components, which include battery minerals. This is one of the reasons why extraction, processing, and recycling of critical minerals such as lithium, cobalt, nickel, manganese, and graphite are gaining a large amount of attention as important parts of the supply chain. They are produced in upstream activities which include extraction and refining of raw materials and are inputs to midstream activities such as manufacturing of precursor substances and electrode active materials and production of electrolytes.

In addition to growing demand from the transportation industry, these minerals are also experiencing increasing demand across many other sectors of the global economy as the world seeks to reduce carbon emissions. As with any technology that is experiencing rapid demand growth, a robust supply chain to support increasing production of these products is continuing to develop. At the present time in the U.S., some of these minerals are not produced domestically in large quantities and are often sourced to varying degrees from global suppliers with whom manufacturers have developed supply relationships.

Here it is important to reiterate that it is erroneous to assume that the U.S. must establish a fully independent domestic supply chain in order to contemplate increased manufacture of products that use these minerals. Such a position is without any credible analogy in other products, including ICE vehicles, that are used widely in the U.S. on a daily basis. As discussed previously, it has long been the norm that global supply chains are involved in providing many products that are commonly available in the U.S. market. In the context of critical minerals needed for PEV production, the relevant concern is to develop and secure a supply chain that includes not only domestic production where possible and appropriate but also includes sourcing from FTA countries as well as our many economic allies with whom the U.S. has good trade relations.

In the proposal, we examined the outlook for U.S. and global critical mineral supply and demand in light of our projections of U.S. PEV demand under the proposed standards. We collected and reviewed a number of independent studies and forecasts, including numerous studies by analyst firms and various stakeholders. We also considered a compilation of lithium mining projects compiled by the Department of Energy and Argonne National Laboratory. Through this work it was our assessment that, among the critical minerals that were most likely to pose a potential constraint on PEV production, lithium availability was the most important consideration. We proceeded to examine detailed forecasts of supply and demand for lithium chemical products used in battery cell production, and reports of rapidly growing activity in securing sourcing agreements and lithium resource exploration in the U.S. Our review of this information indicated that the industry was responding rapidly to meet current and anticipated demand, and that this activity was likely to continue. Our analysis examined many uncertainties of the sort that are common to any forward-looking analysis but did not identify any hard constraint that indicated that global and domestic lithium supply would not be sufficient to support battery demand under the proposed standards. Our assessment found that availability of lithium chemical product was not likely to pose a limitation on the ability of auto manufacturers to meet the standards.

We received a variety of comments on our analysis of critical minerals, some of which disagreed with our findings and others which supported them. Supportive comments often included detailed analysis and discussion that built upon EPA's analysis by providing additional examples of domestic and global activity in critical mineral development, examples of how the BIL and IRA have been promoting this activity, and other information about the outlook for critical mineral supply and demand. Commenters who disagreed with our findings largely expressed the position that EPA did not adequately address the issue of critical minerals, particularly for minerals other than lithium such as nickel, cobalt, and graphite, that we had not adequately considered the risks associated with potential instability of the global critical minerals market, and that the pace of domestic critical mineral development and/or domestic mineral processing would be insufficient to meet demand under the proposed standards.

EPA appreciates and has carefully considered the substantive and detailed comments offered by the various commenters. Much of the information provided by commenters who disagreed with our findings expands upon the evidence that EPA already presented in the proposal concerning the risks and uncertainties associated with the development of the critical mineral supply chain. Much of the information provided by supportive commenters also expands on the evidence EPA presented in the proposal about the pace of activity and overall outlook for buildout of the critical mineral supply chain. While contributing to the record, the information provided by the commenters largely parallels the considerations and trends that were already identified and considered by EPA. In particular, the comments relating to risk and uncertainty largely present information of a similar nature to that which EPA identified and considered in the proposal, and do not identify new, specific constraints that would change the conclusions we reached in the proposal. Taken together, the totality of information in the public record continues to indicate that development of the critical mineral supply chain is proceeding both domestically and globally in the expected manner in response to anticipated demand. In light of this information provided in the public comments and additional information that EPA has collected through continued research, and as further explained below, it continues to be our assessment that future availability of critical minerals is not likely to pose a constraint on automakers' ability to meet the standards.

The additional information EPA has collected, and other aspects of the updated analysis, largely respond to the concerns raised by the commenters. In particular, the Department of Energy through ANL has conducted an updated assessment [1158] of mineral supply development that further reinforces the growth in supply available from North America, FTA countries, MSP partners, and other economic allies that we noted in the proposal. The assessment considers geological resources and current international development activities that contribute to the understanding of mineral supply security as the jurisdictions around the world seek to reduce emissions. The ANL study [1159] focuses on five materials identified in the 2023 DOE Critical Materials Assessment,[1160] including lithium, nickel, cobalt, graphite, and manganese.

The study collects and examines potential domestic sources as well as sources outside the U.S., including Free Trade Agreement (FTA) partners, members of the Mineral Security Partnership (MSP), economic allies without FTAs (referred to as ''Non-FTA countries'' in the ANL study), and FEOC sources associated with covered nations. The study also highlights current activities that are intended to expand a secure supply chain for critical minerals both domestically and among U.S. allies and partner nations, and considers the potential to meet U.S. demand with domestic and other secure sources. EPA considers the assessment by DOE/ANL to be thorough and up to date.

In response to comments that we should consider availability of critical minerals other than lithium, we have included in this section additional analysis and discussion of graphite, cobalt, nickel, and lithium based on ANL's assessment.

As is already true for many of the materials used to produce ICE vehicles, the ANL analysis confirms that imports will be needed to supplement domestic supplies for many of the key minerals used in PEV production. However, there is ample evidence to indicate that the U.S. is fully capable of securing these minerals in the time frame needed for this rulemaking without harm to economic or national security. The ANL analysis shows that many of the minerals needed to support worldwide decarbonization goals are abundant outside of China and other covered nations, and those needed by the U.S. to meet the final standards can ultimately be supplied in the time frame needed for this rulemaking by relying primarily if not exclusively on a combination of domestic sources and sources accessed through FTA partners, MSP partners, and other economic allies. Hence the ensuing discussion, and in general the issue of future adequacy of the supply chain for critical minerals and PEV production to support the standards, is focused on the outlook for securing a mineral supply chain that includes domestic supply as well as supply accessible through our global trading partners.

In contrast to the concerns stated by some commenters, the evidence does not indicate that the status of mineral availability to comply with the standards is dire, nor that the U.S. must rely heavily in the long-term on covered nations or FEOCs. Rather, the U.S. and U.S. firms can secure sufficient minerals by executing strategies that have already been identified and are underway. While completing the development of a secure supply chain will require a deliberate effort between the U.S., allies, and partner countries, the work is already underway and is being further supported by strong government initiatives. The U.S. automotive industry is already engaging actively and successfully in efforts to secure these sources for their own production needs (motivated in part by IRA incentives that promote U.S. battery and battery component production, North American final assembly, and U.S./FTA mineral sourcing), and the U.S. government is also engaged in numerous activities that are further enabling U.S. industry to expand a secure supply chain for critical minerals among U.S. allies and partner nations. These include substantial efforts to scale mining supply domestically and in partner countries, strong financial support and technical guidance supporting investment in U.S. production facilities and technology research and development, building international partnerships that directly act to establish and secure mineral trade with friendly nations, and scaling battery recycling.

To illustrate the diversity of America's trade allies, and the many ways in which the U.S. already has or is actively developing relationships relevant to securing battery minerals and materials through these partners, Argonne National Laboratory has compiled an accounting of international initiatives (Figure 38). This figure identifies 85 countries that together comprise our FTA partners, MSP partners, Trade and Investment Framework Agreement partners, and parties to other bilateral investment treaties, multilateral initiatives or defense agreements.[1161]

[1158] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1159] Id.

[1160] Department of Energy, ''Critical Materials Assessment,'' July 2023. At *https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf.*

[1161] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

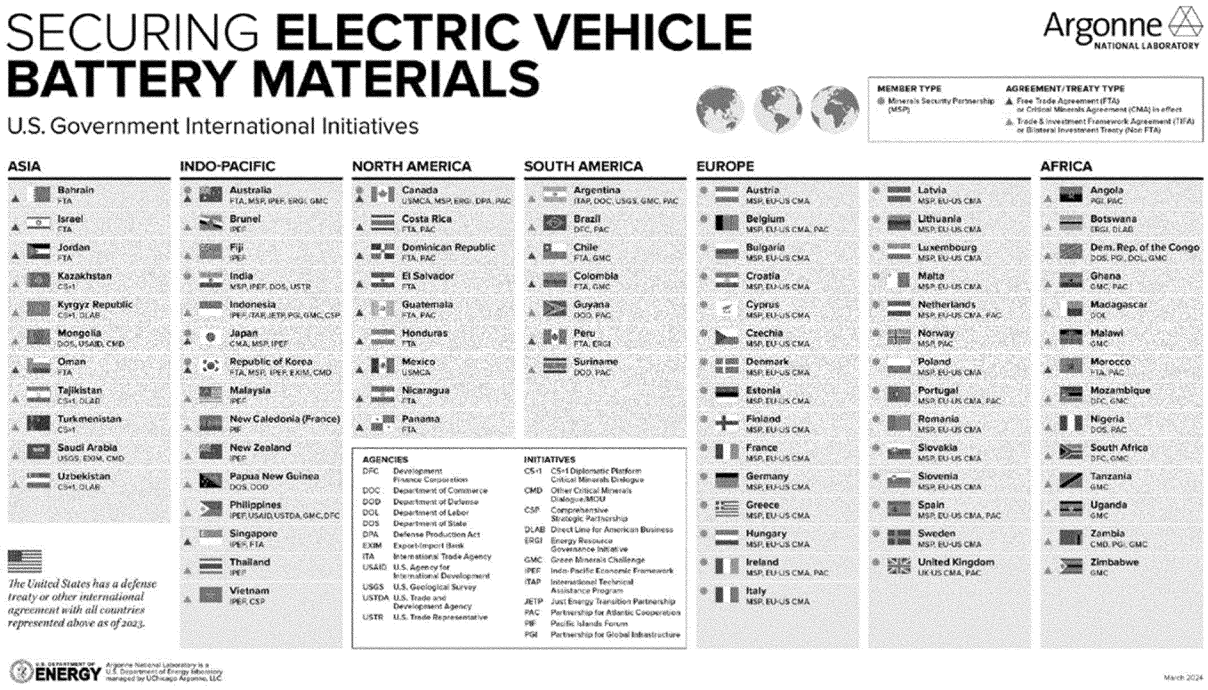

Figure 38: U.S. Government International Initiatives To Secure Battery Minerals and Materials [1162]

ANL concludes that a diversified sourcing strategy that includes these international sources coupled with strategic investments at home and abroad represent a viable pathway to sustainable and secure critical mineral supplies for the U.S. This strategy includes the formation of ''economic partnerships and trade with non-FTA countries that have significant capacity; strengthening processing, refining, and recycling in the U.S. and allied nations; and fostering collaborative efforts with FTA and MSP partners to ensure the success of mining projects.'' [1163] ANL also identifies a portfolio of actions supporting this comprehensive approach that are already underway to build capacity, secure financing, improve governance, and pursue innovative solutions both at home and abroad.

Internationally, the U.S. industry and federal government are actively working to facilitate the securing of minerals. These efforts include diversification of sourcing strategies by strengthening currently existing trade agreements and building new economic, technology, and regional security alliances. IRA incentives are also key to promoting onshoring and friendshoring of production. Manufacturers within the U.S. and globally are already beginning to alter their trading patterns in response, with U.S. manufacturers beginning to substitute supplies formerly obtained from FEOC sources with those from domestic sources or from FTA countries and other economic allies. Moves such as these are likely to reduce the potential for volatility in international supply chains. The U.S. government is facilitating this substitution through a range of initiatives that directly and indirectly enhance the resilience of the domestic battery components industry while also supporting that of its partners and allies.

We now examine the outlook for U.S. battery cell and electrode active material manufacturers to access sufficient critical minerals from domestic sources and global trade partners and allies.

As seen in Figure 39, ANL assessed potential upstream mined mineral supply based on the location of mine production.[1164] ANL categorized potential U.S. trading partners into four primary groups: countries with which the U.S. has a Free Trade Agreement (FTA), countries that are members of the Minerals Security Partnership (MSP), countries that do not have an FTA agreement nor are partners of the MSP (Non FTA (Non MSP)), and sources that would be considered a Foreign Entity of Concern (FEOC) as defined by the U.S. Department of Energy.[1165] [1166]

The white horizontal line and the ''+'' represent low and high domestic demand scenarios, respectively. While ANL could not specifically assess domestic demand under the final standards (which were not yet public at the time of the study), ANL's description of BEV penetrations in each scenario indicates that the final standards would align closely to the ''ANL-Low'' scenario,[1167] indicated by the white horizontal line.

[1162] Id.

[1163] Id.

[1164] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1165] Foreign entities of concern include entities (individuals and businesses) ''owned by, controlled by, or subject to jurisdiction or direction of'' a ''covered nation'' (defined in 10 U.S. Code 2533(c)(d)(2) as the Democratic People's Republic of North Korea, the People's Republic of China, the Russian Federation, and the Islamic Republic of Iran).

[1166] Department of Energy, ''Department of Energy Releases Proposed Interpretive Guidance on Foreign Entity of Concern for Public Comment,'' December 1, 2023. *https://www.energy.gov/articles/department-energy-releases-proposed-interpretive-guidance-foreign-entity-concern-public.*

[1167] ''In ANL-Low, the BEV sales share of LDV reaches 50% in 2030 and 69% in 2035.'' ANL includes a figure titled ''EV sales for LDV and MHDV under Low and High scenarios'' in which the 2032 BEV penetration under the ANL-Low scenario is about 59 percent. See: Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

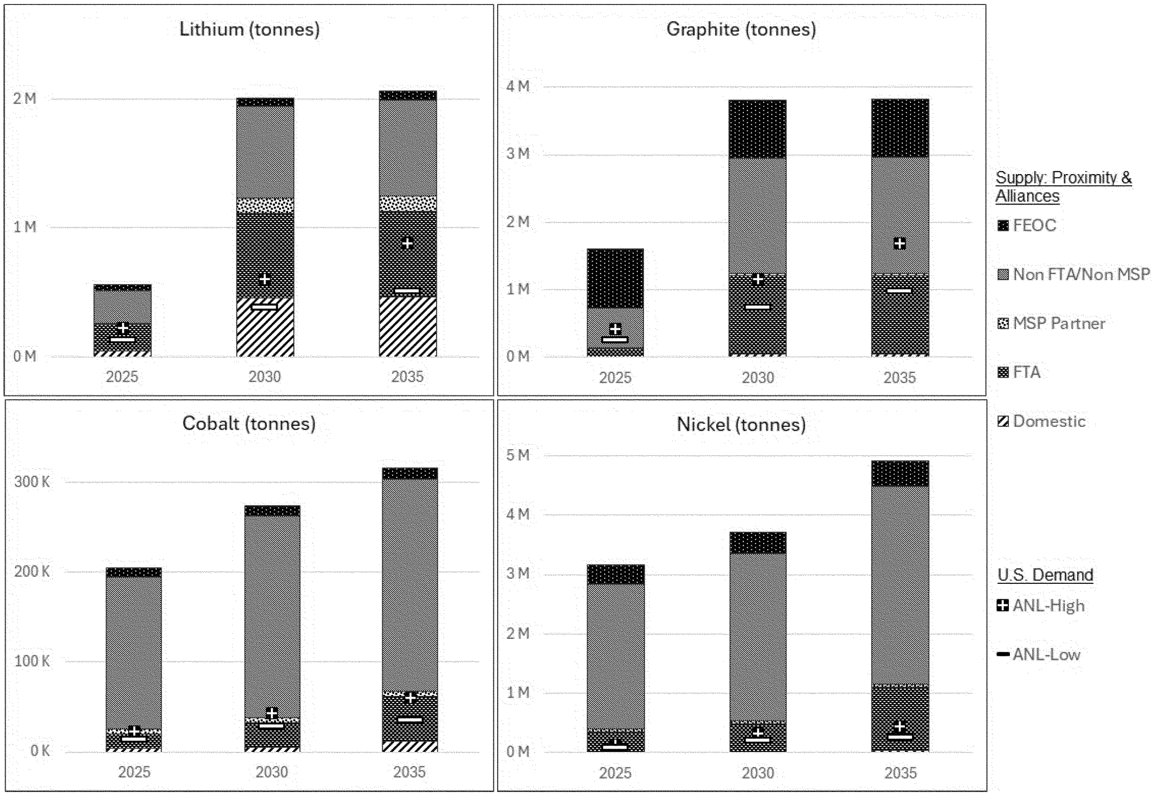

Figure 39: Potential Upstream Mined Critical Minerals Supply Grouped by Location of Mine Production

These results indicate that from 2025 to 2035, the currently identified capacity for lithium and nickel in the U.S. and FTA and MSP countries is significantly greater than U.S. demand under both the low and high domestic demand scenarios, and greater for cobalt under at least the low scenario. In particular, the U.S. is poised to become a key global producer of lithium, and supplemented by supply from FTA countries, the U.S. is positioned well for lithium through 2035. Of course, U.S. demand will be in competition with the demand for minerals created by other countries' decarbonization goals, particularly those outside of China. As a practical matter, this means that some portion of U.S. demand for these minerals might be secured to some degree from sources in partner countries that are not currently free trade partners or MSP members (but also are not covered nations or FEOCs). As previously shown in Figure 38, many of these non-FTA, non-MSP countries are economic allies that share other cooperative relationships or partnerships with the U.S. FTA, MSP, and the latter group of countries possess significant reserves. For example, an accounting of known mineral reserves in democratic countries across the world indicates that they surpass projected global needs through 2030 for the five minerals assessed by ANL, under a demand scenario that limits global temperature rise to 1.5 °C.[1168] As opposed to resources, which include possibly unrecoverable materials, reserves include ''measured and indicated deposits that have been deemed economically viable.'' [1169] While this statistic does not demonstrate that these reserves will be extracted in any specific time frame, it demonstrates their presence and potential availability. As demand increases, particularly for secure supplies, further exploration and development of existing resources in these countries is likely to further increase these reserves. In addition, as discussed in more detail later in this section, EPA has examined pricing forecasts for critical minerals during the time frame of the rule, not only to inform its battery cost projections but also as a general indicator of industry sentiment regarding future availability. The evidence does not show expectation of large steep increases in future pricing, suggesting that industry at large has not identified hard constraints on the sufficiency of global supply to meet demand. Rather, the level of constructive activity in the auto industry and among its suppliers to secure supplies for these minerals suggests that the industry sees the identification of a gap between present supply and future demand not as a cause for panic but as a business opportunity.

Figure 39 suggests that, among the minerals profiled, graphite is most exposed to potential need for supply from non-FTA, non-MSP countries. However, alternatives to imported graphite exist and are poised to become increasingly important during the time frame of the rule. ANL notes that synthetic graphite is already being produced and that scaling domestic synthetic graphite production holds significant promise for closing the gap. Unlike natural graphite, synthetic graphite does not depend on the existence of natural mineral deposits nor does it require the long permitting and approval time associated with mine development. Synthetic graphite can be manufactured from organic materials

[1168] Allan, B. et al., ''Friendshoring Critical Minerals: What Could the U.S. and Its Partners Produce?,'' Carnegie Endowment for International Peace, May 3, 2023. At *https://carnegieendowment.org/2023/05/03/friendshoring-critical-minerals-what-could-u.s.-and-its-partners-produce-pub-89659.*

[1169] Similarly, the USGS defines reserves as ''that part of the reserve base which could be economically extracted or produced at the time of determination. The term reserves need not signify that extraction facilities are in place and operative.'' U.S. Bureau of Mines and the U.S. Geological Survey, ''Principles of a Resource/Reserve Classification For Minerals,'' Geological Survey Circular 831, 1980.

such as lignin [1170] as well as coal, coal waste, and plastic waste [1171] and can substitute for natural graphite as a lithium-ion anode active material, as already done by some manufacturers.[1172] ANL indicates that synthetic graphite can help meet future demands for this mineral over time. To this end, the Department of Energy has awarded a $100 million grant to Novonix to expand domestic production at its facility in Chattanooga, Tennessee.[1173] Silicon is also increasingly used in place of a portion of anode graphite content, and on a mass basis can store much more lithium than graphite. The IEA indicates that in 2023, about 30 percent of anodes in production already contained a portion of silicon.[1174] ANL has projected that anodes in common nickel-manganese chemistries will contain up to 15 weight percent silicon in the anode by 2030,[1175] and some expect the global market for silicon anode material to expand by a factor of ten by 2035.[1176] Both of these substitutes for imported graphite are growing and will play a rapidly growing role during the time frame of the rule. According to Wood Mackenzie, ''synthetic graphite will remain dominant in this space over the next decade, although the shift to silicon-containing anodes is accelerating.'' [1177]

In addition to these trends, supply sources of natural graphite are expected to become more diverse over time with new planned capacity in FTA countries (Canada and Australia) and in other economic allies (Tanzania and Mozambique), and others supported by the MSP.

The DOE grant to Novonix is just one example of how the DOE's Office of Manufacturing and Energy Supply Chains (MESC) program, enabled by the BIL, is targeting key elements of the U.S. battery supply chain for accelerated development. As previously described in section IV.C.7.i, the BIL provides for $7.9 billion to support development of the domestic supply chain for battery manufacturing, recycling, and critical minerals.[1178] For example, with respect to critical minerals, the BIL supports the development and implementation of a $675 million Critical Materials Research, Development, Demonstration, and Commercialization Program administered by the Department of Energy (DOE),[1179] and has created numerous other programs in related areas, such as critical minerals data collection by the U.S. Geological Survey (USGS).[1180] Provisions extend across several areas including critical minerals mining and recycling research, USGS energy and minerals research, rare earth elements extraction and separation research and demonstration, and expansion of DOE loan programs in critical minerals and zero-carbon technologies.[1181] [1182] Further, the DOE Loan Programs Office continues to disburse substantial amounts of assistance through its loans programs that include extraction, processing and recycling of lithium and other critical minerals.[1183] Through the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program and Title 17 Innovative Energy Loan Guarantee Program over $20 billion in loans and loan guarantees is available to finance critical materials projects. Some examples of recent projects, amounting to $3.4 billion in loan support, are outlined in RIA Chapter 3.1.4.

EPA notes that the categorization of mineral origins in Figure 39 refers to mine location and not where the extracted material is processed into inputs to cell manufacturing such as precursors or electrode powders. As noted in the study, a large portion of processing capacity for mined battery minerals is located in China. However, unlike mining of mineral resources, refining and processing can take place in any country where capacity is built. Just as with other elements of the supply chain, mineral processing is also receiving attention from the domestic battery industry and the federal government. For example, mineral processing facilities are eligible for the Qualifying Advanced Energy Project Credit (48C), and are among the projects in a first round of $4 billion in tax credits that have been announced.[1184] Critical materials processing is also included among projects eligible for the DOE ATVM loan program,[1185] and the program has already issued conditional commitments to two projects for lithium carbonate and natural graphite active material production totaling $802 million.[1186] [1187]

In addition to EPA's assessment of the supply chain for critical minerals, several specific aspects of our updated compliance analysis act to address commenters' concerns about supply chain risk and uncertainty. Our updated central case projects a substantially lower demand for battery production than in the proposal, which would reduce resultant demand for critical minerals compared to the proposal. We

[1170] Zhang, J. et al., ''Graphite Flows in the U.S.: Insights into a Key Ingredient of Energy Transition,'' Environ. Sci. Technol. 2023, 57, 3402–3414.

[1171] National Energy Technology Laboratory, ''NETL Driving Research To Produce Graphite for Electric Vehicles, Other Green Applications,'' September 19, 2023.

[1172] Zhang, J. et al., ''Graphite Flows in the U.S.: Insights into a Key Ingredient of Energy Transition,'' Environ. Sci. Technol. 2023, 57, 3402–3414.

[1173] NOVONIX, ''NOVONIX Finalizes US$100 Million Grant Award from U.S. Department of Energy,'' Press Release, November 1, 2023. Accessed on February 24, 2024 at *https://ir.novonixgroup.com/news-releases/news-release-details/novonix-finalizes-us100-million-grant-award-us-department-energy*.

[1174] International Energy Agency, ''Global EV Outlook 2023,'' p. 58, 2023. Accessed on November 30, 2023 at *https://www.iea.org/reports/global-ev-outlook-2023*.

[1175] Argonne National Laboratory, ''Cost Analysis and Projections for U.S.-Manufactured Automotive Lithium-ion Batteries,'' ANL/CSE–24/1, January 2024.

[1176] Sang, S.H., ''EV battery makers' silicon anode demand set for take-off,'' Korea Economic Daily, February 23, 2024. Accessed on March 12, 2024 at *https://www.kedglobal.com/batteries/newsView/ked202402230020*.

[1177] Wood Mackenzie, ''Global graphite investment horizon outlook,'' slide 4, December 2023 (filename: global-graphite-investment-horizon-outlook-q4-2023). Available to subscribers.

[1178] Congressional Research Service, ''Energy and Minerals Provisions in the Infrastructure Investment and Jobs Act (Pub. L. 117–58)'', February 16, 2022. *https://crsreports.congress.gov/product/pdf/R/R47034*.

[1179] Department of Energy, ''Biden-Harris Administration Launches $675 Million Bipartisan Infrastructure Law Program to Expand Domestic Critical Materials Supply Chains,'' August 9, 2022. Available at *https://www.energy.gov/articles/biden-harris-administration-launches-675-million-bipartisan-infrastructure-law-program*.

[1180] U.S. Geological Survey, ''Bipartisan Infrastructure Law supports critical-minerals research in central Great Plains,'' October 26, 2022. Available at *https://www.usgs.gov/news/state-news-release/bipartisan-infrastructure-law-supports-critical-minerals-research-central*.

[1181] Congressional Research Service, ''Energy and Minerals Provisions in the Infrastructure Investment and Jobs Act (Pub. L. 117–58)'', February 16, 2022. *https://crsreports.congress.gov/product/pdf/R/R47034*.

[1182] International Energy Agency, ''Infrastructure and Jobs act: Critical Minerals,'' October 26, 2022. *https://www.iea.org/policies/14995-infrastructure-and-jobs-act-critical-minerals*.

[1183] Department of Energy Loan Programs Office, ''Critical Materials Loans & Loan Guarantees,'' *https://www.energy.gov/sites/default/files/2021-06/DOE-LPO_Program_Handout_Critical_Materials_June2021_0.pdf*.

[1184] Department of Energy, ''Qualifying Advanced Energy Project Credit (48C) Program—48C Updates,'' web page. Accessed on March 1, 2024 at *https://www.energy.gov/infrastructure/qualifying-advanced-energy-project-credit-48c-program*.

[1185] Id.

[1186] Department of Energy, ''LPO Announces Conditional Commitment to Ioneer Rhyolite Ridge to Advance Domestic Production of Lithium and Boron, Boost U.S. Battery Supply Chain,'' website announcement, January 13, 2023. *https://www.energy.gov/lpo/articles/lpo-announces-conditional-commitment-ioneer-rhyolite-ridge-advance-domestic-production*.

[1187] Department of Energy, ''DOE Announces First Advanced Technology Vehicles Manufacturing Loan in More than a Decade,'' website announcement, July 27, 2022. *https://www.energy.gov/articles/doe-announces-first-advanced-technology-vehicles-manufacturing-loan-more-decade*.

also are using substantially higher battery costs than in the proposal, which along with our upper battery cost sensitivity (which increases battery cost by an additional 25 percent), additionally recognizes and addresses commenters' concerns regarding uncertainty of future mineral prices. We also show multiple pathways that illustrate it is possible to comply with the standards with lower levels of BEVs (and hence lower demand for battery minerals) than in the central analysis, which further supports our conclusion that the standards can be met from the perspective of critical mineral availability.

Regarding U.S. automaker access to critical minerals, EPA notes that U.S. automakers are actively addressing their need to secure a supply of critical minerals. In addition to continuing to reduce cobalt and rare earth magnet content in batteries and electric machines, manufacturers are also directly securing supplies of critical battery and rare-earth minerals necessary for increasing the scale of BEV production, often with a focus on U.S. sources.[1188] [1189] [1190] [1191] [1192] [1193] [1194] [1195] Here it is relevant to repeat that domestic sourcing of minerals primarily affects eligibility for the 30D Clean Vehicle Credit and does not otherwise prevent PEVs from contributing to the U.S. compliance fleet. EPA believes that these developments further indicate that the automotive industry has recognized the need to establish a supply chain for electrified vehicles and is taking appropriate action to address this business need.

As demand for these materials increases, we expect that mining and processing capacity across the world will continue to expand. Globally and in the U.S., interest and motivation toward developing new resources and expanding existing ones has become very high and is expected to remain so, as the demand outlook for lithium and other battery minerals continues to be robust. In the U.S. specifically, the process of establishing new mining capacity can be subject to greater uncertainty stemming from issues such as permitting; investor expectations of demand and future prices also make it difficult to predict with precision the rate at which new mines will be developed and brought online. For example, new lithium mining sources are sometimes described as taking from five to ten years or longer to develop. Comments from Toyota, for example, cite ''exploration and feasibility studies, approval and permitting processes, potential for project abandonment and delays, learning rates for new companies, and production ramp up'' as primary factors. These factors are well known in the industry and are typically considered by industry analysts when assessing production potential in future years, by assigning a percentage of potential production to each project based on their knowledge of the specific circumstances of each, including the level of development that has already taken place. Potential expansion of production at already-operating projects or resumption of halted or mothballed projects are typically weighted higher than entirely new operations. The 2024 ANL critical minerals analysis has identified numerous examples of mining development efforts in the U.S. that are currently in various stages of development, and has projected significant output in the future, particularly for lithium.[1196] Canada is also taking specific steps to shorten permitting time, and also has significant mineral reserves as do other economic allies.[1197]

Additionally, the U.S. government is taking steps to promote the production of critical minerals through both mining and recycling. This includes developing recommendations for improving the process of mining on public lands including modernization of the U.S. Mining Law of 1872,[1198] [1199] and streamlining permitting processes under the Federal Permitting Improvement Steering Council (FAST–41).[1200] The ANL mineral study also identifies a number of enabling approaches to promote critical mineral production. Additionally, the BIL and the IRA have introduced a number of incentives to scale domestic processing and recycling of critical minerals. These incentives include grants, such as the $3 billion Battery Manufacturing and Recycling Grant Program,[1201] as well as the IRC 45X and 48C tax credits. In 2022, approximately $2.8 billion of BIL funding was invested in the battery supply chain, including processing and recycling, across the country.[1202]

Complementing select mining investments through the Defense Production Act (DPA), midstream and downstream investments are expected to incentivize upstream operations. Companies are competing to secure materials to feed domestic mid-stream operations, such as processing, cathode, and anode production. As of January 2024, more than 600 facilities across the battery supply chain, including 79

[1188] Hawkins, A.J. General Motors makes moves to source rare earth metals for EV motors in North America. The Verge, 12/09/2021. Accessed on 12/10/2021 at *https://www.theverge.com/2021/12/9/22825948/gm-ev-motor-rare-earth-metal-magnet-mp-materials*.

[1189] General Motors Press Release. GM to Source U.S.-Based Lithium for Next-Generation EV Batteries Through Closed-Loop Process with Low Carbon Emissions. Accessed on 12/10/2021 at *https://media.gm.com/media/us/en/gm/home.detail.html/content/Pages/news/us/en/2021/jul/0702-ultium.html*.

[1190] Waylund, M. GM to form new joint venture to produce crucial materials for EVs. CNBC, 12–0102021. Accessed on 12/10/2021 at *https://www.cnbc.com/2021/12/01/gm-to-form-new-joint-venture-to-produce-costly-raw-materials-for-evs.html*.

[1191] Lambert, F. Tesla secures lithium supply contract from world's largest producer. Electrek, 11/01/2021. Accessed on 12/10/2021 at *https://electrek.co/2021/11/01/tesla-secures-lithium-supply-contract-ganfeng-lithium*.

[1192] Lambert, F. Tesla secures large supply of nickel from New Caledonia for battery production. Electrek, 10/13/2021. Accessed on 12/10/2021 at *https://electrek.co/2021/10/13/tesla-secures-large-amount-nickel-from-new-caledonia-battery-production*.

[1193] Lipinski, P., Steitz, C. Volkswagen secures raw materials as part of $34 billion battery push. Reuters, 12/08/2021. Accessed on 12/10/2021 at *https://www.reuters.com/markets/deals/belgiums-umicore-plans-battery-material-venture-supply-volkswagen-2021-12-08*.

[1194] Kilgore, T. Ford invests $50 million into EV battery supply chain company Redwood Materials. Marketwatch, 09/22/2021. Accessed on 12/10/2021 at *https://www.marketwatch.com/story/ford-invests-50-million-into-ev-battery-supply-chain-company-redwood-materials-2021-09-22*.

[1195] LaReau, J.L., ''GM forms 2 new partnerships that will create new factories in US,'' Detroit Free Press, December 9, 2021.

[1196] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1197] Reuters, ''Canada to accelerate critical mineral mining—energy minister,'' February 13, 2024. Accessed on March 10, 2024 at *https://www.reuters.com/markets/commodities/canada-accelerate-critical-mineral-mining-energy-minister-2024-02-13*.

[1198] U.S. Department of the Interior, ''Biden-Harris Administration Report Outlines Reforms Needed to Promote Responsible Mining on Public Lands,'' September 12, 2023. *https://www.doi.gov/pressreleases/biden-harris-administration-report-outlines-reforms-needed-promote-responsible-mining*.

[1199] Interagency Working Group on Mining Laws, Regulations, and Permitting, ''Recommendations to Improve Mining on Public Lands,'' Final Report, September 2023.

[1200] Department of Transportation, Permitting Dashboard Office, ''Permitting Council Moves to Designate the Critical Minerals Supply Chain as a FAST–41 Sector,'' Press Release, September 21, 2023.

[1201] Department of Energy, ''Battery Manufacturing and Recycling Grants,'' website. Located at *https://www.energy.gov/mesc/battery-manufacturing-and-recycling-grants*.

[1202] Department of Energy, ''Bipartisan Infrastructure Law Battery Materials Processing and Battery Manufacturing & Recycling Funding Opportunity Announcement (DE–FOA–0002678) Selections,'' Factsheets, October 19, 2022. Located at *https://www.energy.gov/sites/default/files/2022-10/DOE%20BIL%20Battery%20FOA-2678%20Selectee%20Fact%20Sheets%20-%201_2.pdf*.

facilities for electrode and cell manufacturing and 63 facilities for battery grade components manufacturing, are in various stages of development across the U.S.[1203] New battery manufacturing and supply chain investments total more than $120 billion, with over 80,000 potential new jobs, and DOE estimates that announced battery cell factories could supply batteries for more than 10 million new EVs every year.[1204] Following enactment of the IRA, numerous investments in battery minerals have been announced across the country. Notable examples include the Kings Mountain lithium project by Albemarle in North Carolina, and the Smackover lithium project by ExxonMobil in Arkansas. In addition, the Export-Import Bank of the U.S. (EXIM) is supporting critical minerals projects, including in mining and processing, in the U.S. and abroad through an array of financing products including direct loans, loan guarantees, and export credit insurance.[1205]

The federal government is also taking many other steps to assist with domestic critical mineral development. For example, the U.S. Geological Survey (USGS) is leading numerous projects under the Earth Mapping Resources Initiative (Earth MRI) to improve mapping and exploration of domestic resources, including already-announced or in-progress projects in Alabama, Florida, New York, Montana, Kentucky, Tennessee, Georgia, and across the U.S. including projects focused on Arizona and Nevada.[1206] [1207] The FY24 National Defense Authorization Act (NDAA) created the Intergovernmental Critical Minerals Task Force to facilitate coordination for data sharing, capacity building, workforce development, policy review, environmental responsibility, onshoring opportunities, and identifying alternatives. The FY24 NDAA also directs the Department of Defense to develop a University Affiliated Research Center for Critical Minerals.[1208] USGS, DOD, and DOE are also collaborating to leverage AI and machine learning for assessment of domestic critical mineral resources.[1209] Many more examples of similar efforts have been compiled by ANL in its 2024 study of critical minerals.[1210]

With regard to lithium, rapid growth in demand has driven new development of global resources and robust growth in supply, which is likely a factor in recently observed reductions in lithium price.[1211] The IEA states that lithium ''is attracting substantial attention from mining investors'' and ''production levels are also increasing at a significant pace, with an annual growth rate ranging between 25 percent and 35 percent.'' [1212] Growth in supply has also occurred in other battery minerals, sometimes outpacing growth in demand. For example, BloombergNEF projects that globally, cobalt and nickel reserves ''are now enough to supply both our Economic Transition and Net Zero scenarios,'' the latter of which is an aggressive global decarbonization scenario.[1213]

In the proposal we cited expectations that the price of lithium and other critical minerals was likely to stabilize in the mid-2020s,[1214] which we noted was also supported by proprietary battery price forecasts such as those EPA examined from Wood Mackenzie.[1215] [1216] Since the proposal we have continued to see evidence supporting that assessment. Numerous reports in the press that cite a decline in many critical mineral prices including lithium throughout 2023 [1217] [1218] are also supported by the latest subscription forecasts by Wood Mackenzie for key critical minerals and precursor chemicals. These forecasts indicate that prices are expected to stabilize and remain relatively low through 2028. For example, the 2028 forecast for lithium carbonate and lithium hydroxide indicates stabilization at more than 20 percent below 2023 prices, with other minerals and precursors including flake graphite all similar to 2023 prices or slightly lower.[1219] [1220] Further out, from 2029 to 2032 prices for electrode raw materials, precursors and cathodes are projected to begin trending upward from the predicted low levels in the period prior to 2028 but not beyond levels already seen in 2022.[1221] [1222] Similarly, projections for pricing of various forms of graphite do not anticipate per annum growth rates beyond low single digits from 2023 through 2032, indicative of a stable response to increasing demand.[1223] These expectations lend further support to EPA's assessment that the combined cost of battery mineral content overall will not continually march upward from now through the time frame of the rulemaking as some commenters have suggested but will find a position within a reasonable range below the peak of prior years as the rapidly growing supply chain continues to mature and price discovery

[1203] National Renewable Energy Laboratory, ''NAATBatt Lithium-Ion Battery Supply Chain Database,'' January 2024. Accessible at *https://www.nrel.gov/transportation/li-ion-battery-supply-chain-database-online.html*.

[1204] U.S. Department of Energy, ''Building America's Clean Energy Future,'' at *https://www.whitehouse.gov/invest/*. Accessed on February 16, 2024.

[1205] Export-Import Bank of the United States, ''EXIM Support for Critical Minerals Transactions,'' website, at: *https://www.exim.gov/about/special-initiatives/ctep/critical-minerals*.

[1206] See website at *https://www.usgs.gov/special-topics/earth-mri*.

[1207] U.S. Geological Survey, ''News Releases or Technical Announcements about or related to Earth MRI,'' accessed on February 24, 2024 at *https://www.usgs.gov/special-topics/earth-mri/news*.

[1208] National Defense Authorization Act, H.R. 2670, Section 227. *https://www.congress.gov/bill/118th-congress/house-bill/2670/text*.

[1209] The White House, ''FACT SHEET: President Biden Announces New Actions to Strengthen America's Supply Chains, Lower Costs for Families, and Secure Key Sectors,'' November 27, 2023.

[1210] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1211] New York Times, ''Falling Lithium Prices Are Making Electric Cars More Affordable,'' March 20, 2023. Accessed on March 23, 2023 at *https://www.nytimes.com/2023/03/20/business/lithium-prices-falling-electric-vehicles.html*.

[1212] International Energy Agency, ''Critical Minerals Market Review 2023,'' December 2023, p. 52.

[1213] BloombergNEF, ''Electric Vehicle Outlook 2023,'' Executive Summary, p. 5.

[1214] For example, EPA cited Sun et al., ''Surging lithium price will not impede the electric vehicle boom,'' *Joule,* doi:10.1016/j.joule. 2022.06.028 (*https://dx.doi.org/10.1016/j.joule.2022.06.028*).

[1215] Wood Mackenzie, ''Battery & raw materials—Investment horizon outlook to 2032,'' September 2022 (filename: brms-q3–2022-iho.pdf). Available to subscribers.

[1216] Wood Mackenzie, ''Battery & raw materials—Investment horizon outlook to 2032,'' accompanying data set, September 2022 (filename: brms-data-q3–2022.xlsx). Available to subscribers.

[1217] The Wall Street Journal, ''Low Battery Metal Prices Set to Persist in 2024, Adding Friction to Energy Transition,'' December 28, 2023. Accessed on February 24, 2024 at *https://www.wsj.com/articles/low-battery-metal-prices-set-to-persist-in-2024-adding-friction-to-energy-transition-3773ba00*.

[1218] Benchmark Minerals, ''OEMs and battery makers on alert as lower lithium prices to push into 2024,'' October 11, 2023. Accessed on February 24, 2024 at *https://source.benchmarkminerals.com/article/oems-and-battery-makers-on-alert-as-lower-lithium-prices-to-push-into-2024-benchmark*.

[1219] Wood Mackenzie, ''Electric Vehicle & Battery Supply Chain Short-term outlook January 2024'', slide 29, February 2, 2024 (filename: evbsc-short-term-outlook-january-2024.pdf). Available to subscribers.

[1220] Wood Mackenzie, ''Global cathode and precursor short-term outlook January 2024,'' slide 5, January 2024 (filename: global-cathode-and-precursor-market-short-term-outlook-january-2024.pdf). Available to subscribers.

[1221] Wood Mackenzie, ''Global cathode & precursor markets investment horizon outlook—Q4 2023,'' slides 21 and 22, December 2023 (filename: global-cathode-and-precursor-market-investment-horizon-outlook-december-2023.pdf). Available to subscribers.

[1222] Wood Mackenzie, ''Global lithium investment horizon outlook Q4 2023,'' slides 23 and 24, December 2023. (filename: global-lithium-investment-horizon-outlook-q4–2023-final.pdf). Available to subscribers.

[1223] Wood Mackenzie, ''Global graphite investment horizon outlook,'' slides 27 and 28, December 2023 (filename: global-graphite-investment-horizon-outlook-q4–2023). Available to subscribers.

gradually occurs in the developing market for each mineral.

EPA considers this projected stability and moderate projected trends in pricing as further evidence of future mineral availability and a ''healthy'' mineral market. That is, the market has been anticipating large increases in mineral and active material demand during the time frame of the forecasts (2023–2028 and 2023–2032), and has also been aware of EPA's projected PEV penetrations through 2032 as published in the proposed rule in April 2023. These demand drivers have had significant time to be ''priced in'' by the market and nonetheless have not resulted in dramatically higher price expectations, which continue to be characterized by moderate upward trends in some minerals and little effect in others, suggesting that an irreconcilable shortfall is not anticipated. This suggests that like EPA, the industry at large has not identified hard constraints on the ability of the supply chain to react to growing demand without causing critical shortages.

Some analysts as well as public commenters have pointed out that lower mineral prices, if they remain low enough for long enough, may begin to discourage continued investments in new supply. For example, in describing the growth rate of lithium production, IEA also stated that the ''recent decline in lithium prices could pose challenges to junior miners and early-stage projects.'' Others have remained positive; for example, strong profit margins have often remained afterward,[1224] and many remain bullish in outlook.[1225] EPA agrees that low prices can have the effect of discouraging long term investment in new production. However, it is well understood that like many other industries, critical mineral mining and production are cyclical industries in which rising prices stimulate new capacity, later resulting in lower prices that cause capacity to be taken out of production, followed again by higher prices, and so on. At this early stage, the previously described activities of the federal government in providing incentives, funding, and assistance can play an important role in sustaining resource development and keeping it focused on the longer term. Furthermore, additional federal government efforts to stockpile minerals, increase price transparency, and establish multi-year procurement contracts can aid in improving certainty for critical minerals development.[1226] [1227]

Some commenters cited specific examples of mines that had received permitting and investment but which were later put on hold, or had production reduced or stopped, due to declining mineral prices. However, EPA notes that these operations can be restarted more quickly in the event of higher prices than new mining operations or new factories. Mineral analysis firms (*e.g.,* BMI) commonly categorize such projects as under ''care and maintenance,'' representing ''projects that were at some point in production, or have been commissioned, but have been idled/placed on care and maintenance,'' and ''could be brought online with less capital and time than other projects.'' [1228] For the purpose of assessing future supply potential, BMI weights such projects at 90 percent of stated capacity.[1229]

Regarding global lithium production, we have also supplemented our lithium analysis from the proposal with newly available research and information. The outlook for lithium production has evolved rapidly, with new projects regularly identified and contributing to higher projections of resource availability and production.

Benchmark Minerals Intelligence (BMI) conducted a comprehensive analysis of global and domestic lithium supply and demand in June 2023 [1230] [1231] that indicates that lithium supply is likely to keep pace with growing demand during the time frame of the rule. In Figure 40 the vertical bars (at full height) represent estimated global demand, including U.S. demand. The top segment of each bar represents BMI's estimate of added U.S. demand under the proposed rule. The lowest line represents BMI's projection of global lithium supply (including U.S.) in GWh equivalent, weighted by current development status of each project. The middle line represents global supply where the U.S. portion is unweighted (*i.e.,* all included projects reach full expected production). These two lines together represent a potential range for future global supply bounded by a standard weighted scenario (lowest line) and a maximum scenario applied to U.S. production only (middle line). In both cases, projected global lithium supply meets or surpasses projected global demand through 2029. Past 2029, global demand is either generally met or within 10 percent of projected demand through 2032. For reference, the uppermost line is a high supply scenario in which global supply is also unweighted.

[1224] New York Times, ''Falling Lithium Prices Are Making Electric Cars More Affordable,'' March 20, 2023. Accessed on March 23, 2023 at *https://www.nytimes.com/2023/03/20/business/lithium-prices-falling-electric-vehicles.html.*

[1225] S&P Global, ''Commodities 2024: US, Canada lithium prospects hope to advance despite headwinds,'' December 19, 2023. Accessed on February 24, 2024 at *https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/121923-us-canada-lithium-prospects-hope-to-advance-in-2024-despite-headwinds.*

[1226] Commodity Futures Trading Commission, ''Statement of Commissioner Christy Goldsmith Romero on U.S. Supply Chain Resilience for Critical Minerals Before the Energy and Environmental Markets Advisory Committee,'' February 13, 2024. At *https://www.cftc.gov/PressRoom/SpeechesTestimony/romerostatement021324.*

[1227] National Defense Authorization Act, H.R. 2670, Section 152. *https://www.congress.gov/bill/118th-congress/house-bill/2670/text.*

[1228] Benchmark Mineral Intelligence (BMI), ''Lithium Mining Projects—Supply Projections,'' slide 2, Presentation, June 2023. Attachment to comment titled ''Comments of Environmental and Public Health Organizations,'' docket EPA–HQ–OAR–2022–0829.

[1229] Id.

[1230] Id.

[1231] Referenced in docket EPA–HQ–OAR–2022–0829, attachment to comment titled ''Comments of Environmental and Public Health Organizations,'' comprising comments attributed to Center for Biological Diversity, Conservation Law Foundation, Environmental Law & Policy Center, Natural Resources Defense Council, Public Citizen, Sierra Club, and the Union of Concerned Scientists.

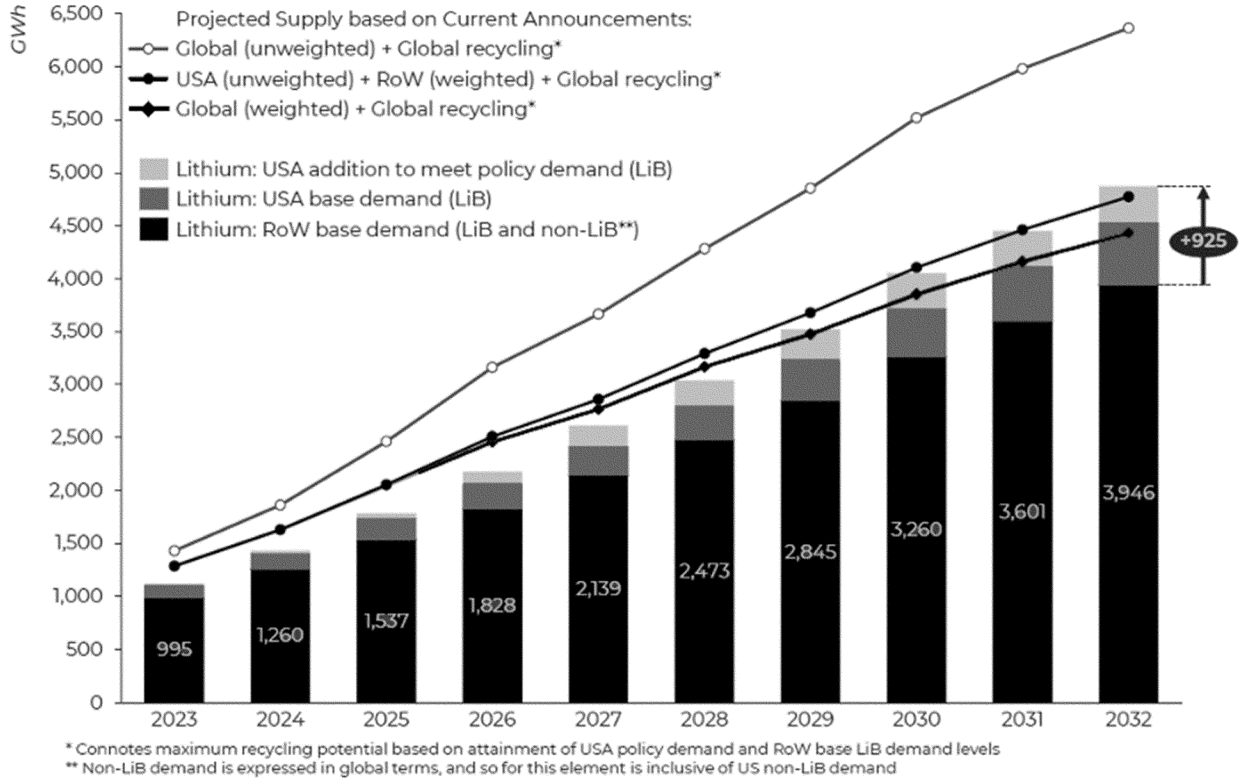

Figure 40: Global Lithium Supply and Demand Based on Current Announcements—GWh Basis

EPA notes that BMI based its estimate of U.S. demand on PEV penetrations under the proposed standards, which projected higher PEV penetrations than in the final standards. This means that the top segment of each bar would be shorter under the final standards, making the depicted results more conservative.

EPA also notes that although BMI states that it is aware of 330 lithium mining projects ranging from announced projects to fully operating projects and stages in between, the supply projections shown here are limited to only 153 projects that are already in production or have publicly identified production estimates as of December 2022 (more than one year ago). Excluded from both the weighted and unweighted supply projections are 177 projects for which no information on likely production level was available. It is standard practice to weight projects that have production estimates according to their stage of development, and BMI has followed this practice with the 153 projects. However, complete exclusion of the potential production of 177 projects (more than half of the total) suggests that the projections shown may be extremely conservative. If even a very conservative estimate of ultimate production from these 177 projects by 2030 were to be added to the chart, projected supply would increase and perhaps meet or surpass demand. At this time of rising mineral demand coupled with active private investment and U.S. government activities to promote mineral resource development, exclusion of potential production from these resources is not likely to reflect their future contribution to U.S. supply.

In Figure 41 we show projections performed by ANL in February 2024 for U.S. lithium supply and demand alone.[1232] Like the BMI projections, the ANL projections include recycling potential. As mentioned previously, the ''ANL-Low'' scenario (solid line) is most similar to the final standards, indicating that domestically mined or recycled lithium would be sufficient to supply the majority of U.S. demand from 2027 to 2029 and all demand in 2030 and after.[1233]

[1232] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1233] In comparing the charts, note that the lines in the BMI chart represent supply (in GWh equivalent), while the lines in the ANL chart represent demand (in K tonnes).

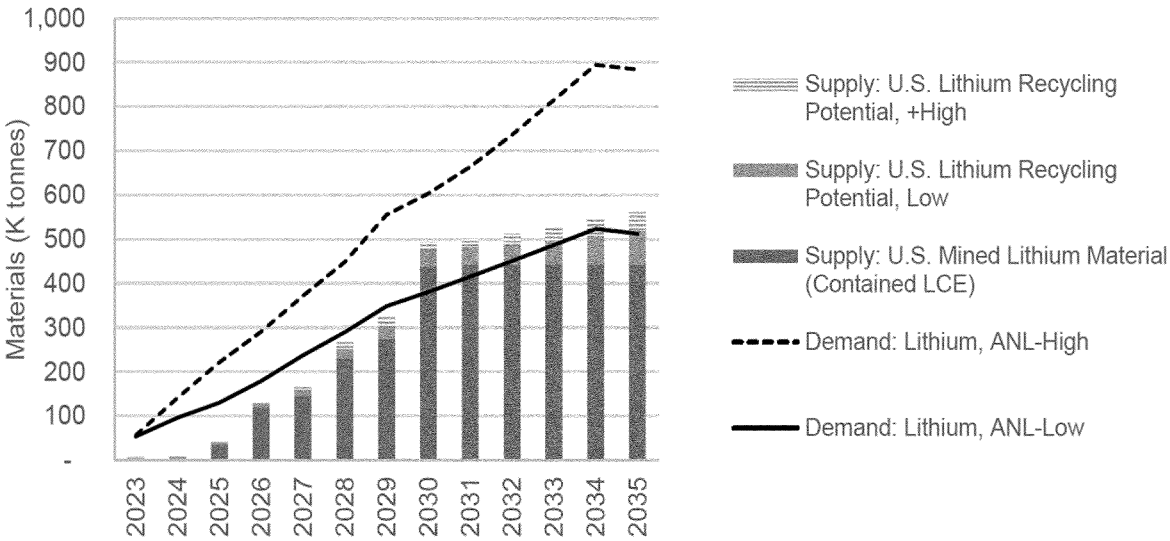

Figure 41: Potential U.S. Lithium Supply and Demand, ANL Study

In mid-2023, some analysts began speaking of the possibility of a future tightness in global lithium supply. Opinions varied, however, about its potential development and timing, with the most bearish opinions suggesting as early as 2025 with others suggesting 2028 or 2030.[1234] However, the projections from BMI suggest only a mild gap in global supply beginning to form in 2030 and only if the 177 projects that were not quantified in the BMI study do not contribute. The ANL study does predict a gap but only in purely domestic supply, and there is no expectation that the U.S. must rely only on domestic lithium.[1235] Further, the analysts quoted as predicting a future tightness stop well short of identifying an unavoidable hard constraint on lithium availability that would reasonably lead EPA to conclude that the standards cannot be met. Forecasts of potential supply and demand, including those that purport to identify a supply shortfall, typically are also accompanied by descriptions of burgeoning activity and investment oriented toward supplying demand, rather than a paucity of activity and investment that would be more indicative of a critical shortage. EPA also notes that since the time of the referenced article, demand for lithium has increasingly been depicted as having underperformed peak expectations. The final standards also project a lower PEV penetration than in the proposal, which would lead to lower demand from the standards than the proposal would have suggested.

We also continue to note developments indicating that the lithium supply continues to respond robustly to demand. Since the proposal, in which we described ongoing work by DOE to characterize lithium mining developments in the U.S.,[1236] the outlook for domestic lithium supplies has continued to expand as new resources have been identified and characterized, projects have continued through engineering economic assessments, and others begin permitting or construction. Significant lithium deposits exist in the U.S. in Nevada, California and several other states,[1237] [1238] and are currently attracting development interest from suppliers and automakers.[1239] For example, largely since the proposal or the date of analyses available at the time, several large U.S. lithium resources have been announced and considered for development, including what could be the largest known lithium resource in the world.[1240] [1241] [1242] The recent discovery of such sources and increased interest in development of known but unutilized sources suggests that resources of lithium, which previously was used only in a limited number of applications, may be underexplored and underdeveloped, and suggests that additional discoveries and developments will continue to improve our understanding of lithium availability.[1243]

DOE's lithium resource assessment work has continued via the February 2024 ANL critical minerals study.[1244] The study continues to confirm a trend of rapidly growing identification of U.S. lithium resources and extraction development. The identification of these resources, some of which were publicly announced within the last year,

[1234] CNBC, ''A worldwide lithium shortage could come as soon as 2025,'' August 29, 2023. Accessed on February 25, 2024 at *https://www.cnbc.com/2023/08/29/a-worldwide-lithium-shortage-could-come-as-soon-as-2025.html*.

[1235] In the case of the solid black line (ANL-Low scenario) which is similar to the final standards in PEV penetration.

[1236] Department of Energy, communication to EPA titled ''Lithium Supplies—additional datapoints and research,'' March 8, 2023. See memorandum to Docket ID No. EPA–HQ–OAR–2022–0829 titled ''DOE Communication to EPA Regarding Critical Mineral Projects.''

[1237] U.S. Geological Survey, ''Mineral Commodity Summaries 2022—Lithium'', January 2022. Available at *https://pubs.usgs.gov/periodicals/mcs2022/mcs2022-lithium.pdf*.

[1238] U.S. Geological Survey, ''Lithium Deposits in the United States,'' June 1, 2020. Available at *https://www.usgs.gov/data/lithium-deposits-united-states*.

[1239] Investing News, ''Which Lithium Juniors Have Supply Deals With EV Makers?,'' February 8, 2023. Accessed on March 24, 2023 at *https://investingnews.com/lithium-juniors-ev-supply-deals*.

[1240] Yirka, B., ''New evidence suggests McDermitt Caldera may be among the largest known lithium reserves in the world,'' August 31, 2023. Accessed on October 18, 2023 at *https://phys.org/news/2023-08-evidence-mcdermitt-caldera-largest-lithium.html*.

[1241] ExxonMobil, ''ExxonMobil drilling first lithium well in Arkansas, aims to be a leading supplier for electric vehicles by 2030,'' Press release, November 13, 2023. Accessed on December 16, 2023 at *https://corporate.exxonmobil.com/news/news-releases/2023/1113_exxonmobil-drilling-first-lithium-well-in-arkansas*.

[1242] Reuters, ''Exxon to start lithium production for EVs in the US by 2027,'' November 13, 2023. Accessed on December 16, 2023 at *https://www.reuters.com/markets/commodities/exxon-start-producing-lithium-by-2027-2023-1-13-*.

[1243] Washington Post, ''A Huge Lithium Discovery That Economists Were Expecting,'' September 11, 2023. Accessed on December 16, 2023 at *https://www.washingtonpost.com/business/energy/2023/09/11/discovery-of-vast-new-lithium-deposit-in-us-shows-power-of-market/baad25be-50d211ee-accf-88c266213aac_story.html*.

[1244] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

exemplifies the dynamic nature of the industry and the likely conservative aspect of existing assessments.

industry and the likely conservative aspect of existing assessments.

TABLE 74—EXAMPLES OF DOMESTIC LITHIUM PROJECTS IDENTIFIED BY ANL

Property name	Development stage	Anticipated annual capacity (tonnes LCE)	State	Projected start date [a]	Data source
Paradox	Feasibility Complete	13,074	Utah	2025	Anson Resources.
Silver Peak	Operational	5,000	Nevada	Active	Steven, 2022.
South-West Arkansas	Prefeasibility complete	26,400	Arkansas	2027	Standard Lithium.
Fort Cady	Under Construction	4,990	California	2026	5E Advanced Materials.
Clayton Valley (Zeus)	Preliminary assessment/ Prefeasibility.	31,900	Nevada	2030	Noram Lithium Corp.
Round Top	Preliminary assessment/ Prefeasibility.	9,800	Texas	2030	Texas Mineral Resource Corp.
Clayton Valley	Feasibility Started	27,400	Nevada	2028	Century Lithium.
Thacker Pass (Phase I)	Under Construction	40,000	Nevada	2026	Lithium Americas.
Thacker Pass (Phase II)	Construction Planned	80,000	Nevada	2029	Lithium Americas.
Piedmont	Feasibility Complete	26,400	North Carolina	2025	Piedmont Lithium.
Rhyolite Ridge	Construction Planned	20,600	Nevada	2026	Ioneer.
TLC Phase I	Prefeasibility	24,000	Nevada	2028	American Lithium.
ABTC	Construction Planned	26,400	Nevada	2026	American Battery Technology Co.
Kings Mountain	Under Construction	50,000	North Carolina	2026	Albemarle.

[a] The start dates for the projects are adopted as provided through press releases or company investor reports. In cases where an anticipated start date is not specified, ANL provides an estimated start date. This estimate is based on assumptions about the typical timeline for project initiation, provided all necessary elements align as anticipated. It is important to note that any failure in meeting necessary prerequisites such as technical requirements, sustaining project economics, permitting, or financing could result in project delays or, in extreme cases, even cancellation. Thus, actual start dates could be earlier or later than reported here. The data was last updated in February 2024. The list only includes projects with publicly available information and is intended solely for illustrative purposes. Some evaluated projects are excluded from this list.

As shown in Figure 42, ANL anticipates that projects such as these will increase U.S. lithium production by almost an order of magnitude from about 50,000 metric tons of lithium carbonate equivalent in 2025 to over 450,000 metric tons by 2030.[1245]

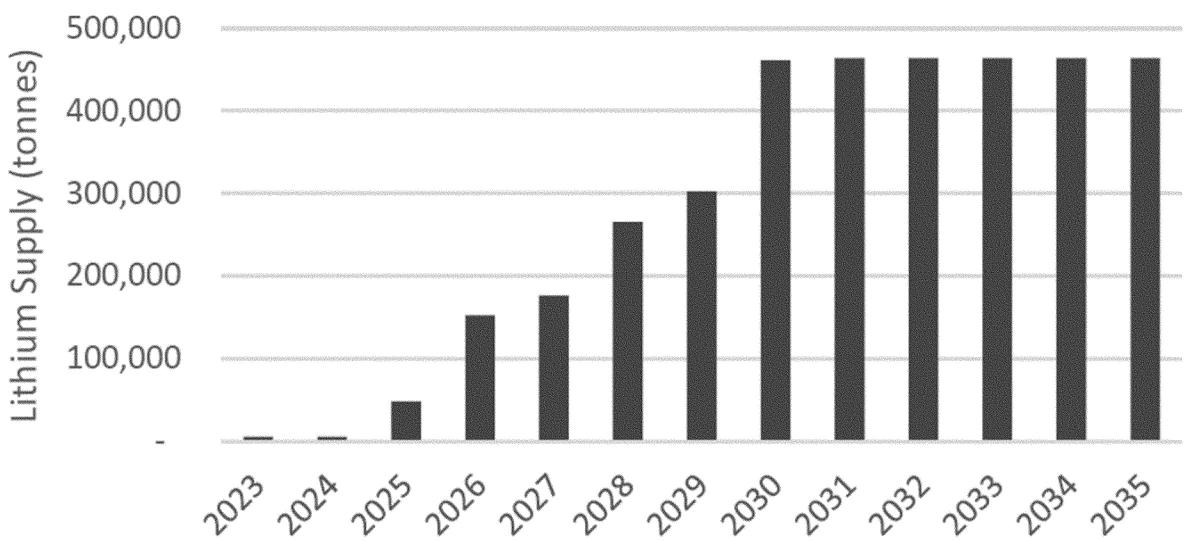

Figure 42: Prospective Domestic Lithium Supply, 2023 to 2035

We also note that the example provided by the critical mineral content requirements for $3,750 of the 30D Clean Vehicle Credit has spurred other countries to consider action that would further expand global lithium supply. For example, the European Union is seeking to promote rapid development of Europe's battery supply chains by considering targeted measures such as accelerating permitting processes and encouraging private investment. To these ends the European Parliament proposed a Critical Raw Materials Act on March 16, 2023, which includes these and other measures to encourage the development of new supplies of critical minerals not currently

[1245] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

anticipated in market projections.[1246] [1247] [1248] The Act was adopted in December 2023.[1249]

We also note, as in the proposal, that supply and demand of some critical minerals is subject to the potential substitution of some minerals for others. We noted as an example that some PEV battery applications already employ a lithium-iron phosphate (LFP) cathode which does not require cobalt, nickel, or manganese. Since the proposal, we continue to see evidence that LFP batteries are increasingly specified for PEV use. Globally, LFP already has about 30 percent market share in PEV applications.[1250] In the U.S., LFP share is currently lower, but in section IV.C.2 of this preamble we discuss evidence that indicates LFP share will grow to about 20 percent in the time frame of the rule. The ANL battery production study finds a similar LFP share among announced U.S. cell manufacturing plants.[1251] Other innovations in battery technology also have the potential to dramatically reduce demand for key battery minerals and are continuing to be developed in both the private and public sector. For example, DOE is prioritizing the reduction or elimination of the use of cobalt in batteries, and Lawrence Berkeley National Laboratory is leading a consortium focused on cheaper, more abundant alternatives to nickel and cobalt.[1252] Sodium-ion chemistry has potential to eventually substitute for lithium-ion and does not require lithium,[1253] lithium-sulfur chemistry has similar potential to replace critical minerals in the cathode.[1254] and silicon is already increasingly displacing graphite in the lithium-ion anode.[1255] Although our analysis has not assumed that these latter chemistries will be ready for vehicle use in the time frame of the rule, they demonstrate a path by which critical minerals may become far less important to PEV battery production in the future than they are today.

Similarly, we continue to assess that rare earth metals used in permanent-magnet electric machines have alternatives in the form of ferrite or other advanced magnets, or the use of induction machines or advanced externally excited motors, which do not use permanent magnets. EPA does not anticipate shortages or high prices in rare earth metals that would prevent compliance with the standards, as indicated by evidence of a gradually increasing but apparently stable price outlook for rare earths used in magnets, and a generally declining outlook for other rare earths, during the time frame of the rule.[1256] According to Wood Mackenzie, ''Demand growth and tight supply will incentivize expansions at existing operations and the development of new supply, both within and outside of China.'' [1257] EPA has reached similar conclusions regarding electrical steel, and we discuss the outlook for electrical steel in detail in section 12.2.3 of the Response to Comments document.

In RIA Chapter 3.1.5, we describe our reasoning behind the selection of lithium supply as the primary mineral-based limiting factor in constraining the potential rate of PEV penetration for modeling purposes. In addition, with respect to other cathode and anode minerals, we note that there is some flexibility in choice of these minerals, as in many cases, opportunity will exist to reduce cobalt and manganese content or to substitute with iron-phosphate chemistries that do not utilize nickel, cobalt or manganese, or use other forms of carbon in the anode, or in conjunction with silicon. However, all chemistries currently used in PEV batteries require lithium in the electrolyte and the cathode, and these have no viable substitute that is expected to be commercially available in the near term.[1258] Accordingly, in RIA Chapter 3.1.5 we focused on lithium availability as a potential limiting factor on the rate of growth of PEV production, and thus the most appropriate basis for establishing a modeling constraint on the rate of PEV penetration into the fleet over the time frame of this rule. In that analysis, we conclude that the scale and pace of demand growth and investment in lithium supply means that it is well positioned to meet anticipated demand as demand increases and supply grows.

Finally, EPA notes that manganese is listed as being ''not critical'' by a 2023 DOE Critical Minerals Assessment in both the near and medium terms, due both to a lack of supply risk and overall level of importance to clean energy technologies.[1259] The 2024 ANL critical mineral report includes analysis of manganese and notes that ''significant manganese reserves are concentrated among a few FTA and MSP trade partners, such as Australia, Canada, and India. Manganese supply from these countries is quite substantial and is likely to be sufficient to meet U.S. demand in both the near and medium term.'' [1260]

Taken together these outlooks support the perspective that critical minerals are not likely to encounter a critical shortage as supply responds to meet growing demand. It continues to be EPA's assessment that future availability of critical minerals will not pose a constraint on automakers' ability to meet the standards.

[1246] European Union, ''7th High-Level Meeting of the European Battery Alliance: main takeaways by the Chair Maroš Šefčovič and the Council Presidency,'' March 1, 2023. Accessed on March 9, 2023 at *https://single-market-economy.ec.europa.eu/system/files/2023-03/Main%20takeaways_7th%20High-Level%20Meeting%20of%20EBA.pdf≤*.

[1247] New York Times, ''U.S. Eyes Trade Deals With Allies to Ease Clash Over Electric Car Subsidies,'' February 24, 2023.

[1248] European Parliament, ''Proposal for a regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials,'' March 16, 2023. *https://single-market-economy.ec.europa.eu/publications/european-critical-raw-materials-act_en*.

[1249] European Parliament, ''Critical raw materials: MEPs adopt plans to secure the EU's supply and sovereignty,'' Press release, December 12, 2023. At *https://www.europarl.europa.eu/news/en/press-room/20231208IPR15763/critical-raw-materials-plans-to-secure-the-eu-s-supply*.

[1250] International Energy Agency, ''Global EV Outlook 2023,'' p. 57, 2023. Accessed on November 30, 2023 at *https://www.iea.org/reports/global-ev-outlook-2023*.

[1251] Argonne National Laboratory, ''Quantification of Commercially Planned Battery Component Supply in North America through 2035,'' ANL–24/14, March 2024. See Figure 18 therein, titled ''Modeled lithium-ion cell production capacity in North America from 2018 to 2035 by cathode chemistry.''

[1252] Duque, T., ''New Consortium to Make Batteries for Electric Vehicles More Sustainable,'' News from Berkeley Lab, September 11, 2023. At *https://newscenter.lbl.gov/2023/09/11/new-consortium-to-make-ev-batteries-more-sustainable/*.

[1253] Argonne National Laboratory, ''Cathode innovation makes sodium-ion battery an attractive option for electric vehicles,'' January 8, 2024. Accessed on March 12, 2024 at *https://www.anl.gov/article/cathode-innovation-makes-sodiumion-battery-an-attractive-option-for-electric-vehicles*.

[1254] Argonne National Laboratory, ''Lithium-sulfur batteries are one step closer to powering the future,'' January 6, 2023. Accessed on March 12, 2024 at *https://www.anl.gov/article/lithiumsulfur-batteries-are-one-step-closer-to-powering-the-future*.

[1255] Patel, P., ''The Age of Silicon Is Here . . . for Batteries,'' IEEE Spectrum, May 4, 2023. Accessed on March 12, 2024 at *https://spectrum.ieee.org/silicon-anode-battery*.

[1256] Wood Mackenzie, ''Global rare earths investment horizon outlook,'' December 2023, p. 15 and 16 (filename: global-rare-earths-investment-horizon-outlook-q4–2023.pdf). Available to subscribers.

[1257] Id.

[1258] In RIA Chapter 3.1.4 we discuss the outlook for alternatives to lithium in battery chemistries that are under development.

[1259] Department of Energy, ''Critical Materials Assessment,'' July 2023. At *https://www.energy.gov/sites/default/files/2023-07/doe-critical-material-assessment_07312023.pdf*.

[1260] See p. 63, Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

For additional details on the mineral supply outlook for the time frame of this rule, see Chapter 3.1.4 of the RIA.

iii. Mineral Security

Mineral security refers to the ability for the U.S. to meet its needs for critical minerals, and the potential economic or national security risks posed by their sourcing.[1261] This section examines the outlook for mineral security as it relates to demand for critical minerals resulting from increased PEV production under the final standards. We note that this section focuses on mineral security, and not on energy security, which relates to security of energy consumed by transportation and other needs. Energy security is discussed separately in section VIII.D.3 of this preamble.

In the context of vehicle manufacturing, concern for U.S. mineral security relates to the global distribution of established supply chains for critical minerals that are important to vehicle production, and the fact that, at present, not all domestic demand for these materials is satisfied through domestic sources or from secure sources such as FTA countries, MSP countries or other economic allies.

Currently, despite a wide distribution of mineral resources globally, mineral production is not evenly distributed across the world. At present, production is concentrated in a relatively small number of countries due to several factors, including where the resources are found in nature, the level of investment that has occurred to develop the resources, economic factors such as infrastructure, and the presence or absence of government policy relating to their production. For example, investment in mineral refinement and processing has received strong emphasis in China, while Japan and South Korea have become leaders in cell and cell component manufacturing, and countries with abundant mineral resources have become leading producers, for example Indonesia for nickel, Australia for lithium, and Democratic Republic of Congo for cobalt.

While the U.S. is not currently a leading producer of minerals used in PEV production, substantial investment has already gone towards and continues to be deployed toward expanding domestic mineral supply and building a more secure supply chain among FTA partners, MSP partners, and economic allies.

To examine U.S. mineral security in the context of the rule, first it is important to understand how mineral security compares to the similar but distinct topic of energy security. As EPA defines them, energy security relates primarily to the securing of energy sources, while mineral security relates to mineral sources that are not a source of energy. Supply disruptions and fluctuating prices are relevant to critical minerals as well as to energy markets, but the impacts of such disruptions to the mineral market are felt differently and by different parties. Disruptions in the price or availability of oil or gasoline has an immediate impact on consumers through higher fuel prices, and thus has an immediate effect on the cost or ability to travel. The same disruptions in critical minerals do not impact the immediate ability to travel but affect only the production and cost of new vehicles. In practice, short-term price fluctuations do not always translate to higher production cost as most manufacturers purchase minerals via long-term contracts that insulate them to a degree from volatility in spot prices. Moreover, critical minerals are not concentrated among a small group of commodities such as crude oil or natural gas, but comprise a larger number of distinct commodities, each having its own supply and demand dynamics, and some being capable of substitution by other minerals. Importantly, while oil is consumed as a fuel and thus requires continuous supply, minerals become a constituent part of the vehicle and have the potential to be recovered and recycled. Thus, even when minerals are imported from other countries, their acquisition adds to the domestic mineral stock that is available for domestic recycling in the future.

In the proposal, EPA analyzed the primary issues surrounding mineral security. We collected and reviewed information relating to the present geographical distribution of developed and known critical mineral resources and products, including information from the U.S. Geological Survey, analyst firms and various stakeholders. In considering these sources we highlighted and examined the potential for the U.S. to secure its sources for critical minerals. Our assessment of the available evidence indicated that the increase in PEV production projected to result from the proposed standards could be accommodated without causing harm to national security.

We received a variety of comments on our analysis, some of which disagreed with our findings and others which supported them. Supportive comments often pointed to examples of rapidly increasing attention to development of mineral resources in the U.S. and in nations with which the U.S. has good trade relations, and also pointed to the current and ongoing influence of support from the BIL and IRA in advancing such projects. Commenters who disagreed with our findings largely expressed the position that EPA did not adequately address the issue, or did not adequately consider the risks posed by increased demand for critical minerals or products that use them. Because mineral security is closely related to development of the domestic supply chain, comments often included references to the state of the domestic supply chain and the commenter's views on how it either is or is not advancing at a sufficient pace to allay mineral security concerns.

EPA appreciates and has carefully considered the substantive and detailed comments offered by the various commenters. Much of the information provided by commenters who disagreed with our assessment tends to expand upon the evidence that EPA already presented in the proposal concerning the risks and uncertainties associated with the future impact of mineral demand on mineral security. Much of the information provided by supportive commenters also expands on the evidence EPA presented in the proposal about the pace of activity and overall outlook for buildout of the critical mineral supply chain. While contributing to the record, the information provided by the commenters largely serves to further inform the trends that were already identified and considered by EPA in the proposal, and do not identify new, specific aspects of mineral security that were not acknowledged in the proposal. Taken together, the totality of information in the public record continues to indicate that development of the critical mineral supply chain is proceeding both domestically and globally in a manner that supports the industry's compliance with the final standards. In light of this information provided in the public comments and additional information that EPA has collected through continued research, it continues to be our assessment that the increase in PEV production projected under the standards will not adversely impact national security.

The findings discussed in section IV.C.7 of this preamble inform our basis for this assessment. In fact, rather than harming national security, EPA finds that the final rule will promote the

[1261] For additional context, consider that according to USGS, the Energy Act of 2020 defines a "critical mineral" as "a non-fuel mineral or mineral material essential to the economic or national security of the U.S. and which has a supply chain vulnerable to disruption."

interest of national security by reducing exposure to the risks associated with reliance on petroleum (benefits which EPA monetizes in section VIII of the preamble), and by providing regulatory and market certainty for the continued development of a secure domestic and allied supply chain for critical minerals (as previously mentioned at the beginning of this section IV.C.7 of the preamble). This is consistent with views prevalent in the industry that acknowledge the value of regulatory certainty in driving investment in production.[1262] [1263] [1264] Some commenters, such as the ''Environmental and Public Health Organizations'' and ZETA, echoed this principle, stating for example, ''clear regulatory signals—like EPA's vehicle emissions regulations—can create further confidence in the private sector to accelerate and expand investments.'' If commenters citing concerns about national security are correct that development of a domestic supply chain for these products will be important to national security and global competitiveness of the U.S., it is also relevant to note that it was in the absence of (*i.e.,* prior to) this rule that U.S. domestic production capacity has lagged far behind that of China and other countries. While the domestic supply chain has already begun to develop in part as a result of rapidly growing industry attention to vehicle electrification as well as the influence of the IRA and BIL, the need to comply with the standards provides additional market certainty to improve confidence in investment in this area and is likely to lead to even faster development of the supply chain. In fact, many of the same critical minerals and the same types of production capacity are necessary not only for complying with the standards, but also for the general competitiveness of the U.S. on a global stage, at a time when the need to reduce greenhouse gases, reduce other pollutants, and produce clean energy is being recognized across the world. The standards are thus consistent with, and are likely to promote, the competitiveness of U.S. industry as well as the national security benefits that accompany such an outcome.

In the proposal, we also acknowledged the well-known fact that critical minerals are distributed widely across the world and are traded via a highly globalized supply chain that includes numerous stages of their production. A description of worldwide sources of critical minerals as they exist today, and key takeaways from the ANL study which explores these issues,[1265] are provided in Chapter 3 of the RIA.

The development of critical mineral mining, processing, and related manufacturing capacity in the U.S. is a primary focus of efforts on the part of both industry and the federal government toward building a secure supply chain that reduces or eliminates exposure to security risks. These efforts are being greatly facilitated by the provisions of the BIL and the IRA as well as large private-sector investments that are already underway and continuing. The Inflation Reduction Act and the Bipartisan Infrastructure Law are in fact continuing to be a highly effective means by which Congress and the Administration are supporting the building of a robust supply chain, and accelerating this activity to ensure that it forms as rapidly as possible.

The U.S. is also taking advantage of a significant and growing portfolio of international engagements to secure mineral supplies, including FTAs, the Minerals Security Partnership (MSP), Trade Investment Framework Agreements (TIFAs), and other bilateral and multilateral agreements such as the Partnership for Global Infrastructure and Investment (PGI). In the words of Assistant Secretary of State for Energy Resources Geoffrey R. Pyatt in June 2023, the administration is ''using all the tools at its disposal, such as investments, loan programs, public-private partnerships, and technical assistance for energy infrastructure and supply chain development.''[1266] Government entities, including the White House, the U.S. Agency for International Development (USAID), the U.S. Development Finance Corporation (DFC), the U.S. Export-Import Bank (EXIM), and the Departments of Defense, State, Commerce, Labor, Interior, and Energy, are engaged in these efforts. These agencies have engaged governments in Asia, Africa, Europe, South America, and Australia on issues spanning investment, cooperative agreements, anti-corruption efforts, research, and economic development. Extensive details on the work being pursued by these and similar efforts are outlined in the ANL study.[1267]

For example, in 2023, the State Department launched the Minerals Investment Network for Vital Energy Security and Transition (MINVEST), a public-private partnership between the U.S. Department of State and SAFE Center for Critical Minerals Strategy to spur investment in mining, processing, and recycling opportunities.[1268] [1269] Another example is the work of Li-Bridge, a public-private alliance committed to accelerating the development of a robust and secure domestic supply chain for lithium-based batteries. It has set forth a goal that by 2030 the United States should capture 60 percent of the economic value associated with the U.S. domestic demand for lithium batteries. Achieving this target would double the economic value expected in the U.S. under ''business as usual'' growth.[1270] More evidence of recent growth in the supply chain is found in a February 2023 report by Pacific Northwest National Laboratory (PNNL), which documents robust growth in the North American lithium battery industry.[1271]

Recent policy recommendations from Congress have also expressed the goal of expanding and strengthening trade relationships with allies. In December 2023 the House Select Committee on US-China Competition released a series

[1262] Allen & Overy, ''U.S. Inflation Reduction Act takes climate change out of political cycle,'' November 3, 2022. Accessed on February 16, 2024 at *https://www.allenovery.com/en-gb/global/news-and-insights/publications/us-inflation-reduction-act-takes-climate-change-out-of-political-cycle*.

[1263] Union of Concerned Scientists, ''Production Tax Credit for Renewable Energy,'' February 9, 2015. Accessed on February 16, 2024 at *https://www.ucsusa.org/resources/production-tax-credit-renewable-energy*.

[1264] Bistline, J. et al., ''Economic Implications of the Climate Provisions of the Inflation Reduction Act,'' Brookings Papers on Economic Activity, BPEA Conference Draft, March 30–31, 2023. Accessed on February 16, 2024 at *https://www.brookings.edu/wp-content/uploads/2023/03/BPEA_Spring2023_Bistline-et-al_unembargoed Updated.pdf*.

[1265] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1266] Written Testimony of Geoffrey R. Pyatt, Assistant Secretary for Energy Resources, United States Department of State Before the House Foreign Affairs Committee, ''Assessing U.S. Efforts to Counter China's Coercive Belt and Road Diplomacy, ''June 14, 2023. *https://docs.cchouse.gov/meetings/FA/FA00/20230614/116025/HHRG-118-FA00-Wstate-PyattG-20230614.pdf*.

[1267] Argonne National Laboratory, ''Securing Critical Materials for the U.S. Electric Vehicle Industry: A Landscape Assessment of Domestic and International Supply Chains for Five Key EV Battery Materials,'' ANL–24/06, February 2024.

[1268] Department of State, ''MINVEST: Minerals Investment Network for Vital Energy Security and Transition,'' website, *https://www.state.gov/minvest*.

[1269] Department of State, ''Final MINVEST One-Pager.'' *https://www.state.gov/wp-content/uploads/2024/02/FINAL-MINVEST-One-Pager.pdf*.

[1270] Department of Energy, Li-Bridge, ''Building a Robust and Resilient U.S. Lithium Battery Supply Chain,'' February 2023.

[1271] Pacific Northwest National Laboratory, ''North American Lithium Battery Materials V 1.2,'' February 2023. Available at *https://www.pnnl.gov/projects/north-american-lithium-battery-materials-industry-report*.

of policy recommendations[1272] that included a resource reserve, advancement of trade agreements, investigation of product dumping, restriction of recycled material exports, enhancement of training programs, and expansion of the MSP. A November letter from Senators Marco Rubio (R–FL) and Mark Warner (D–VA) to the Export-Import Bank requested that projects to secure critical mineral supply chains in allied and partner nations be prioritized.[1273] The 2024 National Defense Authorization Act signed on December 22, 2023 also contains numerous provisions related to securing and diversifying the supply chain for critical materials.[1274]

Since the proposal, EPA has observed a general trend of continued activity to build the domestic and allied supply chain for critical minerals. EPA believes that this continued progress indicates that automakers, suppliers, and investors are taking advantage of the business opportunities that this need presents, and that the U.S. manufacturing industry is taking the necessary steps to create a secure supply chain for these products. Our assessment of the available evidence indicates that the increase in PEV production projected to result from the proposed standards can be accommodated without causing harm to national security.

iv. Battery and Mineral Recycling

EPA received comment on the potential role of recycling as a means of reducing future reliance on newly mined or acquired critical minerals over the long term. Some commenters supported EPA's view that battery recycling will contribute to mineral security and sustainability, gradually becoming more important as a domestically produced mineral source that will reduce reliance on foreign-sourced minerals. Other commenters expressed the view that recycling would not be a significant factor or would not develop quickly enough.

In the proposal, EPA reviewed the potential for recycling to become an important source of future mineral supply but did not specifically rely on projections of growth in recycling activity or recycled content to justify the feasibility of the standards. Similarly, the compliance analysis for the final standards does not specifically consider recycled content nor rely on specific assumptions regarding the growth of recycling in the future. As such, our analysis is conservative: we find that critical minerals and the battery supply chain will not constrain manufacturers who choose to produce PEVs to comply with the final standards, assuming no recycling activities, even though we believe that recycling has the potential to provide a significant source of critical minerals and other materials for battery production, particularly in later years of the program.

As in the proposal, EPA continues to recognize that recycling will take time to become a strong contributor to ongoing domestic mineral supply. For example, we noted that growth in the return of end-of-life PEV batteries will lag the market penetration of PEVs, and that it is important to consider the development of a battery recycling supply chain during the time frame of the rule and beyond. We also noted evidence that suggest by 2050, battery recycling could be capable of meeting 25 to 50 percent of total lithium demand for battery production.[1275] [1276] The lithium supply projections performed by BMI and ANL described in section IV.C.7.i of the preamble do include projections of recycled lithium content although at lower percentages reflecting the earlier time frame of the estimates. EPA considers the BMI and ANL estimates of potential recycled lithium content to be reasonable and consistent with prevailing expectations that recycled content will be relatively small at first and grow over time as more end-of-life batteries become available for recycling.

EPA continues to note that battery recycling has been and remains a very active area of research. The Department of Energy coordinates much research in this area through the ReCell Center, described as "a national collaboration of industry, academia and national laboratories working together to advance recycling technologies along the entire battery life-cycle for current and future battery chemistries."[1277] Funding is also being disbursed as directed by the Bipartisan Infrastructure Law.[1278] A growing number of private companies are entering the battery recycling market as the rate of recyclable material becoming available from battery production facilities and salvaged vehicles has grown, and manufacturers are already reaching agreements to use these recycled materials for domestic battery manufacturing. For example, Panasonic has contracted with Redwood Materials Inc. to supply domestically processed cathode material, much of which will be sourced from recycled batteries.[1279] Ford and Volvo have also partnered with Redwood to collect end-of-life batteries for recycling and promote a circular, closed-loop supply chain utilizing recycled materials.[1280] Redwood has also announced a battery active materials plant in South Carolina with capacity to supply materials for 100 GWh per year of battery production, and is likely to provide these materials to many of the "battery belt" factories that are developing in a corridor between Michigan and Georgia.[1281] General Motors and LG Energy Solution have also partnered with Li-Cycle to provide recycling of GM's Ultium cells.[1282]

Recycling infrastructure is the subject of several provisions of the BIL. It includes a Battery Processing and Manufacturing program, which grants significant funds to promote U.S. processing and manufacturing of batteries for automotive and electric grid use, by awarding grants for demonstration projects, new construction, retooling and retrofitting, and facility expansion. It will provide a total of $3 billion for battery material processing, $3 billion for battery manufacturing and recycling, $10 million for a lithium-ion battery

[1272] "Reset, Prevent, Build: A Strategy to Win America's Economic Competition with the Chinese Communist Party." At *https://selectcommitteeontheccp.house.gov/sites/evo-subsites/selectcommitteeontheccp.house.gov/files/evo-media-document/reset-prevent-build-scc-report.pdf*.

[1273] Letter from Sens. Marco Rubio and Mark Warner to Reta Jo Lewis, President of the Export-Import Bank of the U.S., November 16, 2023. *https://www.warner.senate.gov/public/_cache/files/1/7/17def9a2-d95c-40b1-9028-119f35769394/FCB942C1068EB79B54E8769260B13F59.11.16.23-rubio-warner-letter-to-exim-re-critical-minerals.pdf-*.

[1274] *https://www.congress.gov/bill/118th-congress/house-bill/2670/text*.

[1275] Sun et al., "Surging lithium price will not impede the electric vehicle boom," *Joule,* doi:10.1016/j.joule. 2022.06.028 (*https://dx.doi.org/10.1016/j.joule.2022.06.028*).

[1276] Ziemann et al., "Modeling the potential impact of lithium recycling from EV batteries on lithium demand: a dynamic MFA approach," Resour. Conserv. Recycl. 133, pp. 76–85. *https://doi.org/10.1016/j.resconrec.2018.01.031*.

[1277] *https://recellcenter.org/about*.

[1278] Department of Energy, "Biden-Harris Administration Announces Nearly $74 Million To Advance Domestic Battery Recycling And Reuse, Strengthen Nation's Battery Supply Chain," Press Release, November 16, 2022.

[1279] Randall, T., "The Battery Supply Chain Is Finally Coming to America," Bloomberg, November 15, 2022.

[1280] Automotive News Europe, "Ford, Volvo join Redwood in EV battery recycling push in California," February 17, 2022. *https://europe.autonews.com/automakers/ford-volvo-join-redwood-ev-battery-recycling-push-california*.

[1281] Wards Auto, "Battery Recycler Redwood Plans $3.5 Billion South Carolina Plant," December 27, 2022. *https://www.wardsauto.com/industry-news/battery-recycler-redwood-plans-35-billion-south-carolina-plant*.

[1282] General Motors, "Ultium Cells LLC and Li-Cycle Collaborate to Expand Recycling in North America," Press Release, May 11, 2021. *https://news.gm.com/newsroom.detail.html/Pages/news/us/en/2021/may/0511-ultium.html*.

recycling prize competition, $60 million for research and development activities in battery recycling, an additional $50 million for state and local programs, and $15 million to develop a collection system for used batteries. In addition, the Electric Drive Vehicle Battery Recycling and Second-Life Application Program will provide $200 million in funds for research, development, and demonstration of battery recycling and second-life applications.[1283] Outside the BIL, DOE recently announced the three-phase Electronics Scrap Recycling Advancement Prize, a $3.95 million challenge with the goal of increasing the domestic supply of critical minerals from electronics scrap.[1284]

The efforts to fund and build a mid-chain processing supply chain for active materials and related products will also be important to reclaiming minerals through domestic recycling. While domestic recycling can recover minerals and other materials needed for battery cell production, these materials commonly are recovered in elemental forms that require further midstream processing into precursor substances and active material powders that can be used in cell production. The DOE ReCell Center coordinates extensive research on development of a domestic lithium-ion recycling supply chain, including direct recycling, in which materials can be recycled for direct use in cell production without destroying their chemical structure, and advanced resource recovery, which uses chemical conversion to recover raw minerals for processing into new constituents.[1285]

Currently, pilot-scale battery recycling research projects and private recycling startups have access to only limited amounts of recycling stock that originate from sources such as manufacturer waste, crashed vehicles, and occasional manufacturer recall/repair events. As PEVs are currently only a small portion of the U.S. vehicle stock, some time will pass before vehicle scrappage can provide a steady supply of end-of-life batteries to support large-scale battery recycling. During this time, we expect that the mid-chain processing portion of the supply chain will continue to develop and will be able to capture much of the resources made available by the recycling of used batteries coming in from the fleet.

D. Projected Compliance Costs and Technology Penetrations

1. Technology Penetration Rates

i. Light-Duty Technology Penetrations

In this section, we discuss the projected new vehicles sales technology penetration rates from EPA's analysis for the final standards. EPA has incorporated PHEVs into our analysis for the final rule, as requested by commenters and as we had indicated in the proposal was our plan. Table 75 and Table 76 reflect the projected penetration rates of PEVs (which include BEVs and PHEVs [1286]) for the final standards and No Action case, respectively, by body style (sedans, crossover/SUVs and pickups). It is important to note that these are projections and represent one of many possible compliance pathways for the industry. The standards are performance-based and do not mandate any specific technology for any manufacturer or any vehicle type. Each manufacturer is free to choose its own set of technologies with which it will demonstrate compliance with the standards. In our projections, as the final standards become more stringent over MYs 2027 to 2032, the penetration of PEVs increases by 36 percentage points over this 6-year period, from 32 percent in MY 2027 to 68 percent of overall vehicle production in MY 2032. Note that the standards are not anticipated to increase PEV penetration significantly above the No Action scenario in 2027, and while the standards are anticipated to increase PEV penetration to 68 percent by 2032, the level of PEVs under the No Action case are projected to reach 47 percent in that year. Thus, the majority of the increase in PEV penetration is anticipated to occur as a result of developments in the market attributable to factors such as the IRA, increasing consumer acceptance, and automaker investments, rather than as a result of EPA's standards.

We note that we have also analyzed several sensitivities (refer to section IV.F of this preamble), including one looking at the impact of adoption of ACC II policies in various states and other sensitivities considering the possibility of higher or lower battery costs.[1287] These scenarios may have different penetrations of various technologies for their No Action case as well as for the final standards. For example, PEV penetration rates in the No Action baseline in 2032 for these sensitivities varies from 18 percent to 60 percent and PEV penetration rates under the final standards in 2032 range from 62 percent to 70 percent. The penetration rates for other technologies similarly vary, *e.g.,* ICE penetration rates in these analyses range from 2 percent to 32 percent under the final standards in 2032. EPA considers our central case analysis combined with the range of sensitivity analyses to illustrate a range of possible outcomes which are each technically feasible, have reasonable costs, and provide sufficient lead time.

TABLE 75—FLEET PEV PENETRATION RATES, BY BODY STYLE, UNDER THE FINAL LIGHT-DUTY GHG STANDARDS

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	40	47	58	66	69	75
Crossovers/SUVs	31	35	43	49	59	66
Pickups	27	31	45	55	63	67
Total	32	37	46	53	61	68

[1283] Environmental Defense Fund and ERM, ''Electric Vehicle Market Update: Manufacturer Commitments and Public Policy Initiatives Supporting Electric Mobility in the U.S. and Worldwide,'' September 2022.

[1284] Department of Energy, ''Electronics Scrap Recycling Advancement Prize,'' web page. At *https://www.energy.gov/eere/ammto/electronics-scrap-recycling-advancement-prize.*

[1285] Department of Energy, ''The ReCell Center for Advanced Battery Recycling FY22 Q4 Report,'' October 20, 2022. Available at: *https://recellcenter.org/2022/12/15/recell-advanced-battery-recycling-center-fourth-quarter-progress-report-2022/.*

[1286] PHEVs were added as a technology option to all vehicle types in OMEGA in a similar fashion as BEV and ICE technologies. A more detailed description of the PHEV modeling assumptions can be found in RIA Chapter 2.4.4.2 and 2.6.1.4.

[1287] Though not considered as a sensitivity, we also assessed an additional illustrative scenario, ''No Additional BEVs,'' which assumes no additional BEV production beyond that in the MY 2022 base year fleet. See Section IV.H of the preamble.

TABLE 76—FLEET PEV PENETRATION RATES, BY BODY STYLE, UNDER THE NO ACTION CASE

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	40	41	45	46	52	56
Crossovers/SUVs	30	32	36	38	40	45
Pickups	25	30	34	38	39	45
Total	31	33	37	39	42	47

For both the final standards as well as the No Action case, BEVs make up the majority of PEVs. From 2027 MY to 2032 MY for the final standards, PHEV projections grow from 4 percent to 8 percent in sedans, 7 percent to 14 percent in pickups and 6 percent up to 13 percent in crossovers. The remainder of the projected PEV shares are BEVs. Table 77 and Table 78 show projected PHEV penetrations rates for the final standards and the No Action case.

TABLE 77—FLEET PHEV PENETRATION RATES, BY BODY STYLE, UNDER THE FINAL LIGHT-DUTY GHG STANDARDS

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	4	5	6	7	9	8
Crossovers/SUVs	6	7	8	9	10	13
Pickups	7	5	8	12	13	14
Total	6	6	8	9	11	13

TABLE 78—FLEET PHEV PENETRATION RATES, BY BODY STYLE, UNDER THE NO ACTION CASE

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	4	5	6	6	7	10
Crossovers/SUVs	6	6	8	9	9	13
Pickups	6	4	7	8	9	14
Total	5	6	7	8	8	12

Table 79 and Table 80 show the projected market penetrations for strong HEVs under the final standards and the No Action case. For MY 2027–2032, penetrations are less than 5 percent, and under the final standards are projected to decrease over time. However, these results do not imply that strong HEVs are ineffective as a compliance option. Instead, under the cost-minimizing compliance strategy used in our analysis, strong HEVs are being displaced by PEVs that provide emissions reductions at a relatively lower cost per Mg CO_2 reduced. In other words, comparing the incremental cost of HEVs and PEVs relative to the amount of vehicle CO_2 pollution they prevent, we find that PEVs cost much less to reduce the same amount of CO_2. While manufacturers may choose any compliance pathway that meets the final standards, we expect that they, as any other private businesses, would generally choose the least-cost pathway (*i.e.,* PEVs over strong HEVs, as well as the advanced ICE discussed below). This choice would be made not because of an EPA regulatory mandate (since EPA does not mandate any particular technology for compliance), but rather in order to maximize profits and remain economically competitive within the vehicle manufacturing sector. In the No Action case, the industry is already overachieving the standards due to increased sales of BEVs and the market penetration of strong HEVs remains relatively constant. The potential for strong HEVs as a potentially important compliance technology is discussed in section IV.F.4 of this preamble.

TABLE 79—FLEET STRONG HEV PENETRATION RATES UNDER THE FINAL STANDARDS

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	4	1	1	1	1	1
Crossovers/SUVs	4	6	5	5	4	3
Pickups	2	2	2	2	2	2
Total	4	4	4	3	3	2

TABLE 80—FLEET STRONG HEV PENETRATIONS RATES UNDER THE NO ACTION CASE

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	5	1	2	2	1	1
Crossovers/SUVs	4	4	4	4	3	3
Pickups	3	2	2	2	13	14
Total	4	3	3	3	5	5

Consistent with past rulemakings, EPA has evaluated a range of advanced technologies for ICE vehicles (''advanced ICE'') which include advanced turbocharged downsized engines (TURB12), advanced Atkinson (ATK) engines, and Miller (MIL) cycle engines.[1288] Further details on EPA's modeling of engine technologies can be found in RIA Chapters 2.4.5.1 and 3.5.1. This grouping of ICE engines includes some of the more cost-effective non-electrified technologies for GHG compliance. However, like HEVs, they are still not as cost-effective as PEVs in achieving lower levels of GHG targets and are not eligible for tax credits under the IRA. The advanced ICE technologies are projected to decline as sales of PEVs increase over time, both for the final standards as well as the No Action case. For example, advanced ICE is anticipated to capture 33 percent of the market in 2032 under the No Action scenario, down to 21 percent under the final standards. Table 81 and Table 82 show the projected market penetrations for advanced ICE engines in the final standards and the No Action case. Note that a majority of ICE vehicles are projected to be advanced ICE vehicles for both the final standards and the No Action case. Table 83 and Table 84 show the projected penetrations of advanced ICE vehicles as a percentage of ICE vehicles under the final standards and the No Action case, respectively.

TABLE 81—ADVANCED ICE PENETRATION RATES UNDER THE FINAL STANDARDS

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	44	27	22	18	17	14
Crossovers/SUVs	48	41	37	33	26	21
Pickups	64	60	48	39	32	28
Total	50	42	36	31	26	21

TABLE 82—ADVANCED ICE PENETRATION RATES UNDER THE NO ACTION CASE

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	44	36	33	33	29	26
Crossovers/SUVs	48	42	39	38	37	34
Pickups	66	61	58	54	42	36
Total	51	44	41	40	36	33

TABLE 83—ADVANCED ICE PENETRATION RATES (PERCENTAGE OF ICE VEHICLES), UNDER THE FINAL STANDARDS

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	79	57	57	58	60	59
Crossovers/SUVs	74	71	71	71	71	71
Pickups	91	91	91	91	90	90
Total	78	73	73	73	73	73

TABLE 84—ADVANCED ICE PENETRATIONS RATES (PERCENTAGE OF ICE VEHICLES) UNDER THE NO ACTION CASE

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Sedans	79	65	65	66	65	65
Crossovers/SUVs	74	65	65	65	65	66
Pickups	90	90	90	89	87	86

[1288] All mild hybrid vehicles, with or without advanced engines, are grouped separately as MHEVs. As a result, technology groupings are distributed into one of the following independent architectures: BEV, PHEV, strong HEV, MHEV, advanced ICE and base ICE.

TABLE 84—ADVANCED ICE PENETRATIONS RATES (PERCENTAGE OF ICE VEHICLES) UNDER THE NO ACTION CASE—Continued

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Total	78	70	70	70	69	69

ii. Medium-Duty Technology Penetrations

In this section we discuss the projected MDV [1289] technology penetration rates based on EPA's analysis for the final standards. Table 85 and Table 86 show EPA projected penetration rates of PEV technology under the final standards and the No Action case by body style, comparing vans, MDV pickups and the fleet total. It is important to note that this is a projection and represents one of many possible compliance pathways manufacturers could choose. The standards are performance-based and do not mandate any specific technology for any manufacturer or any vehicle type. Each manufacturer is free to choose its own set of technologies with which it will demonstrate compliance with the standards. As the standards become more stringent over MYs 2027 to 2032, the projected penetration of PEVs (driven largely by electrification of vans) increases from 3 percent in MY 2027 to 43 percent of overall MDV production in MY 2032.

TABLE 85—FLEET PEV PENETRATION RATES, BY BODY STYLE, UNDER THE FINAL STANDARDS FOR MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Vans	3	4	24	44	64	76
Pickups	3	4	8	17	15	26
Total	3	4	14	27	32	43

TABLE 86—FLEET PEV PENETRATION RATES, BY BODY STYLE, UNDER THE NO ACTION CASE FOR MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Vans	3	4	5	6	7	8
Pickups	3	4	5	6	7	8
Total	3	4	5	6	7	8

The projected PHEV penetrations (which are a subset of total PEVs) are provided for the final standards in Table 87. Similar to what was seen in light-duty vehicles, for the van segment and the MDV fleet overall, most of the PEVs in the medium-duty compliance modeling are projected to be BEVs. However, for MDV pickups PHEV penetrations make up over half of the PEVs for that segment by MY 2032.

TABLE 87—FLEET PHEV PENETRATION RATES, BY BODY STYLE, UNDER THE FINAL STANDARDS FOR MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Vans	0	0	0	0	0	1
Pickups	0	0	0	8	5	16
Total	0	0	0	5	3	11

No strong HEVs were projected for the medium-duty fleet. However, there remain a significant penetration of advanced ICE vehicles (although their sales shares are projected to decline as the standards become more stringent). Table 88 and Table 89 show the penetration rates for advanced ICE vehicles for the final standards and the No Action case. For reference, Table 90 shows the advanced ICE percentage of all ICE vehicles for the final standards.

[1289] MDVs were not broken down into separate Class 2b and Class 3 categories in the analysis for this rule. The GHG standards apply to Class 2b and Class 3 as a single MDV class. The analysis does include a breakdown between MDV vans and MDV pickups due to differences in use-case and applicable technologies.

TABLE 88—ADVANCED ICE PENETRATION RATES, BY BODY STYLE, UNDER THE FINAL STANDARDS FOR MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Vans	86	85	68	50	32	22
Pickups	42	41	39	35	37	32
Total	57	57	49	40	35	28

TABLE 89—ADVANCED ICE PENETRATION RATES, BY BODY STYLE, UNDER THE NO ACTION CASE FOR MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Vans	87	86	85	84	83	82
Pickups	42	41	41	40	40	39
Total	57	57	56	55	55	54

TABLE 90—ADVANCED ICE PENETRATION RATES (PERCENTAGE OF ICE VEHICLES), BY BODY STYLE, UNDER THE FINAL STANDARDS FOR MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Vans	89	89	89	89	89	89
Pickups	43	43	43	43	43	43
Total	59	59	57	55	51	50

2. Criteria Pollutant Technology Penetrations

To meet the final criteria pollutant standards, vehicle manufacturers are anticipated to apply better emissions control technologies to ICE, hybrid and PHEV vehicles. While BEVs are anticipated to provide some contribution to a manufacturer's compliance, we expect that manufacturers will also choose to improve the emissions control of their ICE vehicles. ICE vehicles, hybrids and PHEVs can continue their downward trend in $NMOG+NO_X$ emissions through better design, controls, and calibrations of engines and TWC systems. EPA anticipates that all ICE-based vehicles will be equipped with gasoline particulate filters by the time this rulemaking is fully phased in to meet the final PM standards. Changes will also be required to meet the revised CO standards. In order to meet the three light-duty vehicle provisions aligned with the CARB ACC II program, we expect manufacturers will choose to adopt improved controls on ICE vehicles to meet the early driveaway requirements and the mid-temperature starts. Similarly, manufacturers that choose to produce PHEVs will require PHEV control changes to meet the new high load cold start provision. Finally, incomplete medium-duty vehicles will require evaporative emission controls to support the new ORVR requirement. Additional detail regarding technology adoption for meeting the criteria pollutant standards, refer to RIA Chapters 3.2.5.1 and 3.2.6.1.

3. CO_2 Targets and Compliance Levels

i. Light-Duty Vehicle CO_2 Targets and Compliance Levels

The final footprint CO_2 standards curve coefficients for light-duty vehicles were presented in section III.C.2.iv of the preamble. Here we present the projected industry average fleet targets for both the final standards and the No Action case for reference. These average targets (for the final standards and the No Action case,[1290] respectively) are presented for both the car and truck regulatory classes in Table 91 and Table 92, and then for three different modeled body styles: sedans, crossovers and SUVs, and pickup trucks,[1291] in Table 93 and Table 94. The projected targets for each are based on the industry sales weighted average of vehicle models (and their respective footprints) within the regulatory class or body style.[1292] The industry total targets have increased slightly compared to the respective Alternative 3 targets presented in the NPRM, due mainly to an increase in the truck sales share as projected by AEO 2023, and also slightly larger size trucks in the updated base year vehicle fleet. AEO 2023 predicts that new vehicle sales in 2032 will be 30 percent cars and 70 percent trucks (in NPRM, the projection was 40 percent cars and 60 percent trucks).

[1290] The No Action case continues MY 2026 flexibilities for the off-cycle and A/C credits available to OEMs as defined in the 2021 Final Rule.

[1291] All sedans are of the car regulatory class; crossovers and SUVs include both cars and trucks; and all pickups are of the truck regulatory class.

[1292] Note that these targets are projected based on both projected future sales in applicable MYs and our final standards; the targets will change in each future model year depending on each manufacturer's actual sales.

TABLE 91—PROJECTED TARGETS FOR FINAL LIGHT-DUTY VEHICLE GHG STANDARDS, BY REGULATORY CLASS

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Cars	139	125	112	99	86	73
Trucks	184	165	146	128	109	90
Total	170	153	136	119	102	85

TABLE 92—PROJECTED TARGETS FOR LIGHT-DUTY VEHICLE NO ACTION CASE, BY REGULATORY CLASS

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Cars	132	131	132	132	133	133
Trucks	185	185	186	186	187	188
Total	168	169	169	170	171	171

TABLE 93—PROJECTED TARGETS FOR FINAL LIGHT-DUTY VEHICLE GHG STANDARDS, BY BODY STYLE

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Sedans	139	126	112	99	86	73
Crossovers/SUVs	167	149	133	117	99	83
Pickups	216	193	171	149	126	104
Total	170	153	136	119	102	85

TABLE 94—PROJECTED TARGETS FOR LIGHT-DUTY VEHICLE NO ACTION CASE, BY BODY STYLE

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Sedans	133	133	133	133	134	134
Crossovers/SUVs	164	164	165	165	165	166
Pickups	222	223	224	225	228	229
Total	168	169	169	170	171	171

The modeled achieved CO_2 levels for the final standards and the No Action case are shown for both the car and truck regulatory class in Table 97 and Table 98 and then by body style in Table 99 and Table 100, respectively. These values were produced by the modeling analysis and represent the projected, sales-weighted average certification emissions values for possible compliance approaches with the standards. The achieved CO_2 levels are calculated from projected 2-cycle tailpipe emissions (via modeled application of emissions-reduction technologies) minus the modeled application of off-cycle credit technologies and A/C credits. Table 95 and Table 96 summarize the fleet average contribution of off-cycle credits and A/C credits towards the achieved CO_2 levels for the final standards and the No Action case.[1293]

TABLE 95—FINAL LIGHT-DUTY VEHICLE GHG STANDARDS—ACHIEVED LEVELS SUMMARY

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Tailpipe emissions	187.5	169.2	145.7	127.6	109.3	94.3
A/C leakage credits	12.9	9.7	6.5	3.2	1.9	1.9
Off-cycle + A/C eff credits	10.2	10.1	9.0	8.5	7.0	5.3
Achieved CO_2 g/mile (unrounded)	164.4	149.3	130.2	115.8	100.5	87.1

[1293] In contrast to the maximum allowable credits presented in Table 10 and Table 11 in section III.C of the preamble, these credit levels shown are modeling results that reflect projected penetration of BEVs for the final standards and No Action case.

TABLE 96—NO ACTION CASE—ACHIEVED LEVELS SUMMARY
[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Tailpipe emissions	189.4	182.4	171.8	166.5	157.9	147.6
A/C leakage credits	16.1	16.2	16.2	16.2	16.2	16.2
Off-cycle + A/C eff credits	13.5	13.5	13.6	13.8	13.8	13.9
Achieved CO_2 g/mile (unrounded)	159.8	152.7	142.0	136.6	127.9	117.6

TABLE 97—FINAL LIGHT-DUTY VEHICLE GHG STANDARDS—ACHIEVED LEVELS BY REGULATORY CLASS
[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Cars	116	97	83	72	67	57
Trucks	186	173	151	135	115	100
Total	164	149	130	116	100	87

TABLE 98—LIGHT-DUTY VEHICLE GHG NO ACTION CASE—ACHIEVED LEVELS BY REGULATORY CLASS
[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Cars	110	102	94	92	83	76
Trucks	182	175	163	156	148	136
Total	160	153	142	137	128	118

TABLE 99—FINAL LIGHT-DUTY VEHICLE GHG STANDARDS—ACHIEVED LEVELS BY BODY STYLE
[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Sedans	110	91	75	63	63	52
Crossovers/SUVs	165	150	135	125	106	91
Pickups	221	211	172	139	122	111
Total	164	149	130	116	100	87

TABLE 100—LIGHT-DUTY VEHICLE NO ACTION CASE—ACHIEVED LEVELS BY BODY STYLE
[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Sedans	104	97	88	86	74	69
Crossovers/SUVs	160	155	144	141	134	124
Pickups	222	204	194	174	161	147
Total	160	153	142	137	128	118

Comparing the target and achieved values (*e.g.,* Table 91 vs. Table 97) it can be seen that within any given year, the achieved values may be over target (higher emissions) or under target (lower emissions), depending on the body style or regulatory class. This is a feature of the unlimited credit transfer provision, which results in a compliance determination that is based on the combined car and truck fleet credits for each manufacturer, rather than a separate determination of each fleet's compliance. The application of technologies is influenced by the relative cost-effectiveness of technologies among each manufacturer's vehicles. For the combined fleet, the achieved values are typically close to or slightly under the target values, which would represent the banking of credits that can be carried over into other model years. This indicates that overall, the modeled fleet tracks the standards very closely from year-to-year. Note that an achieved value for a manufacturer's combined fleet that is above the target in a given model year does not indicate a likely failure to comply with the standards, since the model includes the GHG program credit banking provisions that allow credits from one year to be carried into another year.

The modeling predicts that the industry will over comply against the MY 2027–2032 standards in the No Action scenario, driven by the projected significant increase in PEVs. This is in part due to the economic opportunities provided for PEVs to both manufacturers and consumers by the IRA. Figure 43 shows a plot of industry average achieved g/mile compared to the projected targets for both the No Action case and the final standards. In

MY 2027, achieved g/mile are lower for the No Action case than shown for the final standards. This is an effect of the additional off-cycle and A/C credits being available in the No Action case that are phased out in the final standards. This makes it appear as though there is a better g/mile outcome under the No Action case. If the No Action case reflected the phasing out of those credits, then it would show higher average compliance g/mile values than are achieved under the final standards. A relative comparison between the two policies, but without this difference in the credit phase out, can be seen by comparing Table 95 and Table 96, which show that the tailpipe g/mile are lower in the final standards for all years than in the No Action case. The modeling results show that the industry as a whole should be able to achieve the standards over the MY 2027–2032 time frame.

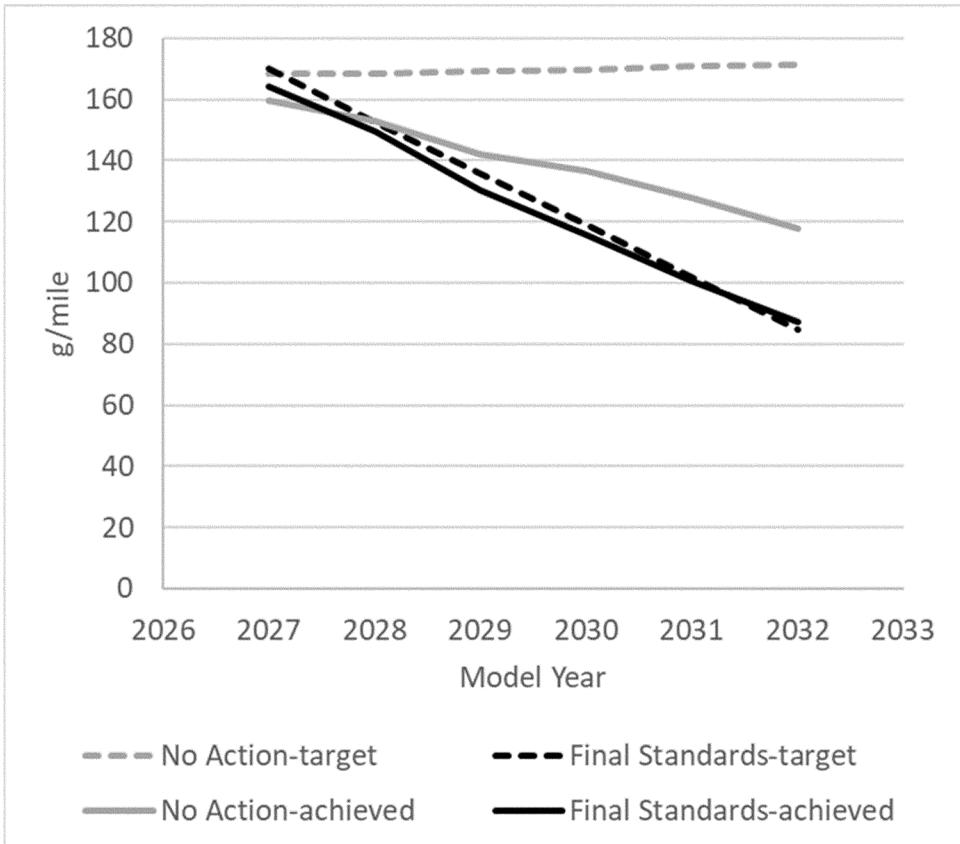

Figure 43: Achieved vs. Target GHG g/mile for No Action Case and Final Standards

ii. Medium-Duty Vehicle Targets and Compliance Levels

Based on the work-factor based standards curve coefficients described in section III.C.3 of the preamble, we present the projected industry average medium-duty vehicle fleet targets for both the final standards and the No Action case in Table 101 and Table 102. These average targets are shown for two different modeled body styles: vans and pickup trucks. The projected targets for each case are based on the industry sales weighted average of vehicle models (and their respective work factors) within each body style.[1294]

TABLE 101—PROJECTED TARGETS FOR FINAL MEDIUM-DUTY VEHICLE GHG STANDARDS, BY BODY STYLE

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Vans	392	391	355	317	281	245
Pickups	497	486	437	371	331	290
Total	461	453	408	353	314	274

TABLE 102—PROJECTED TARGETS FOR MEDIUM-DUTY VEHICLES, NO ACTION CASE, BY BODY STYLE

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Vans	413	412	412	412	412	411
Pickups	508	508	508	507	507	506
Total	475	475	474	474	474	474

The modeled achieved CO_2 levels for the final standards and the No Action case are shown for both vans and pickups in Table 103 and Table 104. These values were produced by the modeling analysis and represent the projected certification emissions values for possible compliance approaches with the final standards, grouped by body style.

TABLE 103—FINAL GHG STANDARDS FOR MEDIUM-DUTY VEHICLES—PROJECTED ACHIEVED LEVELS BY BODY STYLE

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Vans	434	429	340	249	151	103
Pickups	468	463	443	405	396	361
Total	456	451	407	351	312	272

TABLE 104—NO ACTION CASE FOR MEDIUM-DUTY VEHICLES—PROJECTED ACHIEVED LEVELS BY BODY STYLE

[CO_2 grams/mile]

	2027	2028	2029	2030	2031	2032
Vans	435	431	426	422	418	414
Pickups	468	463	458	454	449	444
Total	456	452	447	443	438	434

Similar to light-duty vehicles, within a given year it can be seen that the achieved values might be over target (higher emissions) or under target (lower emissions). This is another example of the unlimited credit transfer provision, which results in a compliance determination that is based on the overall fleet credits for each manufacturer, rather than a separate compliance determination for individual vehicles or groups of vehicles. The application of technologies is influenced by the relative cost-effectiveness of technologies among each manufacturer's vehicles. For the combined fleet, the achieved values are typically close to or slightly under the target values, which would represent the banking of credits that can be carried over into other model years. This indicates that overall, the modeled fleet tracks the standards very closely from year-to-year. Note that an achieved value for a manufacturer's combined fleet that is above the target in a given model year does not indicate a likely failure to comply with the standards, since the model includes the GHG program credit banking provisions that allow credits from one year to be carried into another year.

[1294] Note that these targets are projected based on both projected future sales in applicable MYs and our final standards; the actual targets will change each MY depending on each manufacturer's actual sales.

4. Compliance Costs per Vehicle for the Final Standards

i. Light-Duty Projected Compliance Costs

EPA has performed an assessment of the estimated per-vehicle costs for manufacturers to meet the MY 2027–2032 GHG and criteria air pollutant standards. The fleet average costs per vehicle, again grouped by both regulatory class and body style, are shown in Table 105 and Table 106. As shown, the combined cost for cars and trucks are about $200 for MY 2027 and then increase gradually through MY 2032.

TABLE 105—AVERAGE INCREMENTAL VEHICLE COST BY REGULATORY CLASS, RELATIVE TO THE NO ACTION SCENARIO

[2022 dollars]

	2027	2028	2029	2030	2031	2032	6-year avg
Cars	$135	$348	$552	$968	$849	$934	$631
Trucks	276	642	1,199	1,703	2,318	2,561	1,450
Total	232	552	1,002	1,481	1,875	2,074	1,203

TABLE 106—AVERAGE INCREMENTAL VEHICLE COST BY BODY STYLE, RELATIVE TO THE NO ACTION SCENARIO

[2022 dollars]

	2027	2028	2029	2030	2031	2032	6-year avg
Sedans	$115	$277	$555	$1,036	$666	$821	$578
Crossovers/SUVs	185	694	961	1,443	2,249	2,558	1,348
Pickups	528	349	1,611	2,066	1,816	1,659	1,338
Total	232	552	1,002	1,481	1,875	2,074	1,203

Overall, EPA estimates the average costs of this final rule at approximately $2,100 per vehicle in MY 2032 relative to meeting the No Action case in MY 2032. However, these estimates represent the incremental technology costs to manufacturers; for consumers, these costs are offset by savings in the reduced fuel costs, and, for PEVs, maintenance and repair costs, as discussed in section VIII of the preamble. Additionally, consumers may also benefit from IRA purchase incentives for PEVs.

These light-duty compliance costs are somewhat different from the values presented in the NPRM, and now show lower costs in earlier years and higher costs in 2031 and 2032. These changes are the result of the additional credit flexibilities in the final standards that were not included in the proposed standards, as well as a number of modeling updates made in response to public comments and consideration of the latest and most appropriate data. As described in section IV.A.1 of the preamble, noteworthy updates to projected battery costs and revised ICE powertrain costs both contribute to the increased compliance costs in later years.

ii. Medium-Duty Projected Compliance Costs

EPA's assessment of the estimated per-vehicle costs for manufacturers to meet the final MY 2027–2032 GHG and criteria air pollutant standards for medium-duty vehicles is presented here. The fleet average costs per vehicle, grouped by body style, are shown in Table 107. As shown, the combined cost for vans and pickups generally increases from MY 2027 through MY 2032.

TABLE 107—AVERAGE INCREMENTAL VEHICLE COST BY BODY STYLE, MEDIUM-DUTY VEHICLES

[2022 dollars]

	2027	2028	2029	2030	2031	2032	6-year avg
Vans	$178	$185	$1,443	$2,732	$4,128	$4,915	$2,264
Pickups	97	88	531	1,432	1,516	2,416	1,013
Total	125	122	847	1,881	2,416	3,275	1,444

Overall, EPA estimates the average costs of this rule at approximately $3,300 per medium-duty vehicle in MY 2032 relative to meeting the No Action case in MY 2032. Similar to our light-duty costs, these estimates represent the incremental costs to manufacturers; for consumers, these costs are offset by savings in reduced fuel costs, and for PEVs, maintenance and repair costs, as discussed in section VIII of the preamble. Additionally, consumers may also benefit from IRA purchase incentives for PEVs.

E. How did EPA consider alternatives in selecting the final program?

In section III.F of this preamble, we described alternatives that we considered in addition to the final light-duty vehicle GHG standards. See Figure 5 and Table 18 in section II.C of this preamble. The alternatives analyzed for the final rule, in addition to the standards we are finalizing, are Alternative A (the proposed standards) and Alternative B (less stringent standards). The analyses of the technology penetrations, targets and achieved levels, and compliance cost are summarized below. Additional details for each alternative are presented in the RIA Chapters 4, 8 and 12.

In comparing the per-vehicle costs of the final standards and the two alternatives, costs of Alternative A (the proposed standards) have increased compared to the projections of costs for the proposed standards as estimated in the NPRM. This cost increase is due to updates in technical inputs, as discussed in section IV.D.3 of this preamble and detailed in RIA Chapter 2.1.3. The final standards, which include a slower phase-out of flexibilities and a more gradual year-over-year stringency increase in the standards curves for MY 2027 through 2030, have reduced compliance costs compared to Alternative A.

The 6-year average of the final standards is about $1,200 per vehicle, which is about half of the 6-year average costs for Alternative A ($2,400). The lower costs of the final standards are largely attributed to the reduced compliance costs for MY 2027 through MY 2029 which are projected at or less than $1000 per vehicle.

While Alternative A achieves slightly greater cumulative CO_2 emissions reductions than the final standards in the early years, the final standards achieve similar cumulative CO_2 reductions through 2055 as Alternative A, and 1.8 billion metric tons (about 30 percent) more than Alternative B. See RIA Chapter 8.6.6.1.

EPA's updated analysis shows that the final standards and Alternative A achieve similar levels of technology penetration in MY 2032. The important difference between the final standards and Alternative A is in the per-vehicle costs during the earlier years (MYs 2027 through 2030), where we believe the lower costs of the final standards are important considering the shorter lead time for manufacturers. EPA discusses further in section V of this preamble the reasons we believe the final standards represent the appropriate standards under the CAA.

Table 108 compares the projected PEV penetration rates for the final standards, the alternatives and the No Action case.

TABLE 108—COMPARISON OF PROJECTED PEV PENETRATIONS FOR ALTERNATIVES VS FINAL STANDARDS

Model year	Final standards (%)	Alternative A (%)	Alternative B (%)	No action case (%)
2027	32	39	32	31
2028	37	45	36	33
2029	46	54	46	37
2030	53	58	51	39
2031	61	64	58	42
2032	68	69	65	47

Table 109 compares the projected targets for the alternatives and the final standards, while Table 110 compares the achieved levels for each.

TABLE 109—COMPARISON OF PROJECTED COMBINED FLEET TARGETS TO ALTERNATIVES

[CO_2 grams/mile]

Model year	Final standards	Alternative A	Alternative B	No action case
2026	168	168	168	168
2027	170	155	170	168
2028	153	135	153	169
2029	136	114	136	169
2030	119	105	119	170
2031	102	96	107	171
2032	85	85	95	171

TABLE 110—COMPARISON OF PROJECTED COMBINED FLEET ACHIEVED LEVELS TO ALTERNATIVES

[CO_2 grams/mile]

Model year	Final standards	Alternative A	Alternative B	No action case
2026	166	166	166	166
2027	164	160	163	160
2028	149	132	149	153
2029	130	115	128	142
2030	116	103	116	137
2031	100	93	104	128
2032	87	82	86	118

Table 111 presents a comparison of average incremental per-vehicle costs for the final standards and the alternatives, as well as the average annual cost over the rulemaking period.

TABLE 111—COMPARISON OF PROJECTED INCREMENTAL COSTS RELATIVE TO THE NO ACTION SCENARIO

[CO_2 grams/mile]

Model year	Final standards	Alternative A	Alternative B
2027	$232	$1,114	$214
2028	552	1,794	437
2029	1,002	2,088	936
2030	1,481	2,390	1,375
2031	1,875	2,418	1,561
2032	2,074	2,425	1,867
6-year avg	1,203	2,038	1,065

F. Sensitivities—LD GHG Compliance Modeling

EPA often conducts sensitivity analyses to help assess key areas of uncertainty in both underlying data and modeling assumptions, consistent with OMB Circular No. A–4 which establishes guidelines for conducting regulatory impact analyses, including benefit-cost analysis.[1295] In the analysis for this rule, EPA has evaluated the feasibility and appropriateness of the standards using the central case assumptions for technology, market acceptance, and various other assumptions described throughout this preamble and RIA. For a number of these key assumptions, we have conducted sensitivity analyses for the final standards using alternative sets of assumptions. We believe that, together with the central case assumptions, these sensitivities span ranges of values that reasonably cover uncertainties in the critical areas of state policies, battery costs, the market for PEVs, and manufacturer participation in credit trading. As with the central case, we reach the conclusion that the final standards are feasible given consideration of lead time and cost under each of the individual sensitivity cases presented here.

1. State-Level ZEV Policies (ACC II)

We have provided an analysis that accounts for state-level zero-emission vehicle (ZEV) policies as described by California's ACC II program and other participating states under CAA section 177. California has submitted to EPA a request for a waiver for its ACC II program, which is currently under review; EPA is not prejudging the outcome of any waiver process or whether or not certain states are able to adopt California's regulations under the criteria of section 177. Nevertheless, it is an important question to analyze what the potential effect of state adoption of ZEV policies might be in the context of the No Action case, particularly since manufacturers may be adjusting product plans to account for ACC II, and thus we are providing this sensitivity analysis to explore this question. As shown in Table 112, state adoption of ACC II is projected to amount to about 30 percent of total U.S. light-duty sales in 2027 and beyond. Within the states adopting ACC II, manufacturers are required to sell a certain portion of vehicles that meet the ZEV definition, which includes BEVs, FCEVs, and a limited number of PHEVs that satisfy a minimum requirement for charge depleting range. The required ZEV shares increase by model year, reaching 100 percent in 2035 as shown in Table 113.

TABLE 112—SALES SHARE OF U.S. NEW LIGHT-DUTY VEHICLES IN STATES ADOPTING ACC II, BY MODEL YEAR

Model years	Portion of U.S. new light-duty sales (%)	States adopting ACC II
2018 to 2025	12.6	CA.
2026	25.3	CA, MA, NY, OR, VA, VT, WA.
2027 and later	32.8	CA, CO, DC, DE, MA, MD, NM, NJ, NY, OR, RI, VA, VT, WA.

TABLE 113—ZEV PERCENTAGE SALES REQUIREMENTS WITHIN STATES ADOPTING ACC II, BY MODEL YEAR

2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
14.5	17.0	19.5	22.0	35.0	43.0	51.0	59.0	68.0	76.0	82.0	88.0	94.0	100.0

EPA's analysis of state-level ZEV mandates was conducted by separating the base year fleet into two regions. We applied a minimum PEV sales share constraint to the portion of new vehicles in the ACC II-adopting states, using the values in Table 113. For the remainder of new vehicles, a minimum PEV sales share value of zero was specified. In both ZEV and non-ZEV regions, the OMEGA modeling allowed manufacturers to exceed the minimum PEV shares if it resulted in lower producer generalized cost, while still meeting other modeling constraints including compliance with the National GHG standards for the particular policy case and satisfying the consumer demand for PEVs. The results of the analysis for this state-level ZEV mandate sensitivity are summarized in Table 114 through Table 120.

[1295] Though Circular A–4 was revised on November 9, 2023, the updated guidance will not become effective for final rules that are submitted for OMB review until after December 31, 2024. The analyses conducted in support of this rule follow guidance from Circular A–4 finalized in 2003.

TABLE 114—PROJECTED TARGETS WITH ACC II, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	169	170	171	172	171	172
Final Standards	171	153	136	119	102	85

TABLE 115—PROJECTED ACHIEVED LEVELS WITH ACC II, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED [a]

	2027	2028	2029	2030	2031	2032
No Action	145	129	116	104	91	83
Final Standards	152	136	126	114	100	92

[a] Due to a lower limit of available AC leakage, off-cycle and A/C efficiency credits, the achieved levels in the Final Standards appear higher than in the No Action case, although tailpipe CO_2 is equal or less than the No Action case in each year. That is, we expect the final standards to drive CO_2 emissions decreases relative to the No Action case.

TABLE 116—PEV PENETRATIONS WITH ACC II, FOR NO ACTION CASE AND FINAL STANDARD—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	37	41	45	50	56	59
Final Standards	37	42	47	53	60	64

TABLE 117—PHEV PENETRATIONS WITH ACC II, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	5	6	6	8	14	14
Final Standards	5	6	7	6	8	8

TABLE 118—STRONG HEV PENETRATIONS WITH ACC II, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	4	4	4	4	4	4
Final Standards	4	5	5	5	5	5

TABLE 119—ADVANCED ICE PENETRATIONS WITH ACC II, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	45	38	35	31	27	25
Final Standards	46	40	36	31	25	22

TABLE 120—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE WITH ACC II FOR THE FINAL STANDARD—CARS AND TRUCKS COMBINED

[2022 dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards	$143	$82	$95	$227	$969	$1,003	$420

2. Battery Costs

The following section presents key OMEGA results for the low and high battery cost sensitivities, which are described in more detail in section IV.C.2 of the preamble.

i. Low Battery Costs

The low battery cost assumes a 15 percent reduction in battery pack costs (on a $/kWh basis) from the central case compliance analysis, as described in section IV.C.2. Additionally, we use the 45X figures from the NPRM analysis and the 30D/45W estimates from DOE without the reductions described in IV.C.2 that were applied in the central analysis. The corresponding GHG targets and achieved g/mile levels are provided in Table 121 and Table 122. Technology penetrations of PEVs, PHEVs, strong HEVs, and advanced ICE vehicles are summarized in Table 123, Table 124, Table 125, and Table 126. The resulting incremental compliance costs (against the corresponding No Action case) are given in Table 127.

TABLE 121—PROJECTED TARGETS WITH LOW BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	170	171	172	172	172	172
Final Standards	171	154	136	119	102	85

TABLE 122—PROJECTED ACHIEVED LEVELS WITH LOW BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	131	111	101	101	100	103
Final Standards	140	119	113	111	96	82

TABLE 123—PEV PENETRATIONS WITH LOW BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	42	47	51	51	51	50
Final Standards	42	50	54	55	63	70

TABLE 124—PHEV PENETRATIONS WITH LOW BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	5	6	7	8	8	9
Final Standards	5	6	7	8	9	11

TABLE 125—STRONG HEV PENETRATIONS WITH LOW BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	3	4	3	3	3	4
Final Standards	3	3	3	3	3	2

TABLE 126—ADVANCED ICE PENETRATIONS WITH LOW BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	42	34	31	31	31	31
Final Standards	42	35	32	30	25	20

TABLE 127—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR LOW BATTERY COSTS FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards	$106	−$12	−$72	$25	$653	$1,416	$353

ii. High Battery Costs

The high battery cost assumes a 25 percent increase in battery pack costs (on a $/kWh basis) from the central case compliance analysis. The corresponding GHG targets and achieved g/mile levels are provided in Table 128 and Table 129. Technology penetrations of PEVs, PHEVs, strong HEVs, and advanced ICE vehicles are summarized in Table 130, Table 131, Table 132, and Table 133. The resulting incremental compliance costs (against the corresponding No Action case) are given in Table 134.

TABLE 128—PROJECTED TARGETS WITH HIGH BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	168	168	169	169	170	170
Final Standards	170	154	136	120	102	85

TABLE 129—PROJECTED ACHIEVED LEVELS WITH HIGH BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	163	149	148	144	134	128
Final Standards	168	137	126	108	95	83

TABLE 130—PEV PENETRATIONS WITH HIGH BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	29	29	29	31	35	39
Final Standards	30	36	43	52	61	68

TABLE 131—PHEV PENETRATIONS WITH HIGH BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	10	9	8	9	11	13
Final Standards	10	12	12	13	15	18

TABLE 132—STRONG HEV PENETRATIONS WITH HIGH BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	5	9	9	9	8	8
Final Standards	5	11	11	12	11	8

TABLE 133—ADVANCED ICE PENETRATIONS WITH HIGH BATTERY COSTS, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	49	39	39	38	35	33
Final Standards	49	25	22	16	12	10

TABLE 134—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR HIGH BATTERY COSTS FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards	$230	$1,562	$2,300	$3,335	$3,818	$4,187	$2,572

3. Consumer Acceptance of PEVs

We have included sensitivities on the rate of BEV and PHEV acceptance. Given uncertainties in vehicle markets, we estimate results assuming both faster and slower rates of BEV acceptance for all body styles. We also acknowledge that PHEV acceptance could be more prevalent than we estimate in our central case. For information on what these BEV and PHEV acceptance rates are, refer to RIA Chapter 4.1.3.

i. Faster BEV Acceptance

Results assuming a faster rate of BEV acceptance are provided here. The corresponding GHG targets and achieved g/mile levels are provided in Table 135 and Table 136. Technology penetrations of PEVs, PHEVs, strong HEVs, and advanced ICE vehicles are summarized in Table 137, Table 138, Table 139, and Table 140. The resulting incremental compliance costs (against the corresponding No Action case) are given in Table 141.

TABLE 135—PROJECTED TARGETS WITH FASTER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	170	171	172	173	173	174
Final Standards	171	154	136	120	102	85

TABLE 136—PROJECTED ACHIEVED LEVELS WITH FASTER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	133	108	94	86	75	67
Final Standards	140	114	103	99	91	78

TABLE 137—PEV PENETRATIONS WITH FASTER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	41	48	54	57	62	65
Final Standards	41	51	57	60	65	71

TABLE 138—PHEV PENETRATIONS WITH FASTER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	4	5	6	6	8	9
Final Standards	5	5	5	6	6	9

TABLE 139—STRONG HEV PENETRATIONS WITH FASTER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	3	3	3	3	2	3
Final Standards	3	3	3	2	2	2

TABLE 140—ADVANCED ICE PENETRATIONS WITH FASTER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	42	34	30	28	25	23
Final Standards	42	33	29	27	24	19

TABLE 141—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR FASTER BEV ACCEPTANCE FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards	$138	$193	$181	$40	−$19	$274	$134

ii. Slower BEV Acceptance

Results assuming a slower rate of BEV acceptance are provided here. The corresponding GHG targets and achieved g/mile levels are provided in Table 142 and Table 143. Technology penetrations of PEVs, PHEVs, strong HEVs, and advanced ICE vehicles are summarized in Table 144, Table 145, Table 146, and Table 147. The resulting incremental compliance costs (against the corresponding No Action case) are given in Table 148.

TABLE 142—PROJECTED TARGETS WITH SLOWER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	168	170	170	170	171	171
Final Standards	170	153	136	119	102	85

TABLE 143—PROJECTED ACHIEVED LEVELS WITH SLOWER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	161	151	145	141	129	125
Final Standards	162	136	122	107	98	81

TABLE 144—PEV PENETRATIONS WITH SLOWER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	29	26	29	31	37	39
Final Standards	31	36	45	52	60	68

TABLE 145—PHEV PENETRATIONS WITH SLOWER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	9	9	10	10	11	12
Final Standards	10	11	13	14	15	17

TABLE 146—STRONG HEV PENETRATIONS WITH SLOWER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	5	14	13	13	12	12
Final Standards	5	15	13	15	15	12

TABLE 147—ADVANCED ICE PENETRATIONS WITH SLOWER BEV ACCEPTANCE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	48	34	33	32	30	29
Final Standards	46	25	22	15	11	8

TABLE 148—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR SLOWER BEV ACCEPTANCE FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards	$426	$1,074	$1,512	$2,158	$2,291	$2,887	$1,725

4. No Credit Trading Case

As described in section III.C.4 of this preamble, averaging, banking and trading are some of the key compliance flexibilities that EPA has included in its emissions standards dating back to 1983. EPA expects manufacturers to leverage each of these flexibilities to some extent, including the trading of credits between companies. The OMEGA model is set up to allow trading between companies and can be configured so that all of the credits generated are traded to manufacturers that need them (perfect trading), or that only a percentage of credits are traded (imperfect trading), down to a hypothetical ''no trading'' case where each manufacturer must comply on its own using only averaging and banking without the ability to purchase credits earned by another manufacturer.

As we did for the proposal,[1296] in our central case EPA assumes a CME (credit market efficiency) of 0.8, which indicates that 80 percent of a manufacturer's total debits may be purchased from another manufacturer, with the remaining debits having to be made up via implementation of additional vehicle technology. For this ''no trading'' sensitivity, we are setting the CME at a value of 0. As we did in our no trading sensitivity for the proposal, we also apply a 10 percent compliance buffer which requires the manufacturer to strategically aim for a CO_2 level (in total Mg CO_2) that is 10 percent below the target level in each year, so that a sufficient buffer of banked credits is maintained, in lieu of the use of the credit trading flexibility.

Table 149 and Table 150 present the targets and achieved levels for the No Trading case and the No Action No Trading case. Table 151 through Table 154 show the respective technology penetrations for PEVs, PHEVs, strong HEVs and advanced ICE vehicles, while Table 155 shows the incremental compliance costs for the No Trading case.

TABLE 149—PROJECTED TARGETS UNDER THE NO TRADING SENSITIVITY FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action-No Trading	170	169	169	170	170	170
Final Standards-No Trading	171	153	136	119	102	85

TABLE 150—PROJECTED ACHIEVED LEVELS UNDER THE NO TRADING SENSITIVITY FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action-No Trading	142	141	133	129	121	117
Final Standards-No Trading	146	132	116	103	89	77

TABLE 151—PEV PENETRATIONS UNDER THE NO TRADING SENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No Trading	33	34	37	39	42	45
Final Standards-No Trading	34	40	48	55	63	70

TABLE 152—PHEV PENETRATIONS UNDER THE NO TRADING SENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No Trading	6	6	7	8	9	10
Final Standards-No Trading	6	7	8	9	11	13

[1296] See the memo to docket, EPA–HQ–OAR–2022–0829.

TABLE 153—STRONG HEV PENETRATIONS UNDER THE NO TRADING CENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No Trading	7	7	7	7	6	6
Final Standards-No Trading	7	12	10	12	11	10

TABLE 154—ADVANCED ICE PENETRATIONS UNDER THE NO TRADING SENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No Trading	39	46	44	43	40	39
Final Standards-No Trading	38	32	28	21	17	13

TABLE 155—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE UNDER THE NO TRADING SENSITIVITY FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards-No Trading	$268	$1,055	$1,420	$1,983	$2,365	$2,807	$1,650

5. Alternative Manufacturer Pathways

i. Lower BEV Production

This sensitivity was developed to illustrate a hypothetical scenario where manufacturers choose to limit BEV production and focus on PHEVs as a more significant part of their compliance strategy than in the Central case. Note that this is the scenario referred to as ‘‘Pathway B’’ in section I.B.1 of this preamble. To characterize this scenario, we assume that consumers eventually consider PHEVs and ICE vehicles equally acceptable, all else equal. We also apply a production restriction to BEVs increasing over time in a trajectory similar to the No Action central case.

Results assuming Lower BEV Production are provided below. Table 156 and Table 157 give the targets and achieved levels for the Lower BEV Production case and the No Action case. Table 158 through Table 161 show the respective technology penetrations for PEVs, PHEVs, strong HEVs and advanced ICE vehicles, while Table 162 shows the incremental compliance costs for this pathway compared to its No Action case.

TABLE 156—PROJECTED TARGETS FOR LOWER BEV PRODUCTION, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 G/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	168	169	169	170	171	171
Final Standards	170	153	136	119	102	85

TABLE 157—PROJECTED ACHIEVED LEVELS FOR LOWER BEV PRODUCTION, FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	160	153	142	137	128	118
Final Standards	160	146	133	117	102	88

TABLE 158—PEV PENETRATIONS FOR LOWER BEV PRODUCTION, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	31	33	37	39	42	47
Final Standards	34	41	47	54	65	73

TABLE 159—PHEV PENETRATIONS FOR LOWER BEV PRODUCTION, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	5	6	7	8	8	12
Final Standards	10	12	15	18	24	29

TABLE 160—STRONG HEV PENETRATIONS FOR LOWER BEV PRODUCTION, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	4	4	4	4	5	6
Final Standards	4	4	3	6	7	6

TABLE 161—ADVANCED ICE PENETRATIONS FOR LOWER BEV PRODUCTION, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	51	44	41	40	36	33
Final Standards	46	41	36	28	20	15

TABLE 162—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR LOWER BEV PRODUCTION SCENARIO FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)	6-yr avg
Final Standards	$449	$788	$980	$1,639	$2,303	$2,575	$1,456

ii. No Additional BEVs Beyond the No Action Case

This sensitivity was developed to illustrate a hypothetical scenario where manufacturers choose to limit BEV production to the trajectory observed in the Central No Action case. Again, we assume that manufacturers use an increasing number of PHEVs to comply with the final standards. This scenario is also referred to as ''Pathway C'' in section I.B.1 of this preamble. To characterize this scenario, we assume that consumers eventually consider PHEVs and ICE vehicles equally acceptable, all else equal. We also apply a production restriction to BEVs increasing over time in a trajectory similar to the No Action central case.

Results for this sensitivity are provided below. Table 163 and Table 164 give the targets and achieved levels for the No Additional BEVs case and the No Action case. Table 165 through Table 168 show the respective technology penetrations for PEVs, PHEVs, strong HEVs and advanced ICE vehicles, while Table 169 shows the incremental compliance costs for this pathway compared to its No Action case.

TABLE 163—PROJECTED TARGETS FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE, FOR NO ACTION CASE AND FINAL STANDARD (CO_2 G/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	168	169	169	170	171	171
Final Standards	170	155	137	121	103	86

TABLE 164—PROJECTED ACHIEVED LEVELS FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE, FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action	160	153	142	137	128	118
Final Standards	159	124	112	100	95	90

TABLE 165—PEV PENETRATIONS FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	31	33	37	39	42	47
Final Standards	35	43	52	57	66	71

TABLE 166—PHEV PENETRATIONS FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	5	6	7	8	8	12
Final Standards	10	17	22	27	32	36

TABLE 167—STRONG HEV PENETRATIONS FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	4	4	4	4	5	6
Final Standards	4	15	13	16	15	13

TABLE 168—ADVANCED ICE PENETRATIONS FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action	51	44	41	40	36	33
Final Standards	46	20	17	10	6	5

TABLE 169—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR NO ADDITIONAL BEVS BEYOND THE NO ACTION CASE SCENARIO FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards	$536	$2,517	$2,630	$3,120	$3,334	$3,112	$2,542

6. Overall Consideration of Sensitivity Analyses

The following is a summary of the sensitivities conducted and a comparison of resulting PEV penetrations and incremental technology costs for the standards compared to the respective No Action case.

As can be seen, the projected targets for the final standards are not significantly different across the range of sensitivities discussed in this section.[1297] It is important to note that manufacturers are able to meet the targets for the standards in every year for the range of sensitivities analyzed here. However, the achieved levels do vary in each sensitivity; in some cases, there is greater level of overcompliance (most notably in the Faster BEV Acceptance case).

Table 170 and Table 171 present a comparison for the projected targets and achieved levels for the final standards, based on the various identified sensitivities (the central No Action case is provided for reference). While total PEV penetrations projected to meet the standards (shown in Table 174) do not vary much across the sensitivity cases, the mix of PHEVs and BEVs does vary across sensitivities (refer to Table 175 and Table 176). PEV penetrations in the No Action case vary significantly: projected MY 2032 PEV penetrations range from 39 percent to 65 percent based on different input assumptions which affect consumer demand for electric vehicles and in the case of the State-level ZEV Policies scenario also reflect state required BEV shares. The range of PEV penetrations in the No Action case is provided in Table 177.

Of the metrics considered, the range of sensitivities have the greatest impact on incremental vehicle cost compared to their respective No Action case. We have also provided industry average absolute vehicle costs in Table 178, with the incremental costs of compliance for each sensitivity in Table 179. Compared to a 6-year average incremental cost of about $1,200 for the central case, these sensitivities result in a range of 6-year average incremental costs from $100 (the Faster BEV Acceptance case) per vehicle to about $2,600 (the High Battery Costs case). The two sensitivity cases that result in less BEV penetrations in the No Action case—High Battery Costs and the No Additional BEVs cases—result in the highest incremental costs. Three

[1297] While manufacturers may adjust their product mix as one of their compliance strategies, the OMEGA future car/truck mix is fixed, and based on the forecast from AEO 2023.

sensitivities have substantially lower incremental costs than the central case—the Low Battery Costs, Faster BEV Acceptance, and State-Level ZEV Policies scenarios. Three other sensitivities have incremental costs comparable to those of the central case—Slower BEV Acceptance, No Trading case, and Lower BEV Production. We believe the costs are reasonable across this range of sensitivities, as discussed in section V.B.

TABLE 170—RANGE OF TARGETS FOR FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
Central case—No Action (reference)	168	169	169	170	171	171
Central case—Final Standards	170	153	136	119	102	85
Sensitivities						
State-level Policies	171	153	136	119	102	85
Low Battery Costs	171	154	136	119	102	85
High Battery Costs	170	154	136	120	102	85
Faster BEV Acceptance	171	154	136	120	102	85
Slower BEV Acceptance	170	153	136	119	102	85
No Trading case	171	153	136	119	102	85
Lower BEV Production	170	153	136	119	102	85
No Additional BEVs	170	155	137	121	103	86

TABLE 171—RANGE OF ACHIEVED LEVELS FOR FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED a

	2027	2028	2029	2030	2031	2032
Central case—No Action (reference)	160	153	142	137	128	118
Central case—Final Standards	164	149	130	116	100	87
Sensitivities						
State-level Policies	152	136	126	114	100	92
Low Battery Costs	131	111	101	101	100	103
High Battery Costs	168	137	126	108	95	83
Faster BEV Acceptance	140	114	103	99	91	78
Slower BEV Acceptance	162	136	122	107	98	81
No Trading case	146	132	116	103	89	77
Lower BEV Production	160	146	133	117	102	88
No Additional BEVs	159	124	112	100	95	90

[a] Achieved levels for the No Action case are lower in MY 2027 due to additional off-cycle and A/C credits available to manufacturers.

TABLE 172—RANGE OF TARGETS FOR NO ACTION CASE (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
Central case	168	169	169	170	171	171
State-level Policies	169	170	171	172	171	172
Low Battery Costs	170	171	172	172	172	172
High Battery Costs	168	168	169	169	170	170
Faster BEV Acceptance	170	171	172	173	173	174
Slower BEV Acceptance	168	170	170	170	171	171
No Trading case	170	169	169	170	170	170
Lower BEV Production	168	169	169	170	171	171
No Additional BEVs	168	169	169	170	171	171

TABLE 173—RANGE OF ACHIEVED LEVELS FOR NO ACTION CASE (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
Central case	160	153	142	137	128	118
State-level Policies	145	129	116	104	91	83
Low Battery Costs	131	111	101	101	100	103
High Battery Costs	163	149	148	144	134	128
Faster BEV Acceptance	133	108	94	86	75	67
Slower BEV Acceptance	161	151	145	141	129	125
No Trading case	142	141	133	129	121	117
Lower BEV Production	160	153	142	137	128	118
No Additional BEVs	160	153	142	137	128	118

TABLE 174—RANGE OF PEV PENETRATIONS FOR FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Central case—No Action (reference)	31	33	37	39	42	47
Central case—Final Standards	32	37	46	53	61	68
Sensitivities						
State-level Policies	37	42	47	53	60	64
Low Battery Costs	42	50	54	55	63	70
High Battery Costs	30	36	43	52	61	68
Faster BEV Acceptance	41	51	57	60	65	71
Slower BEV Acceptance	31	36	45	52	60	68
No Trading case	34	40	48	55	63	70
Lower BEV Production	34	41	47	54	65	73
No Additional BEVs	35	43	52	57	66	71

TABLE 175—RANGE OF BEV PENETRATIONS FOR FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Central case—No Action (reference)	26	27	30	31	34	35
Central case—Final Standards	26	31	39	44	51	56
Sensitivities						
State-level Policies	31	36	40	47	52	56
Low Battery Costs	37	44	47	48	54	59
High Battery Costs	20	25	30	38	46	50
Faster BEV Acceptance	37	46	52	54	58	62
Slower BEV Acceptance	21	25	32	38	44	52
No Trading case	28	33	41	46	52	56
Lower BEV Production	24	29	33	37	41	43
No Additional BEVs	24	26	30	31	34	35

TABLE 176—RANGE OF PHEV PENETRATIONS FOR FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Central case—No Action (reference)	5	6	7	8	8	12
Central case—Final Standards	6	6	8	9	11	13
Sensitivities						
State-level Policies	5	6	7	6	8	8
Low Battery Costs	5	6	7	8	9	11
High Battery Costs	10	12	12	13	15	18
Faster BEV Acceptance	5	5	5	6	6	9
Slower BEV Acceptance	10	11	13	14	15	17
No Trading case	6	7	8	9	11	13
Lower BEV Production	10	12	15	18	24	29
No Additional BEVs	10	17	22	27	32	36

TABLE 177—RANGE OF PEV PENETRATIONS FOR NO ACTION CASE—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Central case	31	33	37	39	42	47
State-level Policies	37	41	45	50	56	59
Low Battery Costs	42	47	51	51	51	50
High Battery Costs	29	29	29	31	35	39
Faster BEV Acceptance	41	48	54	57	62	65
Slower BEV Acceptance	29	26	29	31	37	39
No Trading case	33	34	37	39	42	45
Lower BEV Production	31	33	37	39	42	47
No Additional BEVs	31	33	37	39	42	47

TABLE 178—RANGE OF ABSOLUTE VEHICLE COSTS FOR NO ACTION CASE—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Central case	$43,412	$43,561	$43,761	$43,948	$44,357	$44,915	$43,992
State-level Policies	44,127	44,643	44,844	45,313	45,165	45,641	44,956
Low Battery Costs	43,374	43,953	43,996	44,219	44,478	44,593	44,102
High Battery Costs	43,952	44,359	44,157	44,330	44,828	45,175	44,467
Faster BEV Acceptance	44,697	45,532	45,716	46,044	46,496	46,959	45,907
Slower BEV Acceptance	43,298	43,897	43,934	44,044	44,516	44,721	44,068
No Trading case	44,260	44,083	44,155	44,264	44,567	44,830	44,360
Lower BEV Production	43,412	43,561	43,761	43,948	44,357	44,915	43,992
No Additional BEVs	43,412	43,561	43,761	43,948	44,357	44,915	43,992

TABLE 179—RANGE OF INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Central case	$232	$552	$1,002	$1,481	$1,875	$2,074	$1,203
State-level Policies	143	82	95	227	969	1,003	420
Low Battery Costs	106	−12	−72	25	653	1,416	353
High Battery Costs	230	1,562	2,300	3,335	3,818	4,187	2,572
Faster BEV Acceptance	138	193	181	40	−19	274	134
Slower BEV Acceptance	426	1,074	1,512	2,158	2,291	2,887	1,725
No Trading case	268	1,055	1,420	1,983	2,365	2,807	1,650
Lower BEV Production	449	788	980	1,639	2,303	2,575	1,456
No Additional BEVs	536	2,517	2,630	3,120	3,334	3,112	2,542

TABLE 180—ABSOLUTE COST COMPARISON OF NO ACTION AND FINAL STANDARDS FOR CENTRAL CASE AND SENSITIVITIES—2032 MY

	No action absolute cost	Final standards absolute cost	Incremental cost
Central case	$44,915	$46,989	$2,074
State-level Policies	45,641	46,644	1,003
Low Battery Costs	44,593	46,009	1,416
High Battery Costs	45,175	49,362	4,187
Faster BEV Acceptance	46,959	47,233	274
Slower BEV Acceptance	44,721	47,608	2,887
No Trading case	44,830	47,637	2,807
Lower BEV Production	44,915	47,490	2,575
No Additional BEVs	44,915	48,027	3,112

G. Sensitivities—MD GHG Compliance Modeling

1. Battery Costs (Low and High)

For medium-duty vehicles, we have conducted high and low battery pack cost sensitivities, similar to those done for the light-duty GHG analysis (for more information refer to section IV.F.2 of this preamble). The low and high battery pack cost sensitivities have been combined into the summary tables in this section.

Table 181 and Table 182 present a comparison for the targets and the projected achieved levels for the final standards, based on battery costs assumed for the central case and the low and high cost sensitivity cases. The range of PEV penetrations and PHEV penetrations for the final MD standards are provided in Table 183 and Table 184. These tables show generally consistent results between the central case and the battery cost sensitivities because consumer behavior was not reflected in the medium-duty compliance analysis.

Battery costs have the greatest impact on incremental vehicle cost compared to the No Action case. Compared to a 6-year average incremental costs of about $1,400 for the central case, these sensitivities result in a range of incremental costs from $1,100 per vehicle to about $1,900. Incremental vehicle costs for the final standards for the two sensitivities are provided in Table 185.

TABLE 181—PROJECTED TARGETS FOR FINAL STANDARDS (CO_2 GRAMS/MILE)—CENTRAL CASE, LOW AND HIGH BATTERY SENSITIVITIES—MEDIUM-DUTY VEHICLES

	2027	2028	2029	2030	2031	2032
Central case	461	453	408	353	314	274
Low Battery Costs	461	453	408	353	314	274

TABLE 181—PROJECTED TARGETS FOR FINAL STANDARDS (CO_2 GRAMS/MILE)—CENTRAL CASE, LOW AND HIGH BATTERY SENSITIVITIES—MEDIUM-DUTY VEHICLES—Continued

	2027	2028	2029	2030	2031	2032
High Battery Costs	461	453	409	353	315	275

TABLE 182—PROJECTED ACHIEVED LEVELS FOR FINAL STANDARDS (CO_2 GRAMS/MILE)—CENTRAL CASE, LOW AND HIGH BATTERY SENSITIVITIES—MEDIUM-DUTY VEHICLES

	2027	2028	2029	2030	2031	2032
Central case	456	451	407	351	312	272
Low Battery Costs	456	452	407	351	311	272
High Battery Costs	456	451	408	352	314	273

TABLE 183—PEV PENETRATIONS FOR FINAL STANDARDS—CENTRAL CASE, LOW AND HIGH BATTERY SENSITIVITIES—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Central case	3	4	14	27	32	43
Low Battery Costs	3	4	14	27	33	44
High Battery Costs	3	4	14	27	31	42

TABLE 184—PHEV PENETRATIONS FOR FINAL STANDARDS—CENTRAL CASE, LOW AND HIGH BATTERY SENSITIVITIES—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
Central case	0	0	0	5	3	11
Low Battery Costs	0	0	0	5	5	12
High Battery Costs	0	0	4	9	6	11

TABLE 185—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR FINAL STANDARDS—CENTRAL CASE, LOW AND HIGH BATTERY SENSITIVITIES—MEDIUM-DUTY VEHICLES

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Central case	$125	$122	$847	$1,881	$2,416	$3,275	$1,444
Low Battery Costs	125	122	553	1,356	1,863	2,696	1,119
High Battery Costs	125	121	1,120	2,493	3,247	4,206	1,885

2. No Credit Trading Case

Similar to the approach we used for the light-duty GHG modeling sensitivity (section IV.F.4 of the preamble), we conducted a No Trading sensitivity for medium-duty vehicles. Refer to section IV.F.4 of this preamble for modeling details that we applied for this No Trading case.

Table 186 and Table 187 present the CO_2 targets and achieved levels for the No Trading case and the No Action No Trading case. Table 188 and Table 189 show the respective technology penetrations for PEVs and PHEVs. Table 190 shows the incremental compliance costs for the No Trading case for medium-duty vehicles.

TABLE 186—PROJECTED TARGETS UNDER THE NO TRADING SENSITIVITY FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—MEDIUM-DUTY VEHICLES

	2027	2028	2029	2030	2031	2032
No Action-No Trading	473	473	473	473	474	473
Final Standards-No Trading	460	452	408	352	313	274

TABLE 187—PROJECTED ACHIEVED LEVELS UNDER THE NO TRADING SENSITIVITY FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—MEDIUM-DUTY VEHICLES

	2027	2028	2029	2030	2031	2032
No Action-No Trading	426	425	424	423	422	420
Final Standards-No Trading	413	406	366	317	282	247

TABLE 188—PEV PENETRATIONS FOR FINAL STANDARDS—CENTRAL CASE, NO TRADING SENSITIVITY—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No Trading	8	8	8	8	8	9
Final Standards-No Trading	10	11	20	32	40	50

TABLE 189—PHEV PENETRATIONS FOR FINAL STANDARDS—CENTRAL CASE, NO TRADING SENSITIVITY—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No Trading	0	0	0	0	0	0
Final Standards-No Trading	0	0	0	5	11	20

TABLE 190—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE FOR FINAL STANDARDS—CENTRAL CASE, NO TRADING SENSITIVITY—MEDIUM-DUTY VEHICLES

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards-No Trading	$326	$412	$1,086	$2,072	$2,846	$3,806	$1,758

H. Additional Illustrative Scenarios

1. No New BEVs Above Base Year Fleet—Light-Duty Vehicles

For this analysis, EPA has also assessed the ability for manufacturers to comply with the final standards in an illustrative scenario where No New BEV models are sold beyond those that were already present in the MY 2022 fleet (5 percent of the new vehicle market). In this ''No New BEVs Above Base Year Fleet'' scenario, we restricted OMEGA so that ICE vehicles, HEVs and PHEVs cannot be redesigned as a new BEV. EPA also applied this restriction to the No Action case associated with this scenario. It is important to note that MY 2023 BEV sales for the U.S. are expected to approach 10 percent market share, so this analysis assumes a 50 percent reduction in BEV sales even from current levels. Although EPA recognizes that this scenario is highly unlikely to occur given the ongoing investment and growth in consumer acceptance of BEVs, it is illustrative of the potential range of compliance options available to manufacturers to meet these standards.

EPA developed this scenario to evaluate concerns raised by some commenters that the standards imposed a BEV ''mandate'' that would dramatically transform the U.S. economy. All regulated entities indicated their intention to produce BEVs as an increasing share of their fleet to achieve GHG emissions reductions—including in the absence of this rule due to their market strategies, the IRA, and other factors. As already explained, the final standards do not impose any BEV mandate, either legally or practically, and we expect manufacturers to choose to produce a range of BEV, PHEV, HEV and ICE vehicles during the timeframe for this rule. Nothing in the Clean Air Act requires EPA to identify multiple technology pathways to achieve compliance or to show that manufacturers can achieve the standards solely by relying on alternatives to what is currently the most effective technology for controlling emissions. Nonetheless, EPA performed this illustrative scenario to evaluate certain commenters' claims that this rule would force increased BEV adoption. EPA's modeling demonstrates that this is not the case. Rather, the final standards are feasible even with no new BEV adoption, albeit at a greater cost. As the modeling results show, the industry can comply with the final standards by producing the base year percentage of BEVs and a significant percentage of PHEVs. However, as PHEVs are not as cost-effective for compliance as BEVs, the cost of compliance increases. The corresponding GHG targets and achieved g/mile levels are provided in Table 191 and Table 192. Technology penetrations of PEVs, PHEVs, strong HEVs, and advanced ICE vehicles are summarized in Table 193 through Table 196. Incremental costs are relative to the alternative No Action case which also restricts additional production of new BEVs. Costs are provided in Table 197.

TABLE 191—PROJECTED TARGETS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action-No New BEVs	167	167	166	168	167	167
Final Standards-No New BEVs	169	152	134	118	101	84

TABLE 192—PROJECTED ACHIEVED LEVELS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action-No New BEVs	165	165	164	166	164	165
Final Standards-No New BEVs	167	150	133	117	102	84

TABLE 193—PEV PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No New BEVs	14	14	14	13	12	13
Final Standards-No New BEVs	15	25	36	48	74	91

TABLE 194—PHEV PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No New BEVs	9	8	9	7	7	7
Final Standards-No New BEVs	10	19	31	43	69	86

TABLE 195—STRONG HEV PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027	2028	2029	2030	2031	2032
No Action-No New BEVs	20	22	24	18	22	23
Final Standards-No New BEVs	23	26	21	19	15	5

TABLE 196—ADVANCED ICE PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO, FOR NO ACTION CASE AND FINAL STANDARDS—CARS AND TRUCKS COMBINED

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No New BEVs	28	35	37	34	33	37
Final Standards—No New BEVs	20	13	8	5	0	0

TABLE 197—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SCENARIO FOR THE FINAL STANDARDS—CARS AND TRUCKS COMBINED

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards-No New BEVs	$205	$1,538	$2,536	$3,019	$4,722	$5,459	$2,913

2. No New BEVs Above Base Year Fleet—Medium-Duty Vehicles

As we did for light-duty vehicles, EPA has also assessed the ability for manufacturers to comply with the final medium-duty GHG standards in a scenario where No New BEV models are sold beyond those already present in the base year fleet used for this analysis.[1298] In the medium-duty ''No New BEVs'' scenario, OMEGA is restricted so that any ICE, HEV or PHEV vehicle cannot be redesigned as a new BEV. We also

[1298] No BEVs existed in the market for the MY 2020 medium-duty vehicle base year fleet used for this analysis; therefore, ''No New BEVs'' is analogous to ''No BEVs.'' Accordingly, all electrified vehicles for this scenario are PHEVs.

restrict OMEGA from redesigning new BEVs for the corresponding No Action case; OMEGA applies PHEVs to satisfy CARB's Advanced Clean Trucks (ACT) ZEV requirements. Although EPA recognizes that the No New BEVs scenario is highly unlikely to occur given the ongoing investment in BEVs, it is illustrative of the range of compliance options available to the industry to meet these standards.

As the modeling results show, the industry can still comply with the final medium-duty GHG standards by producing a significant percentage of PHEVs. However, as PHEVs are not as cost-effective for compliance as pure battery electric vehicles, the costs of compliance increase. The corresponding GHG targets and achieved g/mile levels are provided in Table 198 and Table 199. Technology penetrations of PEVs, PHEVs, and advanced ICE vehicles[1299] are summarized in Table 200 through Table 202. Incremental costs are relative to the alternative No Action case which also restricts additional production of new BEVs. Costs are provided in Table 203.

TABLE 198—PROJECTED TARGETS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SENSITIVITY FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—MEDIUM-DUTY VEHICLES

	2027	2028	2029	2030	2031	2032
No Action-No New BEVs	477	477	477	478	478	478
Final Standards-No New BEVs	461	454	411	355	318	278

TABLE 199—PROJECTED ACHIEVED LEVELS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SENSITIVITY FOR NO ACTION CASE AND FINAL STANDARDS (CO_2 GRAMS/MILE)—MEDIUM-DUTY VEHICLES

	2027	2028	2029	2030	2031	2032
No Action-No New BEVs	459	455	452	448	445	441
Final Standards-No New BEVs	459	454	411	356	317	279

TABLE 200—PEV PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No New BEVs	3	4	5	6	7	8
Final Standards-No New BEVs	3	4	16	30	39	51

TABLE 201—PHEV PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No New BEVs	3	4	5	6	7	8
Final Standards-No New BEVs	3	4	16	30	39	51

TABLE 202—ADVANCED ICE PENETRATIONS UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SENSITIVITY, FOR NO ACTION CASE AND FINAL STANDARDS—MEDIUM-DUTY VEHICLES

	2027 (%)	2028 (%)	2029 (%)	2030 (%)	2031 (%)	2032 (%)
No Action-No New BEVs	57	57	56	55	55	54
Final Standards-No New BEVs	57	56	50	42	38	31

TABLE 203—AVERAGE INCREMENTAL VEHICLE COST VS. NO ACTION CASE UNDER THE NO NEW BEVS ABOVE BASE YEAR FLEET SENSITIVITY FOR THE FINAL STANDARDS—MEDIUM-DUTY VEHICLES

[2022 Dollars]

	2027	2028	2029	2030	2031	2032	6-yr avg
Final Standards-No New BEVs	$129	$181	$1,284	$2,850	$4,189	$5,360	$2,332

[1299] As discussed, strong HEVs were not modeled for medium-duty vans and pickup trucks.

V. EPA's Basis That the Final Standards are Feasible and Appropriate Under the Clean Air Act

A. Overview

The Clean Air Act authorizes EPA to establish emissions standards for motor vehicles to regulate emissions of air pollutants that contribute to air pollution which, in the Administrator's judgment, may reasonably be anticipated to endanger public health or welfare. See also Coalition for Responsible Regulation v. EPA, 684 F. 3d at 122 (''the job Congress gave [EPA] in CAA section 202(a)'' is ''utilizing emission standards to prevent reasonably anticipated endangerment from maturing into concrete harm''). As discussed in section II of this preamble, emissions from motor vehicles contribute to ambient levels of pollutants for which EPA has established health-based NAAQS. These pollutants are linked with respiratory and/or cardiovascular problems and other adverse health impacts leading to increased medication use, hospital admissions, emergency department visits, and premature mortality. In addition, light and medium-duty vehicles are significant contributors to the U.S. GHG emissions inventories. As discussed in section II of this preamble, there is a critical need for further criteria pollutant and GHG reductions to address the adverse impacts of air pollution from light- and medium-duty vehicles on public health and welfare.

To this end, as in EPA's past light and medium duty rulemakings, in this final rule we considered the following factors in setting final standards: technology effectiveness, its cost (including per vehicle, per manufacturer, and per purchaser), the lead time necessary to implement the technology, and, based on this, the feasibility of potential standards; the impacts of potential standards on emissions reductions; the impacts of standards on oil conservation and energy security; the impacts of standards on fuel savings by vehicle operators; the impacts of standards on the vehicle manufacturing industry; as well as other relevant factors such as impacts on safety. To evaluate and balance these statutory factors and other relevant considerations, EPA must necessarily estimate a means of compliance: what technologies are projected to be available to be used, what do they cost, and what is appropriate lead time for their deployment. Thus, to support the feasibility of the final standards, EPA identified a potential compliance pathway. Having identified one means of compliance, EPA's task is to ''answe[r] any theoretical objections'' to that means of compliance, ''identif[y] the major steps necessary,'' and to ''offe[r] plausible reasons for believing that each of those steps can be completed in the time available.'' NRDC v. EPA, 655 F. 2d at 332. That is what EPA has done here in this final rule, and indeed what it has done in all of the motor vehicle emission standard rules implementing section 202(a) of the Act for half a century.

In assessing the means of compliance, EPA considers updated data available at the time of this rulemaking, including real-world technological and corresponding costs developments related to emissions-reducing technologies for light and medium duty vehicles. The statute directs EPA to assess the ''development and application of the requisite technology, giving appropriate consideration to the cost of compliance within'' the relevant timeframe, and specifically compels EPA to consider relevant emissions-reduction technologies on vehicles and engines regardless of ''whether such vehicles and engines are designed as complete systems or incorporate devices to prevent or control such pollution.'' CAA section 202(a)(1), (2). The statute does not prescribe particular technologies, but rather entrusts to the EPA Administrator the authority and obligation to identify a range of available technologies that have the potential to significantly control or prevent emissions of the relevant pollutants and establish standards based on his consideration of the lead-time and costs for such technologies, along with other factors. Pursuant to the statutory mandate and as explained throughout this preamble, EPA has considered the full range of vehicle technologies that meet these criteria and that we anticipate will be available in the MY 2027–32 timeframe, including numerous ICE and advanced ICE vehicle, HEV, PHEV, and BEV technologies.

With continued advances in internal combustion emissions controls and a range of vehicle electrification technologies being more widely deployed, EPA believes substantial further emissions reductions are feasible and appropriate under the Clean Air Act. It has been a decade since EPA updated light-duty vehicle criteria pollutant standards. While light-duty GHG standards have been updated more recently, various developments since the most recent light-duty standards are supportive of even greater levels of production and adoption of PEV technology, which is highly effective for controlling tailpipe emissions of criteria pollutants and GHGs.[1300] These developments include the public announcements by manufacturers about their plans to transition fleets to electrified vehicles, the increase in PEV model availability across all vehicle types, continued growth in consumer acceptance—and sales—of PEVs, and the additional support for PEVs provided by the Inflation Reduction Act (IRA). Prior to the passage of the IRA, EPA received input from auto manufacturers that increasing the market share of PEVs is now technologically feasible but that it is important to address consumer issues such as charging infrastructure and the cost to purchase a PEV, as well as manufacturing issues such as battery supply and manufacturing costs. The IRA provides powerful incentives in all of these areas that will address these issues in the timeframe considered in this rulemaking. Indeed, EPA's projections, which are consistent with a range of third-party projections, suggest that automakers sell significant numbers of PEVs even absent any revised standards, in part due to the incentives of the IRA. EPA has consulted closely with DOE in considering the impacts of the IRA in our assessment of the appropriate standards and those impacts are an important element of EPA's cost and feasibility assessment.[1301]

The balance of this section summarizes the key factors found in the administrative record (including the entire preamble, RIA, and RTC) that form the basis for the Administrator's determination that the final standards are feasible and appropriate under our Clean Air Act authority. Section V.B of the preamble discusses the statutory factors of technological feasibility, compliance costs, and lead time, and it explains that the final standards are predicated upon technologies that are feasible and of moderate cost during the timeframe for this rule. Section V.C of the preamble evaluates emissions of GHGs and criteria pollutants, and it finds that the final standards would achieve significant GHG and criteria pollutant reductions that make an important contribution to mitigating air pollution, including climate change.

[1300] See also the extensive discussion of recent developments in emission-reducing technologies, including PEV technology, in sections I.A.2 and IV.C.1 of this preamble.

[1301] It is important to note that, although E.O. 14037 identified a goal for 50 percent of U.S. new vehicle sales to be zero-emission vehicles by 2030, the E.O. only directed EPA to consider beginning work on a new rulemaking and to do so consistent with applicable law. EPA exercised its technical judgment based on the record before it in developing this rule consistent with the authority of section 202 of the Clean Air Act.

Section V.D of the preamble evaluates other relevant factors that are important to evaluating the real-world feasibility of the standards as well as their impact, including impacts on purchasers, energy, safety, and other factors. It concludes that the final standards will result in considerable benefits for purchasers and operators of light and medium duty vehicles, create positive energy security benefits for the United States, and not create an unreasonable risk to safety. Section V.E of the preamble explains how the Administrator exercised the discretion Congress entrusted the agency with in balancing the various factors we considered. It articulates the key factors that were dispositive to the Administrator's decision in selecting the final standards, such as feasibility, compliance costs, lead time, and emissions reductions; as well as other factors that were not used to select the standards but that nonetheless provide further support for the Administrator's decision. On balance, this section V, together with the rest of the administrative record, demonstrates that the final standards are supported by voluminous evidence, the product of the agency's well-considered technical judgment and the Administrator's careful weighing of the relevant factors, and that these standards faithfully implement the important directive contained in section 202(a) of the Clean Air Act to reduce emissions of air pollutants from motor vehicles which cause or contribute air pollution that may reasonably be anticipated to endanger public health or welfare.

B. Consideration of Technological Feasibility, Compliance Costs and Lead Time

The technological readiness of the auto industry to meet the final standards for model years 2027–2032 is best understood in the context of over a decade of light-duty vehicle emissions reduction programs in which the auto industry has introduced emissions-reducing technologies in a wide lineup of ever more cost-effective, efficient, and high-volume vehicle applications. Among the range of technologies that have been demonstrated over the past decade, electrification technologies have seen particularly rapid development and lower costs. Since EPA first started assessing technologies for reducing GHG emissions, we have recognized that ''electrification'' represents a full spectrum of technologies, from reducing demand on a gasoline powertrain for certain accessories or circumstances (such as regenerative braking or engine stop-start), to hybrid gasoline-electric powertrains to pure electric powertrains. In light of increased automaker investment and reduced costs, the level of electrification across all the No Action scenarios, as well as the policy alternatives considered in this rule, is higher than in any of EPA's prior rulemakings. In particular, the advancements across the spectrum of electrification technologies, including those with tailpipe emissions rates much lower than ICE-only vehicles, are supportive of EPA setting standards with much lower GHG, $NMOG+NO_X$, and PM levels than was achievable in earlier rulemakings. Manufacturers have also demonstrated impressive gains in controlling $NMOG+NO_X$ and PM from vehicles with internal combustion engines. Many vehicles are already demonstrating emissions performance at one-third to one half of the Tier 3 $NMOG+NO_X$ final fleet average of 30 mg/mile through optimized engine and aftertreatment design and controls. In addition, there have been approximately 100 million gasoline particulate filters (GPFs) installed in light-duty vehicles worldwide, with current GPFs typically reducing PM emissions by over 95 percent.

In this rulemaking, unlike some prior vehicle emissions standards (including those adopted in the Clean Air Act of 1970), the technology necessary to achieve significantly more stringent standards has already been developed and demonstrated in production vehicles. For example, vehicles equipped with gasoline particulate filters are already in widespread use in Europe and China; manufacturers have been building gasoline particulate filter equipped cars and trucks in the U.S. for export to countries with more stringent PM standards; and at least one manufacturer has been selling vehicles with gasoline particulate filters in the U.S.[1302] PEVs are now being produced in large numbers in every segment and size of the current light-duty fleet, ranging from small cars such as Tesla's Model 3 or Hyundai's Kona to light trucks such as Ford's F150 Lightning, and their production for the U.S. market have quadrupled in the last few years.[1303] Large fleet owners have also begun fulfilling fleet electrification commitments by taking delivery of rapidly growing numbers of BEV medium-duty delivery vans.[1304] In setting standards, EPA considers the extent of further deployment that is warranted to provide the benefits to public health and welfare, and potential constraints, such as costs, raw material availability, component supplies, redesign cycles, refueling infrastructure, and consumer acceptance. The extent of these potential constraints has diminished significantly, even since the 2021 rule, as evidenced by increased automaker investments, increased acceptance by consumers, further deployment of charging infrastructure, and significant support from Congress to address such areas as upfront purchase price, charging infrastructure, critical mineral supplies, and domestic supply chain manufacturing.

In response to these diminished constraints and the increased stringency of the standards, we expect that automakers will continue to adopt advanced technologies at an increasing pace across more of their vehicle fleets. EPA has carefully considered potential remaining constraints on further deployment of these advanced technologies. For example, in addition to considering the breadth of current product offerings, EPA has also considered vehicle redesign cycles. Based on previous public comments and industry trends, manufacturers generally require about five years to design, develop, and produce a new vehicle model.[1305] EPA's technical assessment for this rule accounts for these redesign limits.[1306] Within the modeling that EPA conducted to support this rule, we have assumed limits to the rate at which a manufacturer can alter its technology mix. We have also, after consultation with DOE, applied limits to the ramp up of battery production, considering the time needed to increase the availability of raw materials and construct or expand battery production facilities. Constraints for redesign and battery production in our compliance modeling are described in more detail in Chapter 2.6 of the RIA. Our modeling also incorporates constraints related to

[1302] Ferrari noted in its comments it has been selling vehicles with GPF in the US since 2019. (Docket EPA–HQ–OAR–2022–0829–0637, p. 3).

[1303] Estimated at 8.4 percent of production in MY 2022, up from 4.4 percent in MY 2021 and 2.2 percent in MY 2020. See also the discussion of U.S. PEV penetration in I.A.2.ii.

[1304] See the discussion of fleet electrification commitments in I.A.2.ii.

[1305] For example, in its comments on the 2012 rule, Ford stated that manufacturers typically begin to firm up their product plans roughly five years in advance of actual production. Docket OAR–2009–0472–7082.1, p. 10.

[1306] In our compliance modeling, we have limited vehicle redesign opportunities through MY 2029 in our compliance modeling to every 7 years for light- and medium-duty pickup trucks and medium-duty vans, and 5 years for all other vehicles. We are assuming that manufacturers have sufficient lead team to adjust product redesign years after MY 2029, so we do not continue to apply redesign constraints for MYs 2030 and beyond.

consumer acceptance. Under our central case analysis assumptions, the model anticipates that consumers will in the near term tend to favor ICE vehicles over PEVs when two vehicles are comparable in cost and capability.[1307] Taking into account individual consumer preferences, we anticipate that PEV acceptance and adoption will continue to accelerate as consumer familiarity with PEVs grows, as demonstrated in the scientific literature on PEV acceptance and consistent with typical diffusion of innovation. Adoption of PEVs is expected to be further supported by expansion of key enablers of PEV acceptance, namely increasing market presence of PEVs, more model choices, expanding infrastructure, and decreasing costs to consumers.[1308] See also section IV.C.5 of the preamble and RIA Chapter 4. Overall, given the flexibility to adopt diverse compliance strategies, the number and breadth of current low- or zero-emission vehicles and the assumptions we have made to limit the rate at which new vehicle technologies are adopted, our assessment shows that there is sufficient lead time for the industry to deploy existing technologies more broadly and successfully comply with the final standards.

Our analysis projects that for the industry overall, one potential compliance strategy manufacturers could choose to meet the standards is by using 68 percent PEVs in MY 2032, of which 56 percent are BEVs and 13 percent are PHEVs. EPA believes that this is an achievable level based on our technical assessment for this rule that includes consideration of the feasibility and required lead time, including acceptance of PEVs in the market. Our assessment of the appropriateness of the level of PEVs in our analysis is also informed by public announcements by manufacturers about their plans to transition fleets to electrified vehicles, as described in section I.A.2 of this preamble and further discussed in RIA Chapter 3.1.3. We also note that our ''No Action'' scenario, which models the effect of the IRA but does not attempt to account for manufacturers' announced strategies, shows that PEV penetration in the absence of revised standards is expected to grow from 31 percent in MY 2027 to 39 percent in MY 2030. We have good reason to believe that our No Action PEV estimates are conservative, and that they could be higher given that mid-range third party estimates range from 48 percent to 58 percent in 2030.[1309] [1310] [1311] [1312] [1313] [1314] Mid-range third party estimates exclude extreme estimates, which did not implement all IRA incentives (42 percent in 2030) or are self-described as ''High'' (60 and 68 percent in 2030) or ''Advanced'' (65 percent in 2030) by respective study authors.[1315] [1316] [1317] [1318] We project our standards, if manufacturers choose the potential compliance path modeled, would result in PEV penetration rates of 32 percent in MY 2027 and 53 percent in MY 2030 (*i.e.,* almost no change in MY 2027 and only an 14 percentage point increase in 2030 as compared to the No Action scenario). We do anticipate greater PEV penetration in later years (growing from 47 percent in the No Action scenario in MY 2032 to 68 percent under the modeled potential compliance path in 2032) but the very substantial rates of PEV penetration under the No Action scenario underscore that a shift to widespread use of electrification technologies is already well underway, which contributes to the feasibility of further emissions controls under these standards. Indeed, in light of the very substantial rates of PEV penetration anticipated by EPA, as well as a variety of third parties, even in the No Action scenario (*i.e.,* absent revised standards) it would be unreasonable for EPA not to take electrification technologies into account in assessing the feasibility of additional reductions of dangerous air pollutants. More detail about our technical assessment, and the assumptions for the production feasibility and consumer acceptance of PEVs is provided in section IV of this preamble, and Chapters 2, 3, 4, and 6 of the RIA.

At the same time, we note that the GHG and criteria pollutant standards are performance-based, phase-in over six years, and do not mandate any specific technology for any manufacturer or any vehicle. Moreover, the overall industry does not necessarily need to reach this level of PEVs, or this particular percentage of BEVs and PHEVs, in order to comply—the projection in our analysis is one of many possible compliance pathways that manufacturers could choose to take under the performance-based standards. For example, for the GHG standards, our analysis indicates that it would be technologically feasible for PHEVs to meet the CO_2 footprint targets established in this rule across a wide range of footprints and vehicle styles (and thus for a manufacturer to meet the fleetwide average standards with a diverse fleet of PHEVs). The structure of the standards—performance-based with averaging, banking and trading (ABT) flexibilities, phased-in over six model years—enables manufacturers to choose which technologies to apply to which vehicles and when to apply them, which increases consumer choice and reduces costs. For example, under the GHG standards, manufacturers that choose to increase their sales of HEV technologies or apply more advanced technology to existing non-hybrid ICE vehicles, would require a smaller number of PEVs than we have projected in our assessment to comply with the standards. Similarly, manufacturers that choose to sell more vehicles with PHEV

[1307] EPA's compliance modeling estimates the consumer demand for PHEV, BEV and ICE vehicles using a consumer ''generalized cost'' that includes elements of the purchase cost (including any purchase incentives), vehicle maintenance and repair costs, and fuel operating costs as described in RIA Chapter 4.1.

[1308] Jackman, D K, K S Fujita, H C Yang, and M Taylor. 2023. Literature Review of U.S. Consumer Acceptance of New Personally Owned Light Duty Plug-in Electric Vehicles. Washington, DC: U.S. Environmental Protection Agency.

[1309] Cole, Cassandra, Michael Droste, Christopher Knittel, Shanjun Li, and James H. Stock. 2023. ''Policies for Electrifying the Light-Duty Fleet in the United States.'' AEA Papers and Proceedings 113: 316–322. doi: *https://doi.org/10.1257/pandp.20231063*.

[1310] IEA. 2023. ''Global EV Outlook 2023: Catching up with climate ambitions.'' International Energy Agency.

[1311] Forsythe, Connor R., Kenneth T. Gillingham, Jeremy J. Michalek, and Kate S. Whitefoot. 2023. ''Technology advancement is driving electric vehicle adoption.'' PNAS 120 (23). doi: *https://doi.org/10.1073/pnas.2219396120*.

[1312] Bloomberg NEF. 2023. ''Electric Vehicle Outlook 2023.''

[1313] U.S. Department of Energy, Office of Policy. 2023. ''Investing in American Energy: Significant Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Energy Economy and Emissions Reductions.''

[1314] Slowik, Peter, Stephanie Searle, Hussein Basma, Josh Miller, Yuanrong Zhou, Felipe Rodriguez, Claire Buysse, et al. 2023. ''Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States.'' International Council on Clean Transportation and Energy Innovation Policy & Technology LLC.

[1315] Cole, Cassandra, Michael Droste, Christopher Knittel, Shanjun Li, and James H. Stock. 2023. ''Policies for Electrifying the Light-Duty Fleet in the United States.'' AEA Papers and Proceedings 113: 316–322. doi: *https://doi.org/10.1257/pandp.20231063*.

[1316] Slowik, Peter, Stephanie Searle, Hussein Basma, Josh Miller, Yuanrong Zhou, Felipe Rodriguez, Claire Buysse, et al. 2023. ''Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the United States.'' International Council on Clean Transportation and Energy Innovation Policy & Technology LLC.

[1317] Wood, Eric, Brennan Borlaug, Matt Moniot, D–Y Lee, Yanbo Ge, Fan Yang, and Zhaocai Liu. 2023. ''The 2030 National Charging Network: Estimating U.S. Light-Duty Demand for Electric Vehicle Charging Infrastructure.'' National Renewable Energy Laboratory. Accessed December 18, 2023. *https://www.nrel.gov/docs/fy23osti/85654.pdf*.

[1318] U.S. Department of Energy, Office of Policy. 2023. ''Investing in American Energy: Significant Impacts of the Inflation Reduction Act and Bipartisan Infrastructure Law on the U.S. Energy Economy and Emissions Reductions.''

technology would need less improvement to non-hybrid ICE vehicles and smaller volumes of HEVs and BEVs in order to comply.

Moreover, while all the standards can be met by an array of different technologies, the array of available technologies for meeting each standard varies. For example, in addition to the above possibilities, a manufacturer could meet the PM standard solely through adding gasoline particulate filters to ICE vehicles. Similarly, manufacturers could meet the $NMOG+NO_X$ standard solely through improvements in engines and aftertreatment systems in ICE vehicles. In addition, while EPA is basing its judgment regarding feasibility of the standards on the numerous technologies it has identified as available today for meeting all the standards, manufacturers and their suppliers are highly innovative and may develop novel technologies, not available at this time, or find ways of reducing cost and complexity while increasing effectiveness of existing technologies for achieving the requisite emissions reductions. For example, when EPA implemented certain statutory standards following the 1970 Clean Air Act Amendments, manufacturers met those standards through three-way catalysts, a heretofore unproven technology. More recently, manufacturers responded to EPA's 2007 heavy-duty rule by applying selective catalytic reduction technologies, even though EPA had not anticipated such technology would be available for compliance.[1319]

In our technical assessment, we present various sensitivities in which the industry overall is projected to apply technologies in different proportions, with each scenario representing a different feasible compliance pathway. We do not expect, and the standards do not require, that all manufacturers follow a similar pathway. Instead, individual manufacturers can choose to apply a mix of technologies—including various levels of base ICE, advanced ICE, strong HEV, PHEV, and BEV technologies—that best suits the company's particular product mix and market position as well as its strategies for investment and technology development. Considering the range of potential paths for designing compliant vehicles and the diversity of consumer demand for vehicles, EPA anticipates that manufacturers will employ a wide range of technologies, applied to ICE, hybrid, plug-in hybrid and fully electric vehicles to meet their fleetwide average standards.

In considering the feasibility of the standards, EPA also considers the impact of available compliance flexibilities on automakers' compliance options.[1320] The advanced technologies that automakers are continuing to incorporate in vehicle models today directly contribute to each company's compliance plan (*i.e.,* these vehicle models have lower criteria pollutant and GHG emissions), and manufacturers can choose to comply with the standards outright through their choice of emissions reducing technologies. That is, the standards are feasible even absent credit trading across manufacturers, as demonstrated by our ''no credit trading'' sensitivity in section IV.F.4 and G.2.[1321]

At the same time, automakers typically have widely utilized the program's established ABT provisions which provide a variety of flexible paths to plan compliance. We have discussed this dynamic at length in past rules, and we anticipate that this same dynamic will support compliance with this rulemaking. Although the ABT program for GHG and criteria pollutants have some differences (as discussed in detail in sections III.C.4 and III.D.9 of the preamble), they fundamentally operate in a similar fashion. The GHG credit program was designed to recognize that automakers typically have compliance opportunities and strategies that differ across their fleet, as well as a multi-year redesign cycle, so not every vehicle will be redesigned every year to add emissions-reducing technology. Moreover, when technology is added, a given vehicle will generally not achieve emissions reductions corresponding exactly to a single year-over-year change in stringency of the standards. Instead, in any given model year, some vehicles will be ''credit generators,'' over-performing compared to their footprint-based CO_2 emissions targets in that model year, while other vehicles will be ''debit generators'' and under-performing against their standards or targets. As the standards reach increasingly lower numerical emissions levels, some vehicle designs that had generated credits in earlier model years may instead generate debits in later model years. In MY 2032 when the final standards reach the lowest level, it is possible that only some vehicle technologies are generating positive credits, and vehicles equipped with other technologies all generate varying levels of debits. In the criteria pollutant program, the $NMOG+NO_X$ standards also allow manufacturers to average emissions across their fleet, allowing some vehicles to have higher emissions (*i.e.,* certify to higher emissions ''bins''), and other vehicles lower emissions (*i.e.,* certify to lower emissions bins), than the fleet-wide average standard. For example, along the continuum of vehicle electrification, PHEVs with longer all electric range and efficient internal combustion engines and BEVs might generate credits, while non-hybrid ICE vehicles and some less effective PHEVs and strong HEVs might generate some debits. Even in this case, the application of a greater degree of vehicle electrification short of BEV technology, and further adoption of ICE and advanced ICE technologies can remain an important part of a manufacturer's compliance strategy by reducing the amount of debits generated by these vehicles. A greater application of technologies to vehicles with internal combustion engines (*e.g.,* strong hybrids and PHEVs) can enable compliance with fewer BEVs than if less technology was adopted for such vehicles, and therefore enable the tailoring of a compliance strategy to the manufacturer's specific market and product offerings. Together, an automaker's mix of credit-generating and debit-generating vehicles determine its compliance with GHG standards, and certain criteria pollutant standards, for that year.

Moreover, the trading provisions of the program allow each manufacturer to design a compliance strategy relying not only on overcompliance and undercompliance by different vehicles or in different years within its own fleet, but also between different manufacturers. Credit trading is a compliance flexibility provision that allows one vehicle manufacturer to purchase credits from another, accommodating the ability of manufacturers to make strategic choices in planning for and reacting to normal fluctuations in an automotive business cycle. When credits are available for less than the marginal cost of compliance, EPA would anticipate that an automaker might choose to adopt a compliance strategy relying at least in part on purchasing credits.

The final performance-based standards with ABT provisions give manufacturers a degree of flexibility in the design of specific vehicles and their fleet offerings, while allowing industry

[1319] 66 FR 5002, 5036.

[1320] While EPA considered these compliance flexibilities in assessing the feasibility of the standards, EPA did not reopen such flexibilities, except to the extent that we finalized a specific flexibility as in section III of this preamble. Specifically, EPA did not reopen the structure or general availability of ABT.

[1321] Technical feasibility of the standards is further discussed in RIA Chapters 3.2 and 3.5.

overall to meet the standards and thus achieve the health and environmental benefits projected for this rulemaking at a lower cost. EPA has considered ABT in the feasibility assessments for many previous rulemakings since EPA first began incorporating ABT credits provisions in mobile source rulemakings in the 1980s (see section III.C.4 of the preamble for further information on the history of ABT) and continues that practice for this rule. EPA's annual Automotive Trends Report illustrates how different automakers have chosen to make use of the GHG program's various credit features.[1322] It is clear that manufacturers are widely utilizing the various credit programs available, and we have every expectation that manufacturers will continue to take advantage of the compliance flexibilities and crediting programs to their fullest extent, thereby providing them with additional tools in finding the lowest cost compliance solutions in light of the revised standards.

While the potential value of credit trading as a means of reducing costs to automakers was always clear, there is increasing evidence that automakers have successfully adopted credit trading as an important compliance strategy that reduces costs. The market for trading credits is now well established. As shown in the most recent EPA Trends Report, 21 vehicle firms collectively have participated in over 100 credit trading transactions totaling 194 Tg of credits since the inception of the EPA program through Model Year 2022. These firms include many of the largest automotive firms.[1323] Several of these manufacturers have publicly acknowledged the importance of considering credit purchase or sales as part of their business plans to improve their competitive position.[1324] [1325] For firms with new vehicle production made up entirely or primarily of credit-generating vehicles, the revenue generated from credit sales can help to fund the development of GHG-reducing technologies and offset production costs. Other firms have the option of purchasing credits if they choose to make a fleet that is overall deficit-generating. This can be a cost-effective compliance strategy, especially for companies that make lower-volume vehicles where the incremental development costs for GHG-reducing technologies would be higher on a per-vehicle basis than for another company. The opportunity to purchase credits can also enable a company to continue specializing in vehicle applications where the application of advanced GHG-reducing technologies may be more costly than purchasing credits. For example, manufacturers of light- and medium-duty pickups might choose to purchase credits rather than apply BEV technology to some of those vehicles used frequently for long distance towing applications, at least in the shorter term when higher capacity batteries might be used to accommodate the existing charging infrastructure. As another example, a small volume manufacturer, which tends to have fewer vehicle models, might choose to comply partly through the purchase of credits instead of adding across its entire line of models technology that brings the emissions of each vehicle down to the target level.

In light of the evidence of increased adoption of trading as a compliance strategy and the increased vehicle sales from EV-only manufacturers (who are likely to view credit sales as a potential revenue stream), EPA has included the ability of manufacturers to trade credits as part of our central case compliance modeling for this rule, rather than as a sensitivity analysis as we did in the modeling for the 2021 rule. We anticipate that the economic efficiencies of credit trading will generally be attractive to automakers, and thus we consider it appropriate to take trading into account in estimating the costs of the standards. However, trading is an optional compliance flexibility, and we recognize that automakers may choose to use it in their compliance strategies to varying degrees. For this final rule, EPA has analyzed a sensitivity case in which we assume that no manufacturers take advantage of the credit trading flexibility. As noted above, the active and widespread participation in credit trading (including by EV-only manufacturers) to date indicates that such an assumption is unlikely to apply across the entire industry. However, it is an illustrative bounding case since we find that all manufacturers can comply by only the application of technology without any reliance on purchased credits, at a cost that is similar to our central case analysis. In other words, we conclude that the standards are feasible and appropriate even in the absence of trading.

As part of its assessment of technological feasibility and lead time, EPA has considered the cost for the auto industry to comply with the revised standards. See section IV.D of the preamble and Chapter 12 of the RIA for our analysis of compliance costs. The estimated average cost to manufacturers to meet the light-duty standards (both criteria and GHG) is approximately $2,100 (2022 dollars) per vehicle in MY 2032, which is within the range of costs projected in prior rules, which EPA estimated at about $1,800 (2010 dollars, equivalent to approximately $2,400 in 2022 dollars), and $1,000 (2018 dollars, equivalent to approximately $1,200 in 2022 dollars) per vehicle for the 2012 and 2021 LD GHG rules respectively. The estimated average cost to comply for medium-duty manufacturers is projected to be $3,300 (2022 dollars) in 2032, compared to $1,400 (2013 dollars, equivalent to $1,700 in 2022 dollars) in the HD Phase 2 rulemaking.[1326] Over the entire MY 2027–2032 timeframe, the average cost of the light-duty standards ($1,200) represents less than 3 percent of the projected average cost of a new vehicle (about $44,000), comparable to relative cost increases in prior rules.[1327] [1328] Similarly, the medium-

[1322] Environmental Protection Agency, "The 2023 EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975," EPA–420–R–23–033, December 2023.

[1323] EPA 2023 Trends Report, Figure 5.12.

[1324] "FCA historically pursued compliance with fuel economy and greenhouse gas regulations in the markets where it operated through the most cost effective combination of developing, manufacturing and selling vehicles with better fuel economy and lower GHG emissions, purchasing compliance credits, and, as allowed by the U.S. federal Corporate Average Fuel Economy ("CAFE") program, paying regulatory penalties." Stellantis N.V. (2020). "Annual Report and Form 20–F for the year ended December 31, 2020."

[1325] "We have several options to comply with existing and potential new global regulations. Such options include increasing production and sale of certain vehicles, such as EVs, and curtailing production of less fuel efficient ICE vehicles; technology changes, including fuel consumption efficiency and engine upgrades; payment of penalties; and/or purchase of credits from third parties. We regularly evaluate our current and future product plans and strategies for compliance with fuel economy and GHG regulations" General Motors Company (2022). "Annual Report and Form 10–K for the fiscal year ended December 31, 2021."

[1326] We note that the costs we present for this rule in this paragraph reflect the costs of controls to meet all the standards we are promulgating, including for GHG, PM, and $NMOG+NO_X$. By contrast, the costs we present for the prior 2012 LD GHG, 2021 LD GHG, and HD Phase 2 GHG Rules reflects only costs to achieve GHG standards. Were EPA to consider the cumulative costs of prior GHG and criteria pollutant rules, those costs would appear relatively higher.

[1327] The 2010 rule estimated an average MY 2016 per-vehicle cost of $948 (2007 dollar years, see 75 FR 25348), which represents 2.8 percent of the average price of a vehicle in 2016 ($34,077). The 2012 rule estimated an average MY 2023 vehicle cost of $1,425 (2010 dollar years, see 77 FR 62920), which represents 2.9 percent of the average price of a vehicle in 2023 ($48,759). Source for 2016 average vehicle price: *https://www.edmunds.com/about/press/average-vehicle-transaction-price-hits-all-time-high-in-2016-according-to-edmundscom.html#:~:text=SANTA%20MONICA%2C%20CA%20%E2%80%94%20December%2015,shopping%20network%2C%20Edmunds.com. Source for 2023 average vehicle price:https://*

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duty vehicle six-year average (MYs 2027–2032) cost increase is $1,400, which is 2% higher than the 6-year average in the no action case.[1329]

EPA also carefully evaluated a range of sensitivities for both the light-duty and medium-duty standards, as described in detail in section IV of the preamble and RIA Chapter 12.1.4 and 12.2.4. Taken together these sensitivities, encompass a wide array of potential uncertainties and future scenarios, including higher and lower battery cost, greater and lesser consumer acceptance for different vehicle technologies, different assumptions about the availability of IRA tax credits, and a diversity of manufacturer compliance strategies. Specifically, for the light-duty vehicle sensitivity assessments presented in sections IV.F and IV.H.1 of the preamble and RIA Chapter 12.1.4, for the majority of scenarios we estimate six-year average cost increases that represent between 0.3 percent and 3.9 percent increase in the projected total costs of a new vehicle (six-year average costs of $130 to $1,700), with two of the sensitivities showing a projected 5.8 percent increase (six-year average costs of $2,500–$2,600).[1330] These potential cost increases are small in comparison to the average costs of a new vehicle, and they are similar to the projected cost increase in a new vehicle under our central assessment of 2.7 percent, and in some cases smaller. Two of the sensitivities (the ''high battery cost'' and ''no additional BEVs'') have projected six-year average cost increases as high as 5.8 percent of a new vehicle cost. EPA believes both sensitivities are unlikely to occur. The high battery cost sensitivity battery cost projections are much higher than the EPA, DOE or the majority of third party projections, in particular for the 2030–2032 time frame, and in fact we believe our central battery costs projections are conservative and that actual battery costs are likely to be lower. The ''no additional BEVs'' (beyond the no action case) sensitivity is also unlikely to occur, as it is inconsistent with the public announcements and the investments being made by many of the major automotive manufacturers as well as the projections from many researchers and automotive industry consultants. EPA also evaluated an illustrative scenario where no new BEV models are sold beyond those that were already present in the MY 2022 fleet. In this scenario, the six-year average costs ($2,900) increase the projected total cost of a new vehicle by 6.6 percent. We think this scenario is highly unlikely to occur given the ongoing investment and growth in consumer acceptance of BEVs and the fact that 2023 BEV sales already exceed this level, but it is illustrative of the potential range of compliance options available to manufacturers to meet these standards.

EPA also performed cost assessments for the medium-duty vehicle CO_2 standards, as discussed in sections IV.D.4, IV.G, and IV.H.2 of the preamble. EPA performed a central analysis and three medium-duty vehicle sensitivity assessments; across the range of sensitivities, the projected cost increases are similar to those of the central analysis. For the six-year average costs, the central case cost increases ($1,400) represent 2 percent of the total vehicle costs, and across the sensitivities, the six-year average cost increases ($1,100 to $1,900) represent a range from 1.5 percent to 2.6 percent of the total new vehicle cost.[1331] In addition, EPA also assessed an illustrative scenario, which we believe is highly unlikely to occur, in which we assumed there are no new BEVs produced beyond those included in the base year fleet (which for MDVs is MY 2020). Under this illustrative scenario, the six-year average costs ($2,300) represent 3.2 percent of the total vehicle cost. Similar to the light-duty vehicle scenarios, the highest projected cost increases from the medium-duty vehicle scenarios come from the ''high battery cost'' and ''no new BEVs'' scenarios. For similar reasons as for the light-duty sensitivities, EPA finds that that ''high battery cost'' scenario is unlikely to occur, while the ''no new BEVs'' scenario is highly unlikely to occur.

EPA recognizes that, although the costs of the final standards in the first year of the program are lower than those of the proposed standards, updates to our technology cost estimates, for example our battery cost estimates, have resulted in the estimated costs per vehicle of the final standards being higher than the costs of the proposed standards in the later years of the program. Over the 6-year rulemaking period of MYs 2027–2032, average new light-duty vehicle manufacturing costs are increased by $1,200 due to the final standards, compared to the increase of $680 for the proposed standards over the same period. Costs of the final standards in the earlier years are lower and remain in the $200–$1,000 range for MYs 2027–2029. Light-duty vehicle costs increase in the latter three years (MYs 2030–2032) range from $1,500 to the above mentioned $2,100 for MY 2032, which is within the proposal's cost range of $500 to $2,800 (in 2022 dollars) for that year across the sensitivity cases. The general increase in costs is a result of EPA's updated analysis of the inputs and assumptions for the modeling used in projecting costs, informed by public comments, and in consultation with DOE and NHTSA. The final rule uses the same OMEGA2 modeling approach as was used for the proposal, but as discussed in section IV of this preamble and Chapters 2, 3, 4, and 8 of the RIA, various inputs and assumptions have been improved to address certain issues EPA identified in the proposal and in response to public comments. For example, EPA and NHTSA have engaged in extended consultation with DOE and the National Labs to better estimate future availability and cost of batteries used in PEVs and to assess the impacts of the tax credits established in the IRA on manufacturer costs. As a result of this and other work, EPA has updated its inputs for both ICE technology costs and batteries. EPA has also explicitly modeled PHEVs as a compliance option for the final rulemaking analysis. In addition, EPA has revised its car/truck sales share forecast according to the 2023 version of EIA's Annual Energy Outlook, which now projects an increased share of truck sales for future years. This shift to a higher share of truck sales also tends to increase the cost of the fleetwide standards. Overall, these incremental refinements to the inputs have improved the robustness of the

mediaroom.kbb.com/2024-01-11-Automotive-Market-Shifts-to-Favor-Buyers-as-US-New-Vehicle-Prices-Down-Record-2-4-Year-Over-Year-in-December-2023#:~:text=The%20average%20transaction%20price%20(ATP,from%202.7%25%20one%20year%20ago (last accessed February 26, 2024).

[1328] Further, the highest estimated model year cost (MY 2032) of $2,100 represents about 4.5 percent of the projected average cost of a new MY 2032 light-duty vehicle (about $46,700) (both estimates in 2022 dollars). Note that these values are averages across all body styles, powertrains, makes, models, and trims, and there will be differences for each individual vehicle. Also note that, as discussed in RIA Chapter 4.2, the price of a new vehicle has been increasing over time due to factors not associated with our rules. If the average price of a MY 2032 vehicle is higher than our estimate shown here, this estimated percentage increase in cost could well be smaller than 4.5 percent compared to the cost of a new MY 2032 vehicle.

[1329] EPA's central case assessment projects a $3,300 increase in MY2032, which is a 4.5% increase in the average total vehicle costs for the no action case.

[1330] We present detailed costs for each of the sensitivities, including for each MY, in section IV of the preamble and RIA Chapter 12.1.4 and 12.2.4. We considered all the costs presented in evaluating the cost of compliance.

[1331] The projected average cost of a new MY 2032 medium-duty vehicle in our modeling analysis is about $72,500 (in 2022 dollars).

modeling results. Despite the increased costs of the final standards compared to our estimate at proposal, the cost of compliance of the standards in the final year are still smaller than those of the 2012 rule when adjusted for inflation ($2,400 in MY 2025 ($2022)).

As also discussed in section I.A.2.ii of this preamble, EPA has observed a shift toward increased use of electrification technologies both in vehicle sales and across the automotive industry at large, and that these changes are being driven to a large degree by the technological innovation of the automotive industry and the significant funds, estimated at $1.2 trillion by at least one analysis,[1332] [1333] those firms intend to spend by 2030 on developing and deploying electrification technologies. This very significant investment and, particularly in light of the available compliance flexibilities and multiple paths for compliance, supports EPA's conclusion that the standards are feasible and will not cause economic disruption in the automotive industry. Indeed, EPA notes that for the early years of the revised standards our projection is that the standards will have very little cost for manufacturers as we anticipate that the IRA and manufacturers' own product plans will drive sufficient technology adoption to meet the standards for these years with some additional compliance planning. For these years the agency finds that the standards will provide an important degree of certainty and send appropriate market signals to facilitate anticipated investments, not only in technology adoption but also in complementary areas such as supply chains and charging infrastructure. In later years, EPA's modeling suggests that automakers are likely to choose to sell more PEVs than they would under the existing standards, and incur increased costs of emissions control technologies. However, we do not believe the estimated increase in marginal vehicle cost will lead to detrimental effects to automakers for multiple reasons, including the fact that macroeconomic effects are a much larger factor in OEM revenues (for example, inflation, supply chain disruptions, or labor costs), and that automakers regularly adjust product plans and choose the mix of vehicles they produce to maximize profits. We also note that in the first half of 2023, domestic automakers reported increased profits compared to the same period in 2022.[1334] And in that previous year, the same automakers had already reported the highest profits since 2016, even as domestic vehicle sales fell. We also note that our estimates of sales impacts in RIA Chapter 4.4 show very small impacts (ranging from about −0.2 percent to −0.9 percent per year) on vehicle sales. In addition, the significant investments by industry and Congress (*e.g.,* BIL and IRA) in supporting technology that eliminates both criteria and GHG tailpipe emissions, presents an opportunity for a significant step forward in achieving the goals of the Clean Air Act. The compliance costs per vehicle in this rule are reasonable and generally consistent with those in past GHG rules while the standards will achieve substantial emissions reductions for both GHG and criteria pollutants.

For this rule, EPA finds that standards are feasible in the lead time available, and that the expected compliance costs for automakers are reasonable, in light of the emissions reductions in air pollutants and the resulting benefits for public health and welfare. In making this finding we have considered our central case projection, as well as the full range of sensitivity analyses, considering the range of the projected costs, their respective likelihoods, the factors underlying them (*e.g.,* differences in battery costs or consumer acceptance), and their relationship to the central case, for each of light-duty and medium-duty.

C. Consideration of Emissions of GHGs and Criteria Pollutants

An essential factor that EPA considered in determining the appropriate level of the standards is the reductions in air pollutant emissions that will result from the program, including emissions of GHGs, criteria pollutants and air toxics, and associated public health and welfare impacts.

Although EPA has to date coordinated its light-duty GHG and criteria pollutants standards, this is the first time EPA has established both GHG and criteria pollutant standards in a single rulemaking for light-duty, as well as medium-duty, vehicles. The final standards will achieve very significant reductions of both GHG and criteria pollutants. The cumulative GHG emissions reductions through 2055 are projected to be 7,200 MMT of CO_2, 0.12 MMT of CH_4 and 0.13 MMT of N_2O, as the fleet turns over year-by-year to new vehicles that meet the light- and medium-duty standards. This represents a 21 percent reduction in CO_2 over that time period relative to the No Action case. See section VI of this preamble and Chapter 8 of the RIA. These GHG emission reductions will make an important contribution to efforts to limit climate change and its anticipated impacts. See Coal. For Resp. Reg., 684 F. 3d at 128 (removal of 960 million metric tons of CO2e over the life of the GHG vehicle emission standards rule was found by EPA to be ''meaningful mitigation'' of GHG emissions). We also project, in calendar year 2055, 16 percent to 25 percent reductions in $PM_{2.5}$, NO_X, and SO_X emissions. Further, we project over 45 percent reduction in VOC emissions in the year 2055. See section VII of this preamble and Chapter 8 of the RIA. EPA finds that the additional emissions reductions of GHG and criteria pollutants that will be achieved under these standards are important, considered both severally, and together, in reducing the public health and welfare impacts of air pollution, consistent with the purpose and mandate of section 202.

As discussed in section VIII of the preamble, we monetize benefits of the standards and evaluate other costs in part to enable a comparison of costs and benefits pursuant to E.O. 12866, but we recognize there are benefits that we are currently unable to fully quantify. EPA's practice has been to set standards to achieve improved air quality consistent with CAA section 202, and not to rely on cost-benefit calculations, with their uncertainties and limitations, as identifying the appropriate standards. Nonetheless, our conclusion that the estimated benefits exceed the estimated costs of the program reinforces our view that the standards are appropriate under section 202(a).

The annualized value of climate benefits attributable to the standards are estimated at $72 billion using a 2 percent discount rate through 2055. See section VIII of the preamble and Chapter 9 of the RIA for a full discussion of the SC–GHG estimates used to monetize climate benefits and the data and modeling limitations that constrain the ability of SC–GHG estimates to include all the important physical, ecological, and economic impacts of climate change, such that the estimates are a partial accounting of climate change impacts and will therefore tend to be

[1332] Reuters, ''A Reuters analysis of 37 global automakers found that they plan to invest nearly $1.2 trillion in electric vehicles and batteries through 2030,'' October 21, 2022. Accessed on November 4, 2022 at *https://graphics.reuters.com/AUTOS-INVESTMENT/ELECTRIC/akpeqgzqypr/.*

[1333] Reuters, ''Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030,'' October 25, 2022. Accessed on November 4, 2022 at *https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/.*

[1334] Stellantis Press Release, '' First Half 2023 Results'' July 26,2023. Accessed December 18, 2023 at *https://www.stellantis.com/en/news/press-releases/2023/july/first-half-2023-results.*

underestimates of the marginal benefits of abatement.

The annualized value of $PM_{2.5}$-related health benefits attributable to the standards through 2055 is estimated to total $6.4 billion to $13 billion (assuming a 2 percent discount rate and depending on the assumed long-term exposure study of $PM_{2.5}$-related premature mortality risk; see section VIII.F of the preamble).[1335] We separately estimate that in 2055, 1,000 to 2,000 $PM_{2.5}$-related premature deaths will be avoided as a result of the modeled policy scenario, depending on the assumed long-term exposure study of $PM_{2.5}$-related premature mortality risk. We also estimate that the modeled policy scenario will avoid 25 to 550 ozone-related premature deaths, depending on the assumed study of ozone-related mortality risk (see section VII.C of the preamble).

D. Consideration of Impacts on Consumers, Energy, Safety and Other Factors

EPA also considered the impact of the final light- and medium-duty standards on consumers as well as on energy and safety. EPA concludes that the standards would be beneficial for consumers because the lower operating costs would offset increases in vehicle technology costs, even without consideration of PEV purchase incentives in the IRA. For example, in 2055, when the standards have been fully implemented and the in-use vehicle fleet has largely turned over to the new standards, EPA estimates the rule would provide $57 billion in consumer savings associated with reduced fuel consumption despite the increased consumption of electricity of $18 billion (both values on an annualized basis through 2055 at a 2 percent discount rate, see section VIII.C.1 of this preamble). Vehicle technology cost increases for light-and medium-duty vehicles through 2055 are estimated at $40 billion on an annualized basis at a 2 percent discount rate. Annualized maintenance and repair costs at a 2 percent discount rate through 2055 are estimated to be $16 billion lower due to the final standards (See sections VIII.C and VIII.G of the preamble and Chapter 9 of the RIA). Thus, considering fuel savings and the lower maintenance and repair costs the final rule will result in significant savings for consumers.

In addition to the above, EPA also carefully considered the distribution of consumer impacts of these standards, specifically the impacts of low-income consumers. We recognize that increases in upfront purchase costs are likely to be of particular concern to low-income households, but we anticipate that automakers will continue to offer a variety of models at different price points (see Chapter 4 of the RIA). Moreover, because lower-income households spend more of their income on fuel than other households, the effects of reduced fuel costs may be especially important for these households. Similarly, low-income households are more likely to buy used vehicles and own older vehicles, and thus would benefit from significant savings in repair and maintenance costs if they purchase electric vehicles. Furthermore, for used BEVs, there is evidence that the original purchase incentive is passed on to the next buyer (*i.e.,* reduces the used price of BEVs).[1336] In addition, BEV purchase incentives for used vehicles are provided through the IRA. Thus, EPA expects that low-income households like other households will experience significant savings on vehicle operating costs projected as a result of these standards.

EPA has also considered the impact of this rule on consumers through the need for sufficient charging infrastructure and potential impacts on the electricity grid. We expect that through 2055 the majority of light and medium duty PEV charging will occur at home, but we recognize the need for additional public charging infrastructure to support anticipated levels of PEV adoption. As discussed in section IV.C.5 of the preamble and RIA Chapter 5.3, charging infrastructure has grown rapidly over the last decade, and investments in charging infrastructure continue to grow. Based on our evaluation of the record, EPA finds the market for charging is already responding to increased demand through investments from a wide range of public and private entities, and it is reasonable to expect the market will continue to keep up with demand. We further anticipate these final standards will encourage additional investments in charging infrastructure. EPA does not find that the increase in electricity consumption associated with modeled increases in PEV sales will adversely affect reliability of the electric grid, and, as explained in section IV of this preamble and Chapter 5 of the RIA, more widespread adoption of PEVs could have significant benefits for the electric power system.

EPA also evaluated the impacts of the light- and medium-duty standards on energy, in terms of fuel consumption and energy security. This rule is projected to result in a reduction of U.S. gasoline consumption by 780 billion gallons through 2055 and an increase of 6,700 Terawatt hours (TWh) of electricity consumption (see RIA Chapter 8). EPA considered the impacts of these projected changes in fuel consumption on energy security, specifically the avoided costs of macroeconomic disruption (See section VIII.H of the preamble). Promoting energy independence and security through reducing demand for refined petroleum use by motor vehicles has long been a goal of both Congress and the Executive Branch because of both the economic and national security benefits of reduced dependence on imported oil, and was an important reason for amendments to the Clean Air Act in 1990, 2005, and 2007.[1337] A reduction of U.S. net petroleum imports reduces both financial and strategic risks caused by potential sudden disruptions in the supply of petroleum

[1335] The criteria pollutant benefits associated with the standards presented here do not include the full complement of health and environmental benefits that, if quantified and monetized, would increase the total monetized benefits (such as the benefits associated with reductions in human exposure to ambient concentrations of ozone). See section VIII.E of the preamble and RIA Chapter 6 for more information about benefits we are not currently able to fully quantify.

[1336] Turrentine, T., Tal, G., Rapson, D., ''The Dynamics of Plug-in Electric Vehicles in the Secondary Market and Their Implications for Vehicle Demand, Durability, and Emissions,'' April 2018, National Center for Sustainable Transportation, UC Davis, Institute of Transportation Studies, p. 39. Accessed on December 1, 2023 at *https://escholarship.org/uc/item/8wj5b0hn.*

[1337] See *e.g.,* 136 Cong. Rec. 11989 (May 23, 1990) (Rep. Waxman stating that clean fuel vehicles program is ''tremendously significant as well for our national security. We are overly dependent on oil as a monopoly; we need to run our cars on alternative fuels.''); Remarks by President George W. Bush upon signing Energy Policy Act of 2005, 2005 U.S.C.C.A.N. S19, 2005 WL 3693179 (''It's an economic bill, but as [Sen. Pete Domenici] mentioned, it's also a national security bill. . . . Energy conservation is more than a private virtue; it's a public virtue''); Energy Independence and Security Act, P.L. 110–140, section 806 (finding ''the production of transportation fuels from renewable energy would help the United States meet rapidly growing domestic and global energy demands, reduce the dependence of the United States on energy imported from volatile regions of the world that are politically unstable, stabilize the cost and availability of energy, and safeguard the economy and security of the United States''); Statement by George W. Bush upon signing, 2007 U.S.C.C.A.N. S25, 2007 WL 4984165 (''One of the most serious long-term challenges facing our country is dependence on oil—especially oil from foreign lands. It's a serious challenge. . . . Because this dependence harms us economically through high and volatile prices at the gas pump; dependence creates pollution and contributes to greenhouse gas admissions [sic]. It threatens our national security by making us vulnerable to hostile regimes in unstable regions of the world. It makes us vulnerable to terrorists who might attack oil infrastructure.'')

to the U.S., thus increasing U.S. energy security. EPA finds this rule to have significant benefits from an energy security perspective. We estimate the annualized energy security benefits of the rule through 2055 at $1.5 billion to $2.1 billion depending on discount rate (see section VIII.E of this preamble and Chapter 9 of the RIA).

Section 202(a)(4)(A) of the CAA specifically prohibits the use of an emission control device, system or element of design that will cause or contribute to an unreasonable risk to public health, welfare, or safety. EPA has a long history of considering the safety implications of its emission standards from 1980 regulations establishing criteria pollutant standards [1338] up to and including the 2021 light-duty GHG rule. The relationship between emissions standards and safety is multi-faceted, and can be influenced not only by control technologies, but also by consumer decisions about vehicle ownership and use. EPA has estimated the impacts of this rule on safety by accounting for changes in new vehicle purchase, fleet turnover and VMT, changes in vehicle footprint, and vehicle weight changes that are in some cases lower (as an emissions control strategy) and in other cases higher (with the additional weight often associated with electrified vehicles). EPA finds that under this rule, there is no statistically significant change in the estimated risk of fatalities per distance traveled. EPA is presenting non-statistically significant values here in part to enable comparison with prior rules. We have found no change in fatality risk as a result of the standards (see section VIII.K of the preamble). However, as the costs of driving decline due to the improvement in fuel economy, we project consumers overall will choose to drive more miles (this is the ''VMT rebound'' effect). As a result of this personal decision by consumers to drive more due to the reduced cost of driving, EPA projects this will result in an increase in accidents, injuries, and fatalities (*i.e.,* although the rate of injury per mile stays virtually unchanged, an increase in miles driven results in an increase in total number of injuries). EPA's goal in setting motor vehicle standards is to protect public health and welfare while recognizing the importance of the mobility choices of Americans. Because the only statistically significant projected increase in accidents, injuries, and fatalities would be the result of consumers' voluntary choices to drive more when operating costs are reduced, EPA believes it is appropriate to place emphasis on the level of risk of injury per mile traveled, and to consider the projected change in injuries in that context.

As with the 2021 rule, EPA considers safety impacts in the context of all projected health impacts from the rule including public health benefits from the projected reductions in air pollution. In considering these estimates in the context of anticipated public health benefits, EPA notes that the air quality modeling, as discussed further in Chapter 7 of the RIA, estimates that in 2055 such a scenario would prevent between 1,000 and 2,000 premature deaths associated with exposure to $PM_{2.5}$ and prevent between 25 and 550 premature deaths associated with exposure to ozone. We expect that the cumulative number of premature deaths avoided that would occur during the entire period of 2027–2055 as a result of the rule would be much larger than the 2055 estimate.

Finally, EPA notes that the estimated benefits of the standards exceed the estimated costs, and estimates of the present values of net benefits of this rule through 2055 range from $1.7 trillion to $2.1 trillion (7 percent and 2 percent discount rates, with 2 percent near-term Ramsey discount rate for SC–GHG) (see section VIII of the preamble and Chapter 9 of the RIA). We recognize the uncertainties and limitations in these estimates (including unquantified benefits), and the Administrator has not relied on these estimates in identifying the appropriate standards under section 202. Nonetheless, we take note of the fact that estimated benefits exceed the estimated costs of these standards.

E. Selection of the Final Standards Under CAA Section 202(a)

Under section 202(a)(1) EPA has a statutory obligation to set standards to reduce air pollution from classes of motor vehicles that the Administrator has found contribute to air pollution that may be expected to endanger public health and welfare. Consistent with our longstanding approach to setting motor vehicle standards, the Administrator has considered a number of factors in setting these vehicles standards. In setting such standards, the Administrator must, pursuant to section 202(a)(2), provide adequate lead time for the development and application of technology to meet the standards, taking into consideration the cost of compliance. Furthermore, in setting standards for $NMOG+NO_X$, PM and CO for heavy-duty vehicles (including MDVs and light trucks over 6,000 pounds GWVR), EPA acts pursuant to its authority under CAA section 202(a)(3)(A)(i), and such standards shall reflect the greatest degree of emissions reduction that the Administrator determines is achievable for the model year, giving appropriate consideration to cost, energy and safety factors. EPA's standards properly implement these statutory provisions. As discussed in sections II, VI, and VII of the preamble, the standards will achieve significant and important reductions in emissions of a wide range of air pollutants that endanger public health and welfare. Furthermore, as discussed throughout this preamble, the emission reduction technologies needed to meet the standards have already been developed and are feasible and available for manufacturers to utilize in their fleets at reasonable cost in the timeframe of these standards, even after considering key constraints including battery manufacturing capacity, critical materials availability, and vehicle redesign cadence.

Moreover, the provisions for credit carry-forward and deficit carry-forward under the existing GHG program, as well as carry forward of Tier 3 $NMOG+NO_X$ credits, enable manufacturers to spread the compliance requirement for any particular vehicle model year across multiple model years. Similarly, the provisions for averaging enable manufacturers to spread compliance requirements across multiple vehicle models within a model year. Together, these credit banking and averaging provisions further support EPA's conclusion that the standards provide sufficient time for the development and application of technology, giving appropriate consideration to cost.

As noted above, section 202(a)(3) is explicit that, for certain pollutants for certain vehicles, the Administrator shall establish standards that achieve the greatest degree of emissions reduction achievable, although the provision identifies other factors to consider and requires the Administrator to exercise judgment in weighing those factors. Section 202(a)(1)–(2) provides greater discretion to the Administrator to weigh various factors but, as with the 2021 rule, the Administrator notes that the purpose of adopting standards under that provision of the Clean Air Act is to address air pollution that may reasonably be anticipated to endanger public health and welfare and that reducing air pollution has traditionally been the focus of such standards. Thus, for this rulemaking the agency's focus in identifying final standards is on

[1338] See, *e.g.,* 45 FR 14496, 14503. ''EPA would not require a particulate control technology that was known to involve serious safety problems.''.

achieving significant emissions reductions, within the constraints identified by CAA section 202.

There have been very significant developments in the feasibility of further control of pollution from motor vehicles since EPA promulgated the 2021 rule. While at the time of the 2021 rule, estimates of financial commitments to electric vehicle technologies by the automotive industry were in the range of $500–600 billion, more recent estimates are $1.2 trillion, approximately twice that of only two years ago.[1339] [1340] The European Union has finalized standards requiring 100 percent of new cars and vans to have zero tailpipe emissions by 2035, to complement other countries' decisions to phase out ICE engines.[1341] [1342] In 2022, BEVs alone accounted for about 807,000 U.S. new car sales, or about 5.8 percent of the new light-duty passenger vehicle market, up from 3.2 percent BEVs the year before, while in 2023 PEVs were around 1.4 million vehicles, of which 1.1 million were BEVs.[1343] [1344] PEV sales represented 9.1 percent of new light-duty passenger vehicle sales in 2023, up from 6.8 percent in 2022 and 3.2 percent the year before.[1345] The year-over-year growth in U.S. PEV sales suggests that an increasing share of new vehicle buyers are concluding that a PEV is the best vehicle to meet their needs. Furthermore, published studies indicate that consumer demand for PEVs is strong, and that limited availability was a greater constraint than consumer acceptance.[1346] [1347]

One of the most significant developments for U.S. automakers and consumers is Congressional passage of the IRA, which takes a comprehensive approach to addressing many of the potential barriers to wider adoption of PEVs in the United States. The IRA provides tens of billions of dollars in tax credits and direct Federal funding to reduce the upfront cost to consumers of purchasing PEVs, to increase the number of charging stations across the country, to reduce the cost of manufacturing batteries, and to promote domestic sources of critical minerals and other important elements of the PEV supply chain. By addressing all of these potential obstacles to wider PEV adoption in a coordinated, well-financed, strategy, Congress significantly advanced the potential for PEV adoption, and associated emissions reductions, in the near term. In fact, EPA anticipates that the increased PEV penetration for the initial years of these standards will be driven by automakers and consumers making use of IRA incentives, and would occur even in the absence of the revised standards.

In developing this rule, EPA has recognized that these significant developments in automaker investment, PEV market growth, and Congressional support through the BIL and IRA represent a significant opportunity to ensure that the emissions reductions these developments make possible will be realized as fully as possible and at a reasonable cost over the time frame of the rule. It is clear that these ongoing developments have already led to PEVs being increasingly employed across the fleet in both light-duty and medium-duty applications, largely independent of EPA's prior standards. Although the 2021 rule projected a PEV penetration rate of 17 percent for 2026, our updated modeling of the No Action case for this rule suggests a PEV penetration rate for 2026 of 27 percent, even with no change in the standards. As noted above. this projection is consistent with, if not more conservative than, the projections of third-party analysts.[1348] [1349] This rule seeks to build on the trends that these developments and projections indicate, and accelerate the continued deployment of these technologies to achieve further emissions reductions in 2027 and beyond.

In developing our PEV penetration estimates, EPA considered a variety of constraints which have, to date, limited PEV adoption and/or could limit it in the future, including: cost to manufacturers and consumers; refresh and redesign cycles for manufacturers; availability of raw materials, batteries, and other necessary supply chain elements; adequate electricity supply and distribution; and barriers to consumer acceptance such as adequate charging infrastructure and a wide range of vehicle model choices that meet a diverse set of consumer needs.[1350] We also assessed the potential impact of PEVs on the electric grid, as discussed in section IV.C.5 of the preamble, and we conclude that the reliability and resource adequacy of the electric grid will not be adversely affected by this rule. EPA has fully assessed the public record including public comments, and has consulted extensively with analysts from other agencies, including the Federal Energy Regulatory Commission, DOE and the National Labs, DOT, and the Joint Office for Energy and Transportation, extensively reviewed published literature and other data, and, as discussed thoroughly in this preamble and the accompanying RIA, has incorporated limitations into our recognizing that there are uncertainties in our projections. For example, battery costs may turn out to be higher or lower than we project, and consumers may adopt PEVs faster or slower than we anticipate. Overall, we identified a range of potential costs and PEV penetrations which we view as representing a wider range of possible, and still feasible and reasonable, compliance pathways under the standards.

[1339] Reuters, ''A Reuters analysis of 37 global automakers found that they plan to invest nearly $1.2 trillion in electric vehicles and batteries through 2030,'' October 21, 2022. Accessed on November 4, 2022 at *https://graphics.reuters.com/AUTOS-INVESTMENT/ELECTRIC/akpeqgzqypr.*

[1340] Reuters, ''Exclusive: Automakers to double spending on EVs, batteries to $1.2 trillion by 2030,'' October 25, 2022. Accessed on November 4, 2022 at *https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21.*

[1341] European Commission, ''Fit for 55: EU reaches new milestone to make all new cars and vans zero-emission from 2035,'' March 28, 2023. Accessed on January 1, 2024 at *https://climate.ec.europa.eu/news-your-voice/news/fit-55-eu-reaches-new-milestone-make-all-new-cars-and-vans-zero-emission-2035-2023-03-28_en.*

[1342] The EU regulations allow for the use of zero carbon fuels to meet the emissions requirements for 2035 and beyond.

[1343] Colias, M., ''U.S. EV Sales Jolted Higher in 2022 as Newcomers Target Tesla,'' Wall Street Journal, January 6, 2023.

[1344] DOE, FOTW #1327, January 29, 2024: Annual New Light-Duty EV Sales Topped 1 Million for the First Time in 2023 (''Annual sales of EVs more than quadrupled from 2020 to 2023, with a period of rapid growth beginning in 2021. . .'') Accessed on February 21, 2024 at *https://www.energy.gov/eere/vehicles/articles/fotw-1327-january-29-2024-annual-new-light-duty-ev-sales-topped-1-million.*

[1345] Argonne National Laboratory, ''Light Duty Electric Drive Vehicles Monthly Sales Updates,'' January 30, 2024. Accessed on February 2, 2024 at *https://www.anl.gov/esia/light-duty-electric-drive-vehicles-monthly-sales-updates.*

[1346] Gillingham, K.T., A.A. van Benthem, S. Weber, M.A. Saafi, and X. He. 2023. ''Has Consumer Acceptance of Electric Vehicles Been Increasing: Evidence from Microdata on Every New Vehicle Sale in the United States.'' AEA Papers and Proceedings, 113:329–35.

[1347] Bartlett, Jeff. 2022. More Americans Would Buy and Electric Vehicle, and Some Consumers Would Use Low-Carbon Fuels, Survey Shows. Consumer Reports. July 7. Accessed March 2, 2023. *https://www.consumerreports.org/hybrids-evs/interest-in-electric-vehicles-and-low-carbon-fuels-survey-a8457332578.*

[1348] In 2021, IHS Markit projected 27.8 percent BEV, PHEV, and range-extended electric vehicle (REX) for 2027. ''US EPA Proposed Greenhouse Gas Emissions Standards for Model Years 2023–2026; What to Expect,'' August 9, 2021. Accessed on October 28, 2021 at *https://www.spglobal.com/mobility/en/research-analysis/us-epa-proposed-greenhouse-gas-emissions-standards-my2023-26.html.*

[1349] In early 2023 ICCT projected 39 percent PEVs for 2027 under the moderate IRA impact scenario. See International Council on Clean Transportation, ''Analyzing the Impact of the Inflation Reduction Act on Electric Vehicle Uptake in the US,'' ICCT White Paper, January 2023. Available at *https://theicct.org/wp-content/uploads/2023/01/ira-impact-evs-us-jan23.pdf.*

[1350] Although EPA has considered consumer acceptance (including consumer costs) in exercising our discretion under the statute based on the record before us, to assess the feasibility and appropriateness of the standards, we note that it is not a statutorily-enumerated factor under section 202(a)(1)–(3).

modeling to address these potential constraints, as appropriate.

Taking both the significant developments in the automotive market and all of these potential constraints and uncertainties into account, EPA's analyses found that it would be feasible to reduce net emissions (compared to the No Action case) by 37 percent for CO_2, 22 percent for $PM_{2.5}$, 25 percent for NO_X, and 46 percent for VOCs in 2055, the final year analyzed. EPA also analyzed a range of standards which are somewhat more stringent and somewhat less stringent than the final standards.

In particular, EPA carefully considered comments in response to the range of alternatives for GHG standards presented in the proposal. Specifically, EPA considered standards somewhat more stringent (Alternative A, the proposed standards) and somewhat less stringent (Alternative B) than the final standards, as described in section III.F of the preamble. EPA's comparison of costs, technology penetrations and CO_2 emissions reductions for these alternatives is presented in section IV.E of this preamble. We now conclude that Alternative A would be too stringent before MY 2032. Although EPA anticipates that the IRA incentives, consumer demand and significant industry investments will lead to high levels of PEV penetration even in the absence of revised standards, EPA also recognizes that the industry is undergoing a significant shift as a result of a number of forces, including consumer demand, the IRA, automaker strategies and state and international policy direction. This shift, as noted by commenters, requires a number of complementary actions, such as increased battery production (which in turn depends on increased materials supply) and the scale up of PEV production capabilities.

Based on our review of the entire record, including public comments and extensive consultation with other agencies such as the Federal Energy Regulatory Commission, DOE and the National Labs, DOT, and the Joint Office for Energy and Transportation, EPA concludes it is reasonable, for the reasons discussed in section IV of the preamble and the RIA, to anticipate these complementary actions will all occur. EPA also concludes that it is appropriate to provide more lead time to achieve reductions to allow for the possibility that additional flexibility is required for automakers to implement their compliance strategies. EPA takes note of the very significant investments in shifting to cleaner technologies that automakers are anticipated to make before 2030. These standards align with those investments and are not based on significant additional technology costs in those initial years. The final standards established in this rule still achieve the same projected fleet average CO_2 target in MY 2032 and beyond as the proposed standards (Alternative A), and the cumulative reductions through 2055 are very similar; we estimate the cumulative CO_2 reductions through 2055 to be 7.2 billion metric tons under the final standards and 7.6 billion metric tons under the proposed standards curves (Alternative A), as shown in RIA Chapter 8.6.6.1.

EPA finds that the final standards achieve an appropriate level of emission reduction, but the more gradual phase-in of the standards between MYs 2027 and 2032 gives more appropriate consideration to costs and lead-time, particularly in light of the shifts to cleaner technologies occurring in the automotive industry.

EPA also considered adopting less stringent standards (*i.e.,* Alternative B as described in section III.F of the preamble) in this rule. However, EPA concludes that the final standards, particularly with the additional flexibility and lead time before MY 2032, resulting in reduced costs, are feasible and appropriate. EPA notes that for some vehicles and some pollutants it is required by section 202(a)(3) to set standards at the maximum achievable level. However, even for pollutants for which EPA is not required to adopt the maximum achievable stringency, in light of the need for and public health and welfare benefits of additional reductions in air pollution (as discussed in section II of the preamble), EPA finds it appropriate to set standards that achieve significant pollution reductions taking into consideration costs and lead time and other relevant factors. EPA takes note that the less stringent alternative EPA analyzed would result in materially more cumulative GHG emissions through 2055 and finds that forgoing those emissions reductions would not be appropriate under section 202(a).

We acknowledge that both those stakeholders pressing for more and less rapid increases in stringency have submitted considerable technical studies in support of their positions, including analyses purportedly demonstrating that a more or less rapid adoption of emissions reduction technologies, including zero-emissions technologies, is feasible. These studies account for the vast range of economic, technology, regulatory, and other factors described throughout this preamble; draw different assumptions about key variables; and reach very different conclusions. We have carefully reviewed all these studies and further discuss them in the RIA and the RTC. The agency's final standards are premised upon our own extensive technical assessment, which in turn is based on a wide review of the literature and test data, extensive expertise with the industry and with implementation of past standards, peer review, and our modeling analyses. The data and resulting modeling demonstrate a relatively moderate rate of adoption of emission reduction technologies, at rates bounded between the higher and lower rates in studies provided by commenters.

On balance, we think the various comments and studies pressing for faster or slower increases in stringency than the final rule each have their strengths and weaknesses, and we recognize the inherent uncertainties associated with predicting the future of the highly dynamic vehicle and related industries up to eight years from today through MY 2032. This uncertainty pervades both scenarios with lesser and greater increases in stringency than the final standards. For example, slower increases in stringency would be more certainly feasible and less costly for manufacturers, but they would also risk giving up emissions reductions and consequent benefits to public health and welfare that are actually achievable. By contrast, faster increases in stringency would aim to achieve greater emissions reductions and consequent benefits for public health and welfare, but they would also run the risk of incurring greater costs of compliance and potentially being infeasible in light of the lead time provided. The final standards reflect our technical expertise in discerning a reasoned path among the varying sources of data, analyses, and other evidence we have considered, as well as the Administrator's policy judgment as to the appropriate level of emissions reductions that can be achieved at a reasonable cost in the available lead time.

While the final standards are more stringent than the prior standards, EPA applied numerous conservative approaches throughout our analysis (as identified throughout this section IV of the preamble and in the RIA) and the final standards additionally are less stringent than those proposed during the first several years of implementation leading to MY 2032. As explained above and throughout this notice, EPA has assessed the appropriateness and feasibility of these standards taking into consideration the potential benefits to public health and welfare, existing market trends and financial incentives for PEV adoption, and constraints which could shape technology adoption in the future, including: cost to manufacturers and consumers; refresh and redesign cycles for manufacturers; availability of raw materials, batteries, and other necessary supply chain elements; adequate electricity supply and distribution; and barriers to consumer acceptance such as adequate charging infrastructure and a wide range of vehicle model choices that meet a diverse set of consumer needs. As a result of re-evaluating data and analyses in light of public comments, we have revised both our cost estimates and our assessment of the feasibility of more stringent standards, particularly for the early years of the program. For these years the agency is setting standards that we judge can be largely met if manufacturers stay on the technology path we anticipate they would follow in the absence of revised standards, given the IRA and their own product plans, because we find that it is important for the standards to provide an degree of certainty and send appropriate market signals to facilitate the anticipated investments, not only in technology adoption but also in complementary areas such as supply chains and charging infrastructure. In later years of the program, we judge that it will be possible to build on these investments to achieve greater emissions reductions. The Administrator concludes that this approach is within the discretion provided under and consistent with the text and purpose of CAA section 202(a)(1)–(2).

EPA also takes into consideration that this rule is setting coordinated but separate standards for both GHG and criteria pollutants. The widespread adoption of electrification technologies provides an important opportunity for EPA to achieve reductions of these different pollutants which each pose a continuing threat to public health and welfare. In other words, electrification technologies are extremely effective technologies at controlling emissions not only because they can reduce emissions to zero, but because they simultaneously reduce the emissions of multiple harmful pollutants.

Thus, as we have noted in section III of the preamble, the potential compliance strategies we model for the GHG standards would also be sufficient to achieve compliance with the final $NMOG+NO_X$ standards. However, PEVs are certainly not the only potential compliance strategies for meeting the final $NMOG+NO_X$ standards. The standards reflect EPA's judgment about feasible further reductions in $NMOG+NO_X$ as a result of the application of technologies (whether the manufacturer chooses, for instance, further electrification, further improvements to internal combustion engines, or further improvements to exhaust aftertreatment). The technological feasibility of the ICE-based vehicle $NMOG+NO_X$ reductions is discussed in RIA Chapter 3.2.5. EPA judges that the standards could be met at a reasonable cost in the relevant lead time by a mix of these technologies, such as additional PHEVs with additional exhaust aftertreatment.

Likewise, although BEVs are one compliance path to meeting the PM standards, EPA judges that GPF technology is an alternative compliance path which is available at a reasonable cost in the relevant lead time for vehicles that have an internal combustion engine.

Moreover, EPA not only judges the $NMOG+NO_X$ and PM standards to be appropriate under section 202(a)(2) for light duty vehicles in light of cost and lead time, it judges them as required under section 202(a)(3) for heavy duty vehicles, as representing the greatest degree of emissions reduction achievable through the applicable of technology which will be available, giving consideration to cost, energy and safety. The Administrator judges that it would not be consistent with section 202(a)(3) for EPA to set $NMOG+NO_X$ or PM standards for vehicles over 6,000 lbs that are less stringent.

Although EPA finds it appropriate to continue to coordinate GHG and criteria pollutant standards, taking into consideration that some of the available control technologies for these pollutants overlap, EPA has evaluated the feasibility and appropriateness of further GHG and criteria pollutant reductions separately. Each standard that we have set is justified in and of itself. As discussed above, for example, the GHG, $NMOG+NO_X$, and PM standards, for each of light-duty and medium-duty vehicles, for each year, are independently justified.[1351]

Taking into consideration the importance of reducing criteria pollutant and GHG emissions and the primary purpose of CAA section 202 to reduce the threat posed to human health and the environment by air pollution, the Administrator finds it is appropriate and consistent with the text and purpose of section 202 to adopt standards that, when implemented, would result in significant reductions of light- and medium-duty vehicle emissions both in the near term and over the longer term, taking into consideration the cost of compliance within the available lead time. Likewise, the Administrator concludes that these standards are consistent with the text and purpose of section 202 for heavy-duty vehicles by achieving significant reductions of GHGs, taking into consideration the cost of compliance within the available lead time, and by achieving the greatest degree of emissions reduction achievable for certain other pollutants, taking into consideration cost, lead-time, energy and safety factors as specified in section 202(a)(3)(B).

In summary, after consideration of the very significant reductions in criteria pollutant and GHG emissions, given the technical feasibility of the final standards and the costs per vehicle in the available lead time, and taking into account a number of other factors such as the savings to consumers in operating costs over the lifetime of the vehicle, safety, the benefits for energy security, and the greater quantified benefits compared to quantified costs, EPA believes that the final standards are appropriate under EPA's section 202(a) authority.

[1351] We recognize that our presentation of the rationale for the final standards in Section V of this preamble largely discusses the standards as a whole, with select references to specific standards. We emphasize, however, as discussed further in Section X of this preamble, that the standards are severable. As noted in the text here, each standard is set under a separate exercise of EPA's legal authority, and in some cases under the exercise of a different authority. For example, light-duty GHG, $NMOG+NO_X$, and PM, and medium-duty GHG, are each set under a separate exercise of section 202(a)(1)–(2) authority, while medium-duty $NMOG+NO_X$ and PM, are each set under a separate exercise of section 202(a)(3)(A)(i) authority. Further, each standard addresses different air pollution problems and impacts on public health and welfare, given both the nature of each pollutant at issue, see Section II of this preamble, as well as the distinct characteristics of light- and medium-duty vehicles, see Section III of this preamble. Moreover, while there is partial overlap in the technology pathways that support the standards (since some technologies such as electrification control more than one pollutant simultaneously), we have assessed the technologies supporting and costs for each standard separately. For example, as noted, the PM standards can be met entirely through the adoption of gasoline particulate filters, regardless of the level of electrification, and EPA estimates the direct manufacturing costs of adopting this technology at up to $180 per vehicle depending on vehicle's engine size (see Section III.D.3.viii of this preamble). And while EPA demonstrated the feasibility of the GHG and $NMOG+NO_X$ based on the same central case technology pathway, consisting of increases in BEV and PHEV technologies, the $NMOG+NO_X$ standards can be met entirely through increases in ICE technologies relating to engine and aftertreatment improvements. In addition, EPA concludes that each set of standards is feasible, including considering costs, absent the existence of the other standards, and would conclude that it is appropriate to finalize each standard independently even in the absence of the other standards. For more details, see RIA Chapter 3.

VI. How will this rule reduce GHG emissions and their associated effects?

A. Estimating Emission Inventories in OMEGA

To estimate emission inventory effects due to a potential policy, OMEGA uses as inputs a set of vehicle emission rates generated using MOVES vehicle inventories and the associated MOVES VMT and fuel consumption. For refinery emissions, OMEGA uses as inputs the refinery emission inventories generated in support of our air quality modeling along with estimates of the liquid fuel refined to calculate refinery emission rates. Those refinery emissions rates, along with estimates of how changes in domestic liquid fuel demand impact domestic refining, then allow OMEGA to estimate refinery emissions for a given policy. For electricity generating unit (EGU) emissions, OMEGA similarly uses as inputs a set of EGU inventories generated using EPA's Power Sector Modeling Platform, v.6.21,[1352] [1353] along with estimates of U.S. electricity generation, to calculate EGU emission rates specific to a given policy. EPA discusses the methodology used to estimate vehicle, refinery and EGU emissions in greater detail in Chapter 8 of the RIA.

B. Impact on GHG Emissions

Using OMEGA as described in section VI.A of this preamble and in Chapter 8 of the RIA, we estimated annual GHG emissions impacts associated with the final standards for the calendar years 2027 through 2055, as shown in Table 204. CO_2 equivalent (CO_2e) values use 100-year global warming potential values of 28 and 265 for CH_4 and N_2O, respectively.[1354] The table shows that the final standards will result in significant net GHG reductions compared to the No Action scenario. The cumulative CO_2, CH_4, N_2O and CO_2e emissions reductions from the program total 7,200 MMT, 0.12 MMT, 0.13 MMT and 7,200 MMT, respectively, through 2055. These reductions represent 21 percent, 15 percent, 23 percent and 21 percent reductions, respectively, relative to the No Action case (see Chapter 8 of the RIA). In addition, though not quantified, there is the potential that the final program could result in reductions of hydrofluorocarbon (HFC) emissions, depending on how manufacturers respond to the optional A/C leakage credits for MYs 2031 and later (as described in section III.D.5 of this preamble).

TABLE 204—ESTIMATED GHG IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO [a]

Calendar year	Emission impacts relative to no action (million metric tons per year)				Percent change from no action			
	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e
2027	−0.41	0.000011	−0.0000064	−0.41	−0.027	0.022	−0.028	−0.027
2028	−3.5	0.000024	−0.000042	−3.5	−0.24	0.052	−0.19	−0.24
2029	−12	−0.000011	−0.00017	−12	−0.83	−0.026	−0.77	−0.83
2030	−24	−0.000057	−0.00039	−24	−1.8	−0.14	−1.9	−1.8
2031	−40	−0.0001	−0.00064	−40	−3	−0.27	−3.2	−3
2032	−58	−0.00023	−0.00097	−58	−4.6	−0.64	−5	−4.6
2033	−85	−0.00054	−0.0015	−86	−7	−1.6	−7.8	−7
2034	−110	−0.00092	−0.002	−110	−9.5	−2.9	−11	−9.5
2035	−140	−0.0013	−0.0025	−140	−12	−4.5	−14	−12
2036	−170	−0.0018	−0.003	−170	−15	−6.3	−17	−15
2037	−200	−0.0023	−0.0035	−200	−18	−8.4	−19	−18
2038	−220	−0.0029	−0.0039	−230	−20	−11	−22	−20
2039	−250	−0.0034	−0.0043	−250	−23	−13	−24	−23
2040	−270	−0.004	−0.0047	−270	−25	−16	−27	−25
2041	−290	−0.0045	−0.0051	−290	−27	−18	−29	−27
2042	−310	−0.005	−0.0054	−310	−29	−21	−31	−29
2043	−330	−0.0055	−0.0057	−330	−31	−23	−33	−31
2044	−340	−0.006	−0.006	−350	−32	−26	−34	−32
2045	−360	−0.0064	−0.0063	−360	−34	−28	−35	−34
2046	−370	−0.0068	−0.0065	−370	−35	−30	−36	−35
2047	−380	−0.007	−0.0066	−380	−36	−31	−37	−36
2048	−390	−0.0073	−0.0068	−390	−36	−32	−37	−36
2049	−390	−0.0075	−0.0069	−400	−37	−33	−38	−37
2050	−400	−0.0077	−0.007	−400	−37	−34	−38	−37
2051	−400	−0.0078	−0.0071	−410	−37	−34	−38	−37
2052	−410	−0.0078	−0.0071	−410	−38	−34	−38	−38
2053	−410	−0.0079	−0.0071	−410	−38	−35	−38	−38
2054	−410	−0.0079	−0.0072	−410	−37	−34	−38	−37
2055	−410	−0.0079	−0.0072	−410	−37	−34	−38	−37
Sum	−7,200	−0.12	−0.13	−7,200	−21	−15	−23	−21

[a] Negative numbers represent emission decreases while positive numbers represent increases. Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

The estimated emission impacts include refinery emissions and the consideration of the impact of reduced liquid fuel demand on domestic refining. In the NPRM, the central analysis estimated that 93 percent of the reduced liquid fuel demand resulted in reduced domestic refining. EPA noted the possibility, through a sensitivity

[1352] *https://www.epa.gov/power-sector-modeling.*

[1353] *https://www.epa.gov/power-sector-modeling/post-ira-2022-reference-case.*

[1354] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)], pp 87. Available online: *https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf.*

analysis, that reduced domestic demand for liquid fuel would have no impact on domestic refining. In other words, domestic refiners would continue refining liquid fuel at the same levels and any excess from reduced domestic demand for liquid fuel would be exported for use elsewhere. In that event, there would be no decrease in domestic refinery emissions. In the proposal, EPA requested comment on the correct portion of reduced liquid fuel demand that would result in reduced domestic refining. At least one commenter responded by noting EPA's own statements in the proposal about uncertainty around refinery emissions impacts under our standards and urged EPA to explain its basis behind any assumptions. EPA's description of the methodology for assessing refinery emissions impacts is in Chapter 8.6.4 of the RIA.

Considering the comments and an updated analysis of the domestic refining industry (see RIA Chapter 8.6), the final analysis estimates that 50 percent of reduced domestic liquid fuel demand will result in reduced domestic refining. That estimate is reflected in the results presented in Table 204. As a sensitivity, EPA also estimated that 20 percent of reduced domestic liquid fuel demand would result in reduced domestic refining. We chose this sensitivity as an estimate that falls between our central case where 50 percent of reduced demand would result in reduced domestic refining and a possible case in which this final rule would have no impact on domestic refining. EPA presents these results as a sensitivity given the uncertainty surrounding how changes in domestic demand for liquid fuel may or may not impact domestic refining of liquid fuel. The GHG impacts under that sensitivity are shown in Table 205.

TABLE 205—ESTIMATED GHG IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO UNDER THE REFINERY SENSITIVITY

[20 Percent assumption] [a]

Calendar year	Emission impacts relative to no action (million metric tons per year)				Percent change from no action			
	CO_2	CH_4	N_2O	CO_2e	CO_2	CH_4	N_2O	CO_2e
2027	−0.4	0.000011	−0.0000063	−0.4	−0.027	0.024	−0.027	−0.026
2028	−3.4	0.000029	−0.000041	−3.4	−0.23	0.064	−0.18	−0.23
2029	−11	0.0000058	−0.00016	−11	−0.81	0.014	−0.76	−0.81
2030	−23	−0.000024	−0.00038	−24	−1.7	−0.058	−1.8	−1.7
2031	−39	−0.000045	−0.00064	−39	−2.9	−0.12	−3.2	−2.9
2032	−57	−0.00014	−0.00096	−57	−4.5	−0.4	−4.9	−4.5
2033	−83	−0.00042	−0.0015	−84	−6.8	−1.2	−7.7	−6.8
2034	−110	−0.00076	−0.002	−110	−9.3	−2.4	−11	−9.3
2035	−140	−0.0011	−0.0025	−140	−12	−3.8	−14	−12
2036	−170	−0.0016	−0.003	−170	−15	−5.4	−16	−15
2037	−190	−0.002	−0.0034	−190	−17	−7.3	−19	−17
2038	−220	−0.0026	−0.0039	−220	−20	−9.6	−22	−20
2039	−240	−0.0031	−0.0043	−240	−22	−12	−24	−22
2040	−270	−0.0036	−0.0047	−270	−25	−14	−26	−25
2041	−280	−0.0041	−0.005	−290	−26	−17	−28	−26
2042	−300	−0.0046	−0.0054	−310	−28	−19	−30	−28
2043	−320	−0.005	−0.0057	−320	−30	−21	−32	−30
2044	−340	−0.0055	−0.0059	−340	−31	−23	−33	−31
2045	−350	−0.0059	−0.0062	−350	−33	−25	−35	−33
2046	−360	−0.0063	−0.0064	−360	−34	−27	−36	−34
2047	−370	−0.0065	−0.0065	−370	−35	−28	−36	−35
2048	−380	−0.0068	−0.0067	−380	−35	−29	−37	−35
2049	−390	−0.007	−0.0068	−390	−36	−30	−37	−36
2050	−390	−0.0071	−0.0069	−390	−36	−31	−38	−36
2051	−390	−0.0072	−0.007	−400	−36	−31	−38	−36
2052	−400	−0.0073	−0.007	−400	−36	−31	−38	−36
2053	−400	−0.0074	−0.0071	−400	−36	−32	−38	−36
2054	−400	−0.0074	−0.0071	−400	−36	−32	−38	−36
2055	−400	−0.0074	−0.0071	−400	−36	−31	−37	−36
Sum	−7,000	−0.11	−0.12	−7,100	−21	−13	−23	−21

[a] Negative numbers represent emission decreases while positive numbers represent increases. Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

C. Global Climate Impacts Associated With the Rule's GHG Emissions Reductions

The transportation sector is the largest U.S. source of GHG emissions, representing 29 percent of total GHG emissions.[1355] Within the transportation sector, light-duty vehicles are the largest contributor, at 58 percent, and thus comprise 16.5 percent of total U.S. GHG emissions,[1356] even before considering the contribution of medium-duty Class 2b and 3 vehicles which are also included under this rule. Reducing GHG emissions, including the three GHGs (CO_2, CH_4, and N_2O) affected by this program, will make an important contribution to the efforts to limit climate change and subsequently reducing the probability of severe climate change related impacts including heat waves, drought, sea level rise, extreme climate and weather events, coastal flooding, and wildfires. Because of the long lifetime of GHGs, and in particular CO_2, every ton emitted contributes to an increase in global

[1355] *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021.* (EPA–430–R–23–002, published April 2023)

[1356] *Ibid.*

temperatures for decades and centuries in the future: therefore, every ton abated has benefits for centuries. The warming impacts of GHGs are cumulative. While the EPA did not conduct modeling to specifically quantify changes in climate impacts resulting from this rule in terms of avoided temperature change or sea-level rise, the Agency did quantify the climate benefits by monetizing the emission reductions through the application of the social cost of greenhouse gases (SC–GHGs), as described in section VIII.E of this preamble.

VII. How will the rule impact criteria and air toxics emissions and their associated effects?

As described in section VI.A of this preamble (and in more detail in Chapter 8 of the RIA), EPA used OMEGA to estimate criteria air pollutant and air toxic emission inventories associated with the final standards. These estimates are presented in section VII.A of this preamble, and additional estimates for the two alternatives are presented in RIA Chapter 8.6. OMEGA's emissions estimates include emissions from vehicles (using MOVES), electricity generation (using IPM, as described in section IV.B.3 of the preamble), and refineries.

Section VII.B of this preamble discusses the air quality impacts of the rule, section VII.C of the preamble describes how the rule will affect human health, and section VII.D of the preamble presents a summary of a demographic analysis on air quality.

A. Impact on Emissions of Criteria and Air Toxics Pollutants

Table 206 presents changes in criteria air pollutant emissions from vehicles resulting from the final standards.

Table 207 presents changes in criteria air pollutant emissions from EGUs and refineries resulting from the final standards. Note that we were not able to estimate EGU CO emissions.

Table 208 presents net changes in criteria air pollutant emissions from vehicles, EGUs and refineries resulting from the final standards.

Table 209 presents net changes in criteria air pollutant emissions from vehicles, EGUs, and refineries resulting from the final standards using our sensitivity case regarding the changes in U.S. refining in response to the projected lowered demand for liquid fuel (this sensitivity case is described in section VI.B of the preamble). EPA presents these results as a sensitivity given the uncertainty surrounding how changes in domestic demand for liquid fuel may impact domestic refining of liquid fuel.

Table 210 presents changes in emissions of air toxic pollutants from vehicles resulting from the final standards. Note that we were not able to estimate EGU or refinery toxic emissions.

The vehicle reductions in $PM_{2.5}$, NO_X, NMOG, and CO emissions shown in Table 206 are related to the final standards for these pollutants. Vehicle SO_X emissions are a function of the sulfur content of gasoline and diesel fuel. Therefore, the reductions in SO_X emissions from vehicles result from the decrease in gasoline and diesel fuel consumption associated with the GHG standards.

TABLE 206—OMEGA ESTIMATED VEHICLE CRITERIA EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO

[U.S. tons per year] [a]

Calendar year	$PM_{2.5}$	NO_X	NMOG	SO_X	CO
2027	−110	14	−37	−2.9	−410
2028	−290	−88	−470	−21	−6,700
2029	−510	−580	−1,700	−66	−25,000
2030	−860	−1,600	−3,700	−130	−54,000
2031	−1,200	−2,700	−6,400	−220	−91,000
2032	−1,600	−4,300	−9,400	−320	−130,000
2033	−2,000	−6,400	−14,000	−460	−210,000
2034	−2,500	−8,500	−19,000	−600	−290,000
2035	−2,900	−11,000	−25,000	−750	−380,000
2036	−3,300	−13,000	−31,000	−890	−470,000
2037	−3,800	−15,000	−37,000	−1,000	−570,000
2038	−4,300	−17,000	−43,000	−1,100	−670,000
2039	−4,800	−19,000	−48,000	−1,200	−770,000
2040	−5,300	−22,000	−54,000	−1,300	−870,000
2041	−5,700	−23,000	−60,000	−1,400	−960,000
2042	−6,100	−25,000	−67,000	−1,500	−1,100,000
2043	−6,400	−27,000	−73,000	−1,600	−1,200,000
2044	−6,700	−28,000	−80,000	−1,700	−1,300,000
2045	−7,000	−30,000	−85,000	−1,700	−1,300,000
2046	−7,300	−31,000	−92,000	−1,800	−1,400,000
2047	−7,500	−32,000	−99,000	−1,800	−1,500,000
2048	−7,700	−32,000	−110,000	−1,900	−1,600,000
2049	−7,900	−33,000	−110,000	−1,900	−1,600,000
2050	−8,000	−33,000	−120,000	−1,900	−1,600,000
2051	−8,200	−34,000	−120,000	−1,900	−1,700,000
2052	−8,300	−34,000	−130,000	−1,900	−1,700,000
2053	−8,300	−34,000	−130,000	−1,900	−1,700,000
2054	−8,400	−35,000	−140,000	−1,900	−1,700,000
2055	−8,500	−35,000	−140,000	−1,900	−1,700,000

[a] Negative numbers present emission decreases while positive numbers represent increases.

Table 207 shows the ''upstream'' emissions impacts from EGUs and refineries. As explained in section IV.C.3 of the preamble, our power sector modeling predicts that EGU emissions will decrease between 2028 and 2055 due to increasing use of clean electricity primarily driven by provisions of the Inflation Reduction Act (IRA). As a result, the increase in EGU emissions associated with the anticipated increased electricity demand would peak in the late 2030s/early 2040s (depending on the pollutant) and then generally decrease or level off through 2055. Chapter 8.6 of the RIA provides more detail on the estimation of refinery emissions, which EPA predicts will decrease due to the decreased demand for liquid fuel associated with the final GHG standards.

TABLE 207—OMEGA ESTIMATED UPSTREAM CRITERIA EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO

[U.S. tons per year] [a]

Calendar year	EGU				Refinery				
	$PM_{2.5}$	NO_X	NMOG	SO_X	$PM_{2.5}$	NO_X	NMOG	SO_X	CO
2027	17	110	7.8	110	−2.6	−11	−7.6	−3.2	−7.1
2028	73	500	34	490	−18	−74	−53	−22	−49
2029	180	1,200	92	1,000	−55	−230	−160	−68	−150
2030	370	2,200	190	1,700	−110	−460	−330	−140	−310
2031	630	3,700	310	2,800	−190	−780	−550	−230	−520
2032	860	4,900	430	3,700	−270	−1,100	−800	−340	−740
2033	1,100	6,200	570	4,600	−390	−1,600	−1,200	−490	−1,100
2034	1,400	7,300	700	5,100	−520	−2,200	−1,500	−650	−1,400
2035	1,600	8,000	820	5,300	−650	−2,700	−1,900	−810	−1,800
2036	1,700	8,500	900	5,500	−780	−3,200	−2,300	−970	−2,100
2037	1,800	8,600	950	5,400	−890	−3,700	−2,600	−1,100	−2,500
2038	1,800	8,500	980	5,200	−1,000	−4,200	−3,000	−1,200	−2,800
2039	1,800	8,200	1,000	4,800	−1,100	−4,600	−3,300	−1,400	−3,100
2040	1,800	7,900	1,000	4,300	−1,200	−5,100	−3,600	−1,500	−3,300
2041	1,800	7,800	1,000	4,100	−1,300	−5,400	−3,800	−1,600	−3,600
2042	1,800	7,600	1,100	3,800	−1,400	−5,800	−4,100	−1,700	−3,800
2043	1,800	7,400	1,100	3,500	−1,500	−6,100	−4,300	−1,800	−4,000
2044	1,800	7,000	1,100	3,000	−1,500	−6,400	−4,500	−1,900	−4,200
2045	1,700	6,600	1,100	2,600	−1,600	−6,600	−4,600	−2,000	−4,400
2046	1,700	6,500	1,000	2,400	−1,600	−6,800	−4,800	−2,000	−4,500
2047	1,600	6,300	1,000	2,100	−1,700	−7,000	−4,900	−2,100	−4,600
2048	1,600	6,000	1,000	1,800	−1,700	−7,100	−5,000	−2,100	−4,700
2049	1,500	5,700	960	1,500	−1,700	−7,200	−5,000	−2,100	−4,800
2050	1,500	5,500	940	1,300	−1,700	−7,300	−5,100	−2,200	−4,800
2051	1,500	5,600	940	1,300	−1,800	−7,400	−5,100	−2,200	−4,800
2052	1,500	5,600	950	1,300	−1,800	−7,400	−5,200	−2,200	−4,900
2053	1,500	5,600	950	1,300	−1,800	−7,400	−5,200	−2,200	−4,900
2054	1,500	5,600	940	1,300	−1,800	−7,400	−5,100	−2,200	−4,900
2055	1,500	5,500	930	1,300	−1,800	−7,400	−5,100	−2,200	−4,900

[a] Negative numbers present emission decreases while positive numbers represent increases; CO emission rates were not available for calculating CO inventories from EGUs.

Table 208 shows the net impact of the final standards on emissions of criteria pollutants, accounting for vehicle, EGU, and refinery emissions. In 2055, when the fleet will be largely comprised of vehicles that meet the standards, there will be a net decrease in emissions of $PM_{2.5}$, NMOG, NO_X, and SO_X (*i.e.,* all the pollutants for which EPA has emissions estimates from all three source sectors). The rule will result in net reductions of $PM_{2.5,}$ NO_X, NMOG, and CO emissions for all years between 2030 and 2055. Net SO_X emissions will be reduced beginning in 2043. Until then, the increased electricity generation associated with the final standards will result in net increases in SO_X emissions, which will peak in the mid-2030s.

TABLE 208—OMEGA ESTIMATED NET CRITERIA EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO, LIGHT-DUTY AND MEDIUM-DUTY VEHICLES, EGUS AND REFINERIES

[U.S. tons per year] [a]

Calendar year	Emission impacts relative to no action (thousand U.S. tons)					Percent change from no action				
	$PM_{2.5}$	NO_X	NMOG	SO_X	CO	$PM_{2.5}$	NO_X	NMOG	SO_X	CO
2027	−93	120	−37	110	−420	−0.22	0.023	−0.0054	0.32	−0.0039
2028	−230	330	−490	450	−6,700	−0.55	0.072	−0.079	1.3	−0.068
2029	−380	350	−1,800	880	−25,000	−0.92	0.085	−0.31	2.6	−0.28
2030	−600	170	−3,900	1,500	−54,000	−1.5	0.045	−0.72	4.7	−0.64
2031	−770	170	−6,600	2,400	−92,000	−1.9	0.049	−1.3	7.7	−1.2
2032	−970	−480	−9,800	3,100	−140,000	−2.4	−0.16	−2	10	−1.9
2033	−1,300	−1,700	−15,000	3,600	−210,000	−3.3	−0.63	−3.2	12	−3.2
2034	−1,600	−3,400	−20,000	3,800	−300,000	−4.2	−1.3	−4.4	14	−4.7
2035	−2,000	−5,400	−26,000	3,800	−380,000	−5.2	−2.3	−6.1	15	−6.6
2036	−2,400	−7,500	−32,000	3,700	−470,000	−6.3	−3.5	−7.9	15	−8.9
2037	−2,900	−10,000	−38,000	3,300	−570,000	−7.7	−5.1	−10	13	−12
2038	−3,500	−13,000	−45,000	2,800	−680,000	−9.3	−7	−12	12	−15
2039	−4,100	−16,000	−51,000	2,200	−780,000	−11	−9.1	−14	9.4	−18
2040	−4,700	−19,000	−57,000	1,500	−870,000	−13	−11	−17	6.7	−21
2041	−5,200	−21,000	−63,000	1,100	−970,000	−14	−13	−19	4.9	−25
2042	−5,600	−23,000	−70,000	600	−1,100,000	−15	−15	−22	2.8	−29
2043	−6,100	−25,000	−77,000	78	−1,200,000	−16	−17	−24	0.37	−32
2044	−6,500	−28,000	−83,000	−510	−1,300,000	−18	−19	−27	−2.5	−36

TABLE 208—OMEGA ESTIMATED NET CRITERIA EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO, LIGHT-DUTY AND MEDIUM-DUTY VEHICLES, EGUS AND REFINERIES—Continued

[U.S. tons per year] [a]

Calendar year	Emission impacts relative to no action (thousand U.S. tons)					Percent change from no action				
	$PM_{2.5}$	NO_X	NMOG	SO_X	CO	$PM_{2.5}$	NO_X	NMOG	SO_X	CO
2045	−6,900	−30,000	−89,000	−1,100	−1,300,000	−19	−20	−29	−5.7	−39
2046	−7,200	−31,000	−96,000	−1,400	−1,400,000	−19	−22	−32	−7.5	−42
2047	−7,500	−32,000	−100,000	−1,800	−1,500,000	−20	−23	−34	−9.5	−44
2048	−7,800	−34,000	−110,000	−2,100	−1,600,000	−21	−23	−36	−12	−46
2049	−8,100	−34,000	−120,000	−2,500	−1,600,000	−21	−24	−38	−14	−48
2050	−8,300	−35,000	−120,000	−2,800	−1,700,000	−22	−25	−40	−16	−49
2051	−8,400	−36,000	−130,000	−2,800	−1,700,000	−22	−25	−41	−16	−50
2052	−8,500	−36,000	−130,000	−2,800	−1,700,000	−22	−25	−43	−16	−51
2053	−8,600	−36,000	−140,000	−2,800	−1,700,000	−22	−25	−44	−16	−51
2054	−8,700	−36,000	−140,000	−2,800	−1,700,000	−22	−25	−45	−16	−51
2055	−8,700	−36,000	−150,000	−2,800	−1,700,000	−22	−25	−46	−16	−52

[a] Negative numbers present emission decreases while positive numbers represent increases; CO emission rates were not available for calculating CO inventories from EGUs, so CO impacts are from vehicles and refineries only. Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

The estimated refinery emission impacts include consideration of the impact of reduced liquid fuel demand on domestic refining. In the NPRM, the central analysis estimated that impact at 93 percent. In other words, 93 percent of the reduced liquid fuel demand results in reduced domestic refining. EPA noted the possibility that reduced domestic demand for liquid fuel would have no impact on domestic refining. In other words, domestic refiners would continue refining liquid fuel at the same levels and any excess would be exported for use elsewhere. In that event, there would be no decrease in domestic refinery emissions. In the proposal, EPA requested comment on the correct portion of reduced liquid fuel demand that would result in reduced domestic refining. EPA summarized those comments and provided responses in section VI.B of the preamble.

As discussed in RIA Chapter 8.6, the final analysis estimates that 50 percent of reduced domestic liquid fuel demand will result in reduced domestic refining. That estimate is reflected in the results presented in Table 208. As a sensitivity, EPA also estimated that just 20 percent of reduced domestic liquid fuel demand would result in reduced domestic refining. We chose this sensitivity as an estimate that falls between our central case where 50 percent of reduced demand would result in reduced domestic refining and a possible case in which this final rule would have no impact on domestic refining. The criteria pollutant impacts under that sensitivity case are shown in Table 209.

TABLE 209—OMEGA ESTIMATED NET CRITERIA EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO, LIGHT-DUTY AND MEDIUM-DUTY VEHICLES, EGUS AND REFINERIES, UNDER THE REFINERY SENSITIVITY

[U.S. tons per year] [a]

Calendar year	Emission impacts relative to no action (thousand U.S. tons)					Percent change from no action				
	$PM_{2.5}$	NO_X	NMOG	SO_X	CO	$PM_{2.5}$	NO_X	NMOG	SO_X	CO
2027	−91	120	−32	110	−410	−0.21	0.024	−0.0048	0.33	−0.0039
2028	−220	380	−460	460	−6,700	−0.53	0.081	−0.074	1.3	−0.068
2029	−350	490	−1,700	920	−25,000	−0.83	0.12	−0.29	2.7	−0.28
2030	−540	450	−3,700	1,500	−54,000	−1.3	0.12	−0.68	4.9	−0.64
2031	−660	630	−6,300	2,500	−92,000	−1.6	0.18	−1.2	8	−1.2
2032	−810	190	−9,300	3,300	−140,000	−2	0.062	−1.9	10	−1.9
2033	−1,100	−760	−14,000	3,900	−210,000	−2.6	−0.27	−3	13	−3.2
2034	−1,300	−2,100	−19,000	4,200	−290,000	−3.3	−0.81	−4.2	15	−4.7
2035	−1,600	−3,700	−25,000	4,200	−380,000	−4.1	−1.6	−5.8	16	−6.6
2036	−1,900	−5,600	−31,000	4,200	−470,000	−5	−2.6	−7.5	16	−8.9
2037	−2,400	−7,900	−37,000	3,900	−570,000	−6.2	−3.9	−9.7	16	−12
2038	−2,900	−10,000	−43,000	3,600	−670,000	−7.6	−5.5	−12	14	−15
2039	−3,400	−13,000	−49,000	3,000	−770,000	−9	−7.4	−14	12	−18
2040	−3,900	−16,000	−55,000	2,400	−870,000	−10	−9.2	−16	10	−21
2041	−4,400	−18,000	−61,000	2,000	−960,000	−12	−11	−18	8.8	−25
2042	−4,800	−20,000	−67,000	1,600	−1,100,000	−13	−13	−21	7.2	−29
2043	−5,200	−22,000	−74,000	1,200	−1,200,000	−14	−14	−23	5.3	−32
2044	−5,600	−24,000	−80,000	630	−1,300,000	−15	−16	−26	2.9	−36
2045	−5,900	−26,000	−86,000	72	−1,300,000	−16	−17	−28	0.35	−39
2046	−6,200	−27,000	−93,000	−230	−1,400,000	−16	−18	−30	−1.1	−42
2047	−6,500	−28,000	−100,000	−540	−1,500,000	−17	−19	−33	−2.7	−44
2048	−6,800	−29,000	−110,000	−870	−1,600,000	−18	−20	−35	−4.4	−46
2049	−7,000	−30,000	−110,000	−1,200	−1,600,000	−18	−21	−37	−6.2	−47
2050	−7,200	−31,000	−120,000	−1,500	−1,700,000	−19	−21	−38	−7.9	−49
2051	−7,300	−31,000	−120,000	−1,500	−1,700,000	−19	−21	−40	−7.9	−50
2052	−7,400	−32,000	−130,000	−1,500	−1,700,000	−19	−21	−41	−7.9	−50
2053	−7,500	−32,000	−130,000	−1,500	−1,700,000	−19	−21	−43	−7.9	−51
2054	−7,600	−32,000	−140,000	−1,500	−1,700,000	−19	−21	−44	−7.9	−51

TABLE 209—OMEGA ESTIMATED NET CRITERIA EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO, LIGHT-DUTY AND MEDIUM-DUTY VEHICLES, EGUS AND REFINERIES, UNDER THE REFINERY SENSITIVITY—Continued

[U.S. tons per year][a]

Calendar year	Emission impacts relative to no action (thousand U.S. tons)					Percent change from no action				
	$PM_{2.5}$	NO_X	NMOG	SO_X	CO	$PM_{2.5}$	NO_X	NMOG	SO_X	CO
2055	−7,700	−32,000	−140,000	−1,500	−1,700,000	−19	−21	−44	−7.8	−51

[a] Negative numbers present emission decreases while positive numbers represent increases; CO emission rates were not available for calculating CO inventories from EGUs, so CO impacts are from vehicles and refineries only. Percent changes reflect changes associated with the light- and medium-duty fleet, not total U.S. inventories.

Table 210 shows reductions in vehicle emissions of air toxics. EPA expects this rule will reduce emissions of air toxics from light- and medium-duty vehicles. The GPF technology that EPA projects manufacturers will choose to use in meeting the final PM standards will decrease particle-phase pollutants, and the $NMOG+NO_X$ standards will decrease gas-phase toxics.

For most air toxic emissions, EPA relies on estimates from EPA's MOVES emissions model. In MOVES, emissions of most gaseous toxic compounds are estimated as fractions of the emissions of VOC. Toxic species in the particulate phase (*e.g.,* polycyclic aromatic hydrocarbons (PAHs)) are estimated as fractions of total organic carbon smaller than 2.5 μm ($OC_{2.5}$). Thus, reductions in air toxic emissions are proportional to modelled reductions in total VOCs and/or $OC_{2.5}$.[1357] Emission measurements of PAHs in EPA's recent GPF test program (see section III.D.3 of the preamble and RIA Chapter 3.2.5) suggest this is a conservative estimate, as they indicate reduction in emissions of particle-phase PAH compounds of over 99 percent, compared to about 95 percent for total PM.

TABLE 210—OMEGA ESTIMATED VEHICLE AIR TOXIC EMISSION IMPACTS OF THE FINAL STANDARDS RELATIVE TO THE NO ACTION SCENARIO, LIGHT-DUTY AND MEDIUM-DUTY VEHICLES

[U.S. tons per year][a]

Calendar year	Acetaldehyde	Benzene	Formaldehyde	Naphthalene	1,3 Butadiene	15 PAH
2027	−0.74	−2.1	−0.33	−0.093	−0.27	−0.031
2028	−5.2	−15	−2.6	−0.72	−2.1	−0.093
2029	−18	−46	−9.5	−2.2	−6.9	−0.18
2030	−38	−99	−21	−4.4	−15	−0.33
2031	−64	−170	−35	−7.3	−24	−0.49
2032	−93	−240	−52	−11	−35	−0.65
2033	−140	−370	−79	−16	−54	−0.89
2034	−190	−510	−110	−22	−74	−1.1
2035	−250	−650	−140	−28	−95	−1.3
2036	−300	−790	−160	−34	−110	−1.6
2037	−340	−930	−190	−40	−130	−1.8
2038	−390	−1,100	−220	−46	−150	−2
2039	−440	−1,200	−250	−52	−170	−2.3
2040	−490	−1,300	−280	−57	−190	−2.5
2041	−520	−1,500	−300	−62	−200	−2.7
2042	−560	−1,600	−320	−67	−220	−2.9
2043	−600	−1,700	−340	−71	−230	−3.1
2044	−630	−1,800	−360	−75	−240	−3.3
2045	−650	−1,900	−380	−79	−250	−3.4
2046	−680	−2,000	−400	−82	−260	−3.5
2047	−700	−2,000	−410	−84	−270	−3.7
2048	−710	−2,100	−420	−86	−280	−3.8
2049	−720	−2,100	−430	−87	−280	−3.8
2050	−730	−2,200	−430	−89	−280	−3.9
2051	−740	−2,200	−440	−89	−280	−4
2052	−740	−2,300	−440	−90	−290	−4
2053	−750	−2,300	−440	−90	−290	−4.1
2054	−740	−2,300	−440	−90	−290	−4.1
2055	−740	−2,300	−440	−90	−290	−4.1

[a] Negative numbers represent emission decreases while positive numbers represent increases. Note that emission rates were not available for estimating toxics emissions from EGUs or refineries.

B. How will the rule affect air quality?

As discussed in section VII.A of the preamble, we project that the standards in the final rule will result in meaningful reductions in emissions of criteria and toxic pollutants from light- and medium-duty vehicles. We also project that the final standards will impact corresponding ''upstream''

[1357] U. S. EPA (2020) Air Toxic Emissions from Onroad Vehicles in MOVES3. Assessment and Standards Division, Office of Transportation and Air Quality, Report No. EPA–420–R–20–022. November 2020. *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010TJM.pdf.*

emission sources like EGUs (electric generating units) and refineries. When feasible, we conduct full-scale photochemical air quality modeling to estimate levels of criteria and air toxic pollutants, because the atmospheric chemistry related to ambient concentrations of $PM_{2.5}$, ozone, and air toxics is very complex. Air quality modeling was conducted for this rulemaking for the future year 2055, when the program will be fully implemented and when most of the regulated fleet will have turned over. We also modeled a sensitivity case that examined only the air quality impacts of the onroad emissions changes from the rule.

On the basis of the air quality modeling for this final rule, which uses projected emission impacts from the proposed standards,[1358] we conclude that the rule will result in widespread decreases in air pollution in 2055, even when accounting for the impacts of increased electricity generation. We expect the power sector to become cleaner over time as a result of the IRA and future policies, which will reduce the air quality impacts of EGUs. Although the spatial resolution of the air quality modeling is not sufficient to quantify them, this rule's emission reductions will also lead to air pollution reductions in close proximity to major roadways, where people of color and people with low income are disproportionately exposed to elevated concentrations of many air pollutants. The emission reductions provided by the final standards will also be useful in helping areas attain and maintain the NAAQS and prevent future nonattainment. In addition, the final standards are expected to result in better visibility and reduced deposition of air pollutants. Additional information and maps showing expected changes in ambient concentrations of air pollutants in 2055 are included in Chapter 7 of the RIA and in the Air Quality Modeling Memo to the Docket.

1. Particulate Matter

We project that the rule will decrease annual average $PM_{2.5}$ concentrations by an average of 0.02 μg/m³ in 2055, with a maximum decrease of 0.36 μg/m³ and a maximum increase of 0.20 μg/m³. The population-weighted average change in annual average $PM_{2.5}$ concentrations will be a decrease of 0.04 μg/m³ in 2055. In a few isolated areas, this rule is expected to result in increases in annual average $PM_{2.5}$, due to increases in EGU emissions. However, we project that more than 99 percent of the population will experience reductions in annual average $PM_{2.5}$ concentrations as a result of this rule.

When only the onroad emissions impacts of the rule are considered, annual average $PM_{2.5}$ concentrations will decrease by an average of 0.02 μg/m³ in 2055, with a maximum decrease of 0.13 μg/m³. The population-weighted average change in annual average $PM_{2.5}$ concentrations attributable to the onroad emissions reductions will be a decrease of 0.04 μg/m³ in 2055.

We received a few comments about the impacts on ambient $PM_{2.5}$ from the final standards. These commenters noted that the air quality improvements from the PM exhaust standards were not presented separately, and that the reductions in ambient $PM_{2.5}$ from the rule are a relatively small improvement compared to the level of the annual average NAAQS. Additionally, a commenter noted that we did not present projections of county-level concentrations in 2055 which could be compared to the level of the NAAQS. For purposes of the air quality analyses, we model the total impacts of the standards.[1359] Chapter 7.4 of the RIA contains more detail on the impacts of the rule on $PM_{2.5}$, as well as its impacts on county-level $PM_{2.5}$ design value concentrations in 2055. Detailed discussion of the comments we received on the $PM_{2.5}$ emissions and air quality impact of the standards can be found in sections 4 and 11 of the RTC.

2. Ozone

We project that the rule will decrease ozone concentrations by an average of 0.09 ppb in 2055, with a maximum decrease of 0.71 ppb and a maximum increase of 0.36 ppb. The population-weighted average change in ozone concentrations will be a decrease of 0.16 ppb in 2055. In a few isolated areas, this rule is expected to result in increases in annual average ozone, likely due mainly to increases in EGU emissions. However, we project that more than 99 percent of the population will experience reductions in annual average ozone concentrations as a result of this rule.

When only the onroad emissions impacts of the rule are considered, ozone concentrations will decrease by an average of 0.09 ppb in 2055, with a maximum decrease of 0.70 ppb. The population-weighted average change in ozone concentrations attributable to the onroad emissions reductions will be a decrease of 0.16 ppb in 2055.

Chapter 7.4 of the RIA contains more detail on the impacts of the rule on ozone concentrations, as well as its impacts on county-level ozone design value concentrations in 2055.

3. Nitrogen Dioxide

We project that the rule will decrease annual NO_2 concentrations by an average of 0.01 ppb in 2055, with a maximum decrease of 0.34 ppb and a maximum increase of 0.11 ppb. The population-weighted average change in annual average NO_2 concentrations will be a decrease of 0.08 ppb in 2055. In a few isolated areas, this rule is expected to result in increases in annual average NO2, likely due to increases in EGU emissions. However, we project that more than 99 percent of the population will experience reductions in annual average NO_2 concentrations as a result of this rule.

When only the onroad emissions impacts of the rule are considered, NO_2 concentrations will decrease by an average of 0.01 ppb in 2055, with a maximum decrease 0.28 ppb. The population-weighted average change in ozone concentrations attributable to the onroad emissions reductions will be a decrease of 0.07 ppb in 2055

Chapter 7.4 of the RIA contains more detail on the impacts of the rule on NO_2 concentrations.

4. Sulfur Dioxide

We project that the rule will decrease annual SO_2 concentrations by an average of 0.001 ppb in 2055, with a maximum decrease of 0.26 ppb and a maximum increase of 0.32 ppb. The population-weighted average change in annual average SO_2 concentrations will be a decrease of 0.003 ppb in 2055. In some areas, this rule is expected to result in increases in annual average SO_2, likely due to increases in EGU emissions. However, we project that more than 99 percent of the population will experience reductions in annual average SO_2 concentrations as a result of this rule.

When only the onroad emissions impacts of the rule are considered, SO_2 concentrations will decrease by an average of 0.0002 ppb in 2055, with a maximum decrease of 0.01 ppb. The

[1358] Decisions about the emissions and other elements used in the air quality modeling were made early in the analytical process for the final rulemaking. Accordingly, the air quality analysis does not fully represent the final regulatory scenario; however, we consider the modeling results to be a fair reflection of the impact the standards will have on air quality in 2055. Chapter 7 of the RIA has more detail on the modeled scenarios.

[1359] Although the air quality modeling results lend further support to the rationality of the standards, EPA does not view air quality modeling as necessary to the justification of any of the standards. The rationales for the standards, including the significant emissions reductions from the regulated classes of motor vehicles, are set forth in section V of this preamble.

population-weighted average change in SO_2 concentrations attributable to the onroad emissions reductions will be a decrease of 0.001 ppb in 2055.

Chapter 7.4 of the RIA contains more detail on the impacts of the rule on SO_2 concentrations.

5. Air Toxics

In general, the air quality modeling results indicate that the rule will have relatively little impact on national average ambient concentrations of the modeled air toxics in 2055. Specifically, in 2055, our modeling projects that ambient 1,3-butadiene, benzene, and naphthalene concentrations will decrease by an average of less than 0.001 ug/m3 across the country. Acetaldehyde and formaldehyde will generally have small decreases in most areas with average annual reductions of 0.0021 ug/m3 and 0.0023 ppb for acetaldehyde and formaldehyde, respectively. We do project slight increases in benzene and formaldehyde concentrations in a few isolated areas of the country. Chapter 7.4 of the RIA contains more detail on the impacts of the modeled scenario on air toxics concentrations.

C. How will the rule affect human health?

As described in section VII.B of this preamble and RIA Chapter 7, EPA conducted an air quality modeling analysis of a light- and medium-duty vehicle policy scenario in 2055. The results of that analysis found that in 2055, consistent with the OMEGA-based analysis, the standards will result in widespread decreases in criteria pollutant emissions that will lead to substantial improvements in public health and welfare. We estimate that in 2055, 1,000 to 2,000 $PM_{2.5}$-related premature deaths will be avoided as a result of the modeled policy scenario, depending on the assumed long-term exposure study of $PM_{2.5}$-related premature mortality risk. We also estimate that the modeled policy scenario will avoid 25 to 550 ozone-related premature deaths, depending on the assumed study of ozone-related mortality risk. The monetized benefits of the improvements in public health in 2055 related to the modeled policy scenario (which include the monetized benefits of reductions in both mortality and non-fatal illnesses) are $16 to $36 billion at a 2 percent discount rate. See RIA Chapter 7.5 for more detail about the $PM_{2.5}$ and ozone health benefits analysis. We also note that the rule will result in widespread decreases in GHG emissions, leading to significant benefits, including improvements in human health. We discuss climate-related health impacts in section II.A of the preamble and monetize the Social Cost of GHGs in section VIII.E of the preamble.

D. Demographic Analysis of Air Quality

As noted in section VIII.J of the preamble, EPA received several comments related to the environmental justice (EJ) impacts of light- and medium-duty vehicles in general and the impacts of the proposal specifically. After consideration of comments, we conducted an EJ analysis using the 2055 air quality modeling data to evaluate how human exposure to future air quality varies with population characteristics relevant to potential environmental justice concerns in scenarios with and without the rule in place. The analysis is described in detail in RIA Chapter 7.6.

This rule applies nationally and will be implemented consistently throughout the nation. Specifically, because this final rule affects both onroad and upstream emissions, and because PM emission precursors and ozone can undergo long-range transport, we believe it is appropriate to conduct a national-scale EJ assessment of the contiguous U.S. As described in section VII.B of the preamble, and as depicted in the maps presented in RIA Chapter 7.4, these reductions will be geographically widespread. However, the spatial resolution of the air quality modeling data (12km by 12km grid cells) is not sufficient to capture the very local heterogeneity of human exposures, particularly the pollution concentration gradients near roads. Taking these factors into consideration, this analysis evaluates both national population-weighted average exposures and the distribution of exposure outcomes that will result from the final rule.

On average, all population groups included in the analysis will benefit from reductions in exposure to ambient $PM_{2.5}$ and ozone due to the final rule. However, we found that projected disparities in national average $PM_{2.5}$ and ozone concentration exposure in 2055 are not likely mitigated or exacerbated by the rule for most of the population groups evaluated, due to the relatively similar pollution concentration reductions across demographic groups, especially for ozone. However, for some population groups, nationally-averaged exposure disparity is mitigated to a small degree in both absolute and relative terms.

While national average results can provide some insight when comparing within and across population groups, they do not provide information on the full distribution of concentration impacts. This is because both population groups and ambient concentrations can be unevenly distributed across the spectrum of exposures, meaning that average exposures may mask important regional disparities. We therefore conducted a distributional analysis and found that for most of the population groups, the small differences in the distribution of pollution exposure reductions suggest that the rule is not likely to exacerbate nor mitigate $PM_{2.5}$ or ozone exposure concerns. However, differences in the distribution of impacts between some groups do exist. Most notably, we found that populations who live in large urban areas and those who are linguistically isolated are more likely to experience larger reductions in $PM_{2.5}$ concentrations than their comparison groups. We also observed that some race/ethnicity groups, such as Hispanic, Non-Hispanic Black, and Non-Hispanic Asian populations are more likely to experience larger reductions in $PM_{2.5}$ concentration than other race/ethnicity groups.

See RIA Chapter 7.6 for a detailed description of the methods and results of these analyses, including tables of national population-weighted average $PM_{2.5}$ and ozone exposure concentrations for each population group included in the analysis and plots of the cumulative distribution of reductions in pollution related to the final rule for the same population groups.

VIII. Estimated Costs and Benefits and Associated Considerations

This section summarizes our analyses of the rule's estimated costs, savings, and benefits. Overall, these analyses further support the reasonableness of the final standards.

Section VIII.A of the preamble summarizes the monetized costs, benefits, and net benefits of the final standards. Component costs and benefits, as well as transfers, are further discussed in sections VIII.B (vehicle technology and other costs), VIII.C (fueling impacts), V.D (non-emissions benefits), V.E (GHG benefits), V.F (criteria benefits), and V.G (transfers) of the preamble. Overall, EPA finds that the final rule creates significant positive net benefits for society. In addition, even when considering costs alone, this rule creates large cost savings due to cost increases (principally associated with higher vehicle technology and EVSE costs) being offset by significantly larger cost savings (principally associated with repair, maintenance, and fuel savings). The benefits for this rule are also significant. The greatest benefits accrue from GHG and $PM_{2.5}$ emissions reductions, but we also find large benefits from energy security and increased driving value, as well as disbenefits associated with somewhat greater refueling times.

EPA notes that, consistent with CAA section 202, in evaluating potential standards we carefully weighed the statutory factors, including the emissions impacts of the standards and the feasibility of the standards (including cost of compliance in light of available lead time). We monetize benefits of the standards and evaluate other costs in part to enable a comparison of costs and benefits pursuant to E.O. 12866, but we recognize there are benefits that we are currently unable to fully quantify. EPA's practice has been to set standards to achieve improved air quality consistent with CAA section 202, and not to rely on cost-benefit calculations, with their uncertainties and limitations, in identifying the appropriate standards. Nonetheless, our conclusion that the estimated benefits exceed the estimated costs of the final program reinforces our view that the standards are appropriate under section 202(a).

In sections VIII.H–K of this preamble, we consider additional non-monetized factors. As with the cost-benefit analysis, we did not rely on these factors in identifying the appropriate standards, but we find that these factors further support the reasonableness of this rule. In section VIII.H of this preamble, we find that this rule would have very small impacts (less than 0.8 percent) on light-duty vehicle sales, with increases in some years and decreases in other years. Though we do not expect this rule to impact new vehicle sales in a large way, as explained in section VIII.D.1 of this preamble we do expect the final standards will lead to increases in vehicle efficiency, making it possible for people to drive more without spending more and thus benefit from increased access to mobility. In section VIII.I of this preamble, we assess potential employment impacts, noting that the final standards are expected to increase employment in some sectors (*e.g.,* PEV and battery production), but decrease employment in other sectors (*e.g.,* ICE vehicle production). While we have not been able to comprehensively quantify the employment impacts, our partial quantitative analysis finds the potential for either an increase or decrease in net employment, with results that lean toward increased levels of net employment. In section VIII.J of this preamble, we describe how large GHG emissions reductions resulting from the rule will positively impact environmental justice. We also describe how the vehicle-related criteria emissions reductions are also expected to improve environmental conditions for communities near roadways. As described in section VII of this preamble, we expect that this rule will result in widespread decreases in air pollution in 2055, and associated improvements in human health, even when accounting for the impacts of increased electricity generation. In section VIII.K of this preamble, we consider additional factors. Among other things, while we expect increases in fatalities due to expected increases in driving, we find that the rule has no statistically significant impact on fatalities per mile driven. We do find a small, non-statistically significant decrease of 0.01 percent in annual fatalities per billion miles driven. On balance, our analysis of all the factors in section VIII of this preamble further support the reasonableness of the final standards.

A. Summary of Costs and Benefits

EPA estimates that the total benefits of this action far exceed the total costs with the annualized value of monetized net benefits to society estimated at $99 billion through the year 2055, assuming a 2 percent discount rate, as shown in Table 211.[1360] The annualized value of monetized emission benefits is $85 billion, with $72 billion of that attributed to climate-related economic benefits from reducing emissions of GHGs that contribute to climate change and the remainder attributed to reduced emissions of criteria pollutants that contribute to ambient concentrations of smaller particulate matter ($PM_{2.5}$). $PM_{2.5}$ is associated with premature death and serious health effects such as hospital admissions due to respiratory and cardiovascular illnesses, nonfatal heart attacks, aggravated asthma, and decreased lung function.

The annualized value of vehicle technology costs is estimated at $40 billion. Notably, this rule will result in significant savings in vehicle maintenance and repair for consumers, which we estimate at an annualized value of $16 billion (note that these values are presented as negative costs, or savings, in the table). EPA projects generally lower maintenance and repair costs for electric vehicles and those societal maintenance and repair savings grow significantly over time. We also estimate various impacts associated with our assumption that consumers choose to drive more due to the lower cost of driving under the standards, called the rebound effect (as discussed further in section VIII of this preamble and in Chapters 8 and 9 of the RIA). Increased traffic noise and congestion costs are two such effects due to the rebound effect, which we estimate at an annualized value of $1.2 billion.

EPA also estimates impacts associated with fueling the vehicles under our standards. The rule will provide significant savings to society through reduced fuel expenditures with annualized pre-tax fuel savings of $46 billion. Somewhat offsetting those fuel savings is the expected cost of EV chargers, or electric vehicle supply equipment (EVSE), of $9 billion.

This rule includes other benefits not associated with emission reductions. Energy security benefits are estimated at an annualized value of $2.1 billion. The drive value benefit, which is the value of consumers' choice to drive more under the rebound effect, has an estimated annualized value of $2.1 billion. The refueling time impact includes two effects: time saved refueling for ICE vehicles with lower fuel consumption under our standards, and mid-trip recharging events for electric vehicles. Our past GHG rules have estimated that refueling time would be reduced due to the lower fuel consumption of new vehicles; hence, a benefit. However, in this analysis, we are estimating that refueling time will increase somewhat overall for the fleet due to our additional assumption for mid-trip recharging events for electric vehicles. Therefore, the refueling time impact represents a disbenefit (a negative benefit) as shown, with an annualized value at negative $0.8 billion. As noted in section VIII of this preamble and in RIA Chapter 4, we have updated our refueling time estimates but still consider them to be conservatively high for electric vehicles considering the rapid changes taking place in electric vehicle charging infrastructure driven largely by the Bipartisan Infrastructure Law and the Inflation Reduction Act.

Note that some costs are shown as negative values in Table 211. Those entries represent savings but are included under the ''costs'' category because, in past rules, categories such as repair and maintenance have been viewed as costs of vehicle operation; as discussed above, under this rule we project significant savings in repair and maintenance costs for consumers. Where negative values are shown, we

[1360] All subsequent annualized costs and annualized benefits cited in this section refer to the values generated at a 2 percent discount rate.

are estimating that those costs are lower under the final standards than in the No Action case.

EPA received several comments related to the benefit-cost analysis. We summarize and respond to those comments in the Response to Comments document that accompanies this rulemaking. We have updated our analysis in light of comments and new data although we have not changed our general framework for conducting our benefit cost analysis. Consideration of comments also did not affect our conclusion that the benefits of the proposed and final rules significantly outweigh the costs. EPA follows applicable guidance and best practices when conducting its benefit-cost analyses.[1361] We therefore consider our analysis methodologically rigorous and a best estimate of the projected benefits and costs associated with the final rule.

Here we summarize results for the final standards. We present results for the two alternatives in Chapter 9 of the RIA.

[1361] Monetized climate benefits are presented under a 2 percent near-term Ramsey discount rate, consistent with EPA's updated estimates of the SC–GHG. The 2003 version of OMB's Circular A–4 had generally recommended 3 percent and 7 percent as default discount rates for costs and benefits, though as part of the Interagency Working Group on the Social Cost of Greenhouse Gases, OMB had also long recognized that climate effects should be discounted only at appropriate consumption-based discount rates. While we were conducting the analysis for this rule, OMB finalized an update to Circular A–4, in which it recommended the general application of a 2 percent discount rate to costs and benefits (subject to regular updates), as well as the consideration of the shadow price of capital when costs or benefits are likely to accrue to capital (OMB 2023). Because the SC–GHG estimates reflect net climate change damages in terms of reduced consumption (or monetary consumption equivalents), the use of the social rate of return on capital (7 percent under OMB Circular A–4 (2003)) to discount damages estimated in terms of reduced consumption would inappropriately underestimate the impacts of climate change for the purposes of estimating the SC–GHG. See section of VIII.E of the preamble and RIA Chapter 6.2 for more detail.

TABLE 211—SUMMARY OF COSTS, FUEL SAVINGS AND BENEFITS OF THE FINAL RULE

[Billions of 2022 dollars] [a b c d]

	CY 2055	PV, 2%	PV, 3%	PV, 7%	AV, 2%	AV, 3%	AV, 7%
Vehicle Technology Costs	$38	$870	$760	$450	$40	$39	$37
Insurance Costs	1.9	33	28	15	1.5	1.4	1.2
Repair Costs	−7.1	−40	−32	−12	−1.8	−1.6	−0.99
Maintenance Costs	−35	−300	−250	−110	−14	−13	−9.3
Congestion Costs	2.4	25	21	10	1.2	1.1	0.83
Noise Costs	0.04	0.41	0.34	0.17	0.019	0.018	0.014
Sum of Costs	0.59	590	530	350	27	28	29
Pre-tax Fuel Savings	94	1,000	840	420	46	44	34
EVSE Port Costs	8.6	190	160	96	9	8.8	7.9
Sum of Fuel Savings less EVSE Port Costs	86	820	680	330	37	35	26
Drive Value Benefits	4.7	46	38	18	2.1	2	1.5
Refueling Time Benefits	−1.7	−17	−15	−7.5	−0.8	−0.76	−0.61
Energy Security Benefits	4.1	47	39	20	2.1	2	1.6
Sum of Non-Emission Benefits	7	75	62	30	3.4	3.2	2.5
Climate Benefits, 2% Near-term Ramsey	150	1,600	1,600	1,600	72	72	72
$PM_{2.5}$ Health Benefits	25	240	200	88	13	10	7.2
Sum of Emission Benefits	170	1,800	1,800	1,700	85	83	80
Net Benefits	270	2,100	2,000	1,700	99	94	80

[a] Net benefits are emission benefits, non-emission benefits, and fuel savings (less EVSE port costs) minus the costs of the program. Values rounded to two significant figures; totals may not sum due to rounding. Present and annualized values are based on the stream of annual calendar year costs and benefits included in the analysis (2027—2055) and discounted back to year 2027. Climate benefits are based on reductions in GHG emissions and are calculated using three different SC–GHG estimates that assume either a 1.5 percent, 2.0 percent, or 2.5 percent near-term Ramsey discount rate. See EPA's Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (EPA, 2023). For presentational purposes in this table, we use the climate benefits associated with the SC–GHG under the 2-percent near-term Ramsey discount rate. See section VIII.E of this preamble for the full range of monetized climate benefit estimates. All other costs and benefits are discounted using either a 2-percent, 3-percent, or 7-percent constant discount rate. For further discussion of the SC–GHGs and how EPA accounted for these estimates, please refer to section VIII.E of this preamble and Chapter 6.2 of the RIA.

[b] To calculate net benefits, we use the monetized suite of total avoided $PM_{2.5}$-related health effects that includes avoided deaths based on the Pope III et al., 2019 study, which is the larger of the two $PM_{2.5}$ health benefits estimates presented in section VIII.F of this preamble.

[c] The annual $PM_{2.5}$ health benefits estimate presented in the CY 2055 column reflects the value of certain avoided health outcomes, such as avoided deaths, that are expected to accrue over more than a single year discounted using a 3-percent discount rate.

[d] We do not currently have year-over-year estimates of $PM_{2.5}$ benefits that discount such annual health outcomes using a 2-percent discount rate. We have therefore discounted the annual stream of health benefits that reflect a 3-percent discount rate lag adjustment using a 2-percent discount rate to populate the PV, 2 percent and AV, 2 percent columns. The annual stream of $PM_{2.5}$-related health benefits that reflect a 3-percent and 7-percent discount rate lag adjustment were used to populate the PV/AV 3 percent and PV/AV 7 percent columns, respectively. See section VIII.F of this preamble for more details on the annual stream of $PM_{2.5}$-related benefits associated with this rule.

B. Vehicle Technology and Other Costs

Table 212 shows the estimated annual costs of the program for the indicated calendar years (CY). The table also shows the present-values (PV) of those costs and the annualized values (AV) for the calendar years 2027–2055 using 2, 3 and 7 percent discount rates.[1362]

TABLE 212—COSTS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars]

Calendar year	Vehicle technology costs	Insurance costs	Repair costs	Maintenance costs	Congestion costs	Noise costs	Sum of costs
2027	$2.6	$0.02	$0.027	$0.042	$0.0013	$0.000015	$2.7
2028	7.3	0.06	0.081	0.096	0.027	0.00041	7.6
2029	16	0.15	0.16	0.089	0.05	0.00077	17
2030	23	0.27	0.26	−0.027	0.073	0.0011	24
2031	29	0.41	0.35	−0.35	0.094	0.0015	29
2032	30	0.55	0.38	−$0.9	0.11	0.0017	30
2035	55	1.5	0.7	−3.3	0.59	0.0095	54
2040	50	2.1	−0.81	−13	1.3	0.021	40
2045	46	2.3	−3.4	−24	1.9	0.03	23
2050	42	2.1	−5.7	−32	2.3	0.037	9.4
2055	38	1.9	−7.1	−35	2.4	0.04	0.59
PV2	870	33	−40	−300	25	0.41	590
PV3	760	28	−32	−250	21	0.34	530
PV7	450	15	−12	−110	10	0.17	350
AV2	40	1.5	−1.8	−14	1.2	0.019	27
AV3	39	1.4	−1.6	−13	1.1	0.018	28
AV7	37	1.2	−0.99	−9.3	0.83	0.014	29

1. Vehicle Technology Costs

We expect the technology costs of the program will result in a rise in the average purchase price for consumers, for both new and used vehicles. While we expect that vehicle manufacturers may choose to strategically price vehicles (*e.g.,* subsidizing a lower price for some vehicles with a higher price for others), we assume in our modeling that increased vehicle technology costs will fully impact purchase prices paid by consumers. The projected vehicle technology costs shown in Table 212 represent the incremental costs to manufacturers and, because we are presenting social costs, they exclude cost reductions available to manufacturers by the IRA battery tax credits (*i.e.,* the IRC 45X credits). For consumers, projected vehicle technology costs are offset by savings in reduced operating costs, including fuel savings and reduced maintenance and repair costs, as discussed in section VIII.K of this preamble and in Chapter 4 of the RIA. Additionally, consumers may also benefit from IRA purchase incentives for PEVs.

Our estimated incremental vehicle technology costs have increased since the NPRM, which we discuss at length throughout this preamble. The technology cost updates resulted in generally lower cost inputs but the magnitude of the changes were larger for ICE technologies than for HEV, PHEV and BEV technologies. As a result, the incremental costs of our Action scenarios compared to the No Action case have increased.

2. Insurance Costs

Associated with the changing cost of vehicles will be a change in insurance paid by owners and drivers of those vehicles. We received comment that we should have included insurance costs in our analysis, and we agree that it is appropriate to do so. To estimate insurance costs, we made use of an analysis done by ANL which focused on insurance costs associated with comprehensive and collision coverage.[1363] In that report, ANL presented the data shown in Table 213 which is what we have used in OMEGA to estimate insurance costs.

TABLE 213—ANNUAL COMPREHENSIVE AND COLLISION PREMIUM WITH $500 DEDUCTIBLE, 2019 DOLLARS [a]

Body style	ICE, HEV, PHEV, BEV powertrains
Car	(Vehicle value × 0.009 + $220) × 1.19.
CUV/SUV	(Vehicle value × 0.005 + $240) × 1.19.
Pickup	(Vehicle value × 0.006 + $210) × 1.19.

[a] Vehicle value is calculated as the depreciated value of the vehicle as it ages.

To estimate the vehicle value in calculating insurance costs, we used a 14.9 percent annual depreciation rate (see Chapter 4.3.6 of the RIA). That depreciation rate is applied to the estimated price of the vehicle when new, which we take to be the purchase price calculated within OMEGA taking into consideration cross-subsidies and any applicable battery tax credits or, in other words, the estimated price paid by the consumer prior to receiving a vehicle purchase tax credit.

We did not estimate insurance costs in the NPRM, so these costs are new and represent increased costs relative to the proposal. As discussed, our estimated insurance rates differ slightly by body-style, but not by powertrain type. Note that insurance costs are calculated for all years of a vehicle's lifetime.

3. Maintenance and Repair Costs

Maintenance and repair (M&R) are significant components of the cost of ownership for any vehicle. According to Edmunds, maintenance costs consist of two types of maintenance: scheduled and unscheduled. Scheduled maintenance is the performance of factory-recommended items at periodic mileage or calendar intervals. Unscheduled maintenance includes wheel alignment and the replacement of items subject to wear and usage such as the low-voltage battery, brakes, headlights, hoses, exhaust system parts,

[1362] For the estimation of the stream of costs and benefits, we assume that the MY 2032 standards apply to each year thereafter.

[1363] "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains, ANL/ESD–21/4," Argonne National Laboratory, Energy Systems Division, April 2021.

taillight/turn signal bulbs, tires, and wiper blades/inserts.[1364] Repairs, in contrast, are done to fix malfunctioning parts that inhibit the use of the vehicle. The differentiation between the items that are included in unscheduled maintenance versus repairs may be arbitrary, but the items considered repairs generally follow the systems that are covered in vehicle comprehensive (*i.e.,* ''bumper-to-bumper'') warranties offered by automakers, which exclude common ''wear'' items like tires, brakes, and the low-voltage battery.[1365]

We received comment that replacement of the high-voltage battery in PEVs should be considered as a maintenance and repair cost. EPA disagrees that high-voltage batteries will routinely need to be replaced in this way during the useful life of the vehicle. Based on current experience with vehicles in use in the field, and consultations on this topic that EPA has conducted with experts, stakeholders, and manufacturers, EPA finds no evidence that battery replacements out of warranty will typically be necessary for PEVs during their useful life, and therefore we do not include the cost of battery replacement in the cost of PEV maintenance and repair. We also note that the battery durability and warranty standards established in this rule provide greater assurance and transparency regarding battery performance and the conditions under which a warranty repair or replacement must be honored.

To estimate maintenance and repair costs, we have used the data gathered and summarized by Argonne National Laboratory (ANL) in their evaluation of the total cost of ownership for vehicles of various sizes and powertrains.[1366]

i. Maintenance Costs

Maintenance costs are an important consideration in the full accounting of social benefits and costs and in a consumer's purchase decision process. In their study, ANL developed a generic maintenance service schedule for various powertrain types using owner's manuals from various vehicle makes and models, assuming that drivers would follow the recommended service intervals. After developing the maintenance schedules, the authors collected national average costs for each of the preventative and unscheduled services, noting several instances where differences in consumer characteristics and in vehicle attributes were likely important but not quantified/quantifiable.

Using the schedules and costs developed by the ANL authors and presented in the RIA, OMEGA calculates the cumulative maintenance costs from mile zero through mile 225,000. Because maintenance costs typically increase over the life of the vehicle, we estimate maintenance and repair costs per mile at a constant slope with an intercept set to $0 per mile such that the cumulative costs per the maintenance schedule are reached at 225,000 miles. Following this approach, the maintenance cost per mile curves calculated within OMEGA are as shown in Figure 44.

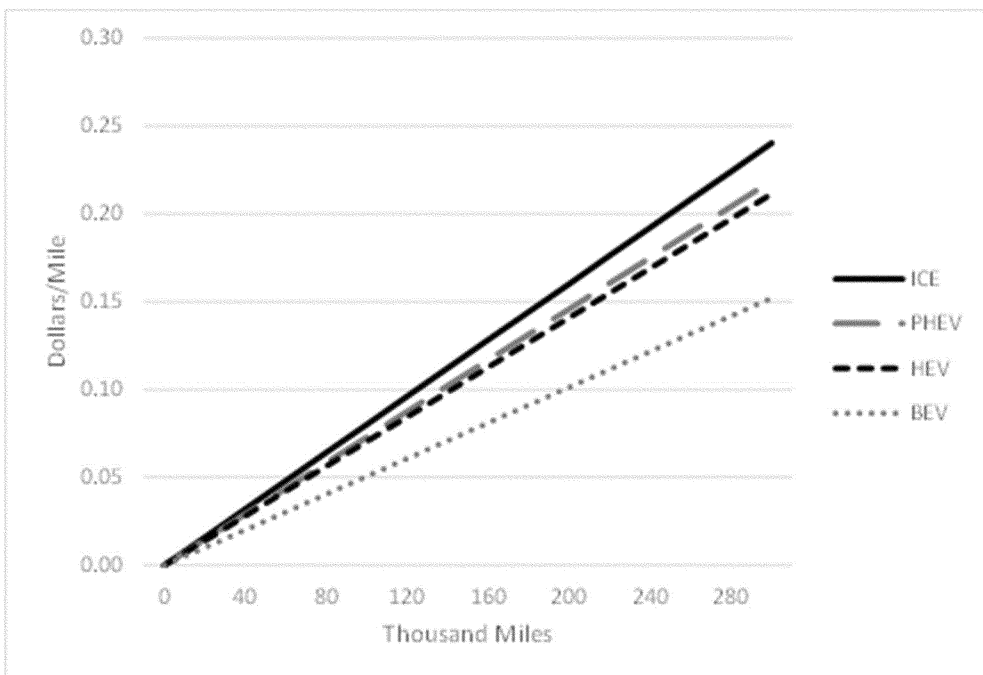

Figure 44: Maintenance Cost per Mile (2019 Dollars) at Various Odometer Readings

Using these maintenance cost per mile curves, OMEGA then calculates the estimated maintenance costs in any given year of a vehicle's life based on the miles traveled in that year. Table 212 presents the maintenance costs (savings) associated with the final rule. For a more detailed discussion of maintenance costs, including costs associated with the alternative scenarios analyzed in support of this final rule, see RIA Chapter 4.

Our maintenance savings are lower in the final analysis than in the NPRM. Because maintenance costs are estimated to depend on both powertrain type and miles driven, our incremental

[1364] Edmunds, ''*Edmunds.com/tco.html*,'' Edmunds, [Online]. Available: *Edmunds.com/tco.html*. Accessed 24 February 2022.

[1365] D. Muller, ''Warranties Defined: The Truth behind the Promises,'' Car and Driver, 29 May 2017.

[1366] ''Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size Classes and Powertrains, ANL/ESD–21/4,'' Argonne National Laboratory, Energy Systems Division, April 2021.

maintenance costs are lower because the central case final analysis has slightly fewer BEVs and slightly more PHEVs and HEVs than the proposal, and because we have more rebound driving in the final analysis than in the NPRM for reasons discussed in Chapter 8.3 of the RIA.

ii. Repair Costs

Repairs are done to fix malfunctioning parts that inhibit the use of the vehicle and are generally considered to address problems associated with parts or systems that are covered under typical manufacturer bumper-to-bumper type warranties. In the ANL study, the authors were able to develop a repair cost curve for a gasoline car and a series of scalers that could be applied to that curve to estimate repair costs for other powertrains and vehicle types.

OMEGA makes use of ANL's cost curve and multipliers to estimate repair costs per mile at any age in a vehicle's life. Figure 45 provides repair cost per mile for a $35,000 car, van/SUV, and pickup, and Figure 46 provides the same information for medium-duty vans and pickups.

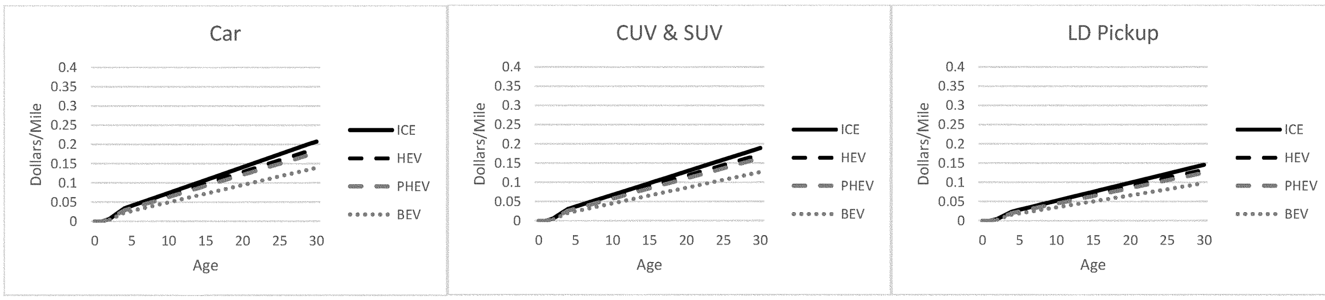

Figure 45: Repair Cost Per Mile (2019 Dollars) for a $35,000 Car, Van/SUV, and Pickup With Various Powertrains by Vehicle Age in Years

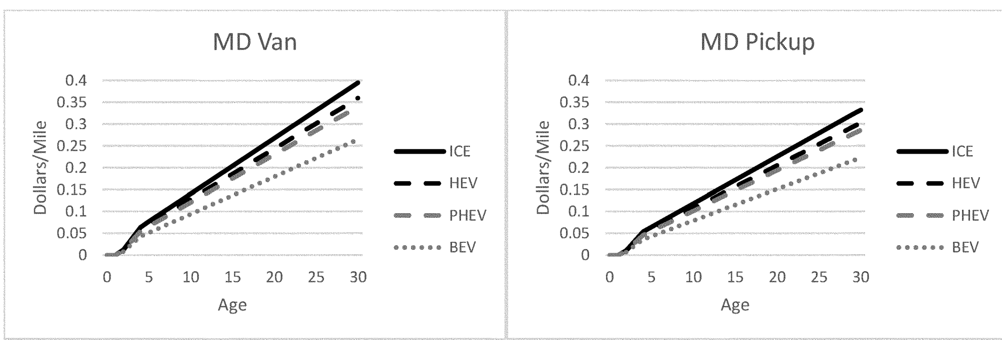

Figure 46: Repair Cost Per Mile (2019 Dollars) for a Medium-Duty Van and Pickup With Various Powertrains by Vehicle Age in Years

Table 212 presents the repair costs associated with the final rule. A more detailed discussion of repair costs appears in RIA Chapter 4.

Similar to maintenance savings, our incremental repair savings are lower in the final analysis compared to the NPRM but for slightly different reasons. Our estimated repair costs depend on body style, powertrain type and, importantly, estimated vehicle cost when new. While our final analysis has more pickups and SUVs than our proposal, which serves to reduce repair costs, our final analysis also has slightly fewer BEVs and more HEVs and PHEVs than in our NPRM which serves to increase costs. More importantly, our incremental vehicle costs are higher in the final analysis due in part to the updated technology costs as discussed in Chapters 2.5 and 2.6 of the RIA and because of inflationary effects on manufacturer suggested retail prices in our base year analysis fleet.

4. Congestion and Noise Costs

Costs associated with congestion and noise can increase in the event that drivers with more efficient vehicles drive more than they otherwise would have. This can occur because more efficient vehicles have lower fuel costs per mile of driving which allows drivers to drive more miles while spending the same amount of money they spent while driving their old, less efficient vehicle. This is known as the ''rebound effect.'' Delays associated with congestion impose higher costs on road users in the form of increased travel time and operating expenses. Likewise, vehicles driving more miles on roadways leads to more road noise from tires, wind, engines, and motors.

As in past rulemakings (*i.e.,* GHG 2010, 2012, and 2021), EPA relies on estimates of congestion and noise costs developed by the Federal Highway Administration's (FHWA's), specifically the ''Middle'' estimates for marginal congestion and noise costs, to estimate the increased external costs caused by added driving due to the rebound effect. FHWA's congestion and noise cost estimates focus on freeways. EPA, however, applies the congestion cost to all vehicle miles, freeway and non-freeway and including rebound miles to ensure that these costs are not underestimated. Table 214 shows the values used as inputs to OMEGA and adjusted within the model to the dollar basis used in the analysis.

TABLE 214—COSTS ASSOCIATED WITH CONGESTION AND NOISE

[2018 Dollars per vehicle mile]

	Sedans/wagons	CUVs/SUVs/vans	Pickups
Congestion	0.0634	0.0634	0.0566
Noise	0.0009	0.0009	0.0009

Both incremental congestion and noise costs are higher in our final analysis than our NPRM due to the additional rebound miles estimated in the final analysis which uses the same rebound rates as in the NPRM but with an updated methodology to more appropriately account for PHEVs (See Chapter 8.3 of the RIA).

C. Fueling Impacts

1. Fuel Savings

The final standards are projected to reduce liquid fuel consumption (gasoline and diesel) while simultaneously increasing electricity consumption. The net effect of these changes in consumption for consumers is decreased fuel expenditures or fuel savings. For more information regarding fuel consumption, including other considerations like rebound driving, see RIA Chapter 4.

Fuel savings arise from reduced expenditures on liquid fuel due to reduced consumption of those fuels. Electricity consumption is expected to increase, with a corresponding increase in expenditures on electricity, due to electric vehicles replacing liquid-fueled vehicles. We describe how we calculate reduced fuel consumption and increased electricity consumption in Chapter 8 of the RIA. Table 215 presents liquid-fuel and electricity consumption impacts.

TABLE 215—LIQUID-FUEL AND ELECTRICITY CONSUMPTION IMPACTS ASSOCIATED WITH THE FINAL RULE

Calendar year	Gasoline (billion gallons)	Diesel (billion gallons)	Electricity (billion kWh)
2027	−0.068	−0.0025	0.94
2028	−0.47	−0.0043	4.1
2029	−1.4	−0.03	13
2030	−2.9	−0.097	27
2031	−4.8	−0.17	47
2032	−6.9	−0.27	67
2035	−16	−0.54	150
2040	−29	−0.8	260
2045	−38	−0.99	330
2050	−41	−1.1	350
2055	−42	−1.3	360
sum	−760	−21	6,700

Table 216 presents the retail fuel savings, net of savings in liquid fuel expenditures and increases in electricity expenditures. These represent savings that consumers would realize. The table also presents the pretax fuel savings, net of savings in liquid fuel expenditures and increases in electricity expenditures. These represent the savings included in the net benefit calculation since fuel taxes do not contribute to the value of the fuel. We present fuel tax impacts along with other transfers in section VIII.G of this preamble.

TABLE 216—FUEL SAVINGS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars] [a]

Calendar year	Gasoline		Diesel		Electricity		Sum	
	Retail	Pretax	Retail	Pretax	Retail	Pretax	Retail	Pretax
2027	$0.18	$0.14	$0.0092	$0.0079	$0.021	$0.02	$0.21	$0.17
2028	1.4	1.1	0.016	0.013	−0.26	−0.24	1.1	0.89
2029	4.3	3.5	0.11	0.095	−1.2	−1.1	3.2	2.5
2030	8.5	7.1	0.35	0.3	−2.6	−2.5	6.3	4.9
2031	14	12	0.61	0.52	−4.5	−4.3	10	7.9
2032	20	17	1	0.86	−6.8	−6.4	14	11
2035	47	39	2	1.7	−14	−13	35	28
2040	85	72	3	2.6	−22	−21	66	53
2045	110	94	3.8	3.3	−27	−26	87	71
2050	130	110	4.5	3.9	−28	−27	100	86
2055	140	120	4.9	4.3	−29	−27	110	94
PV2	1,600	1,300	57	49	−380	−360	1,200	1,000

TABLE 216—FUEL SAVINGS ASSOCIATED WITH THE FINAL RULE—Continued

[Billions of 2022 dollars] [a]

Calendar year	Gasoline		Diesel		Electricity		Sum	
	Retail	Pretax	Retail	Pretax	Retail	Pretax	Retail	Pretax
PV3	1,300	1,100	47	41	−320	−300	1,000	840
PV7	660	560	24	21	−170	−160	520	420
AV2	72	61	2.6	2.3	−18	−17	57	46
AV3	68	58	2.5	2.2	−17	−16	54	44
AV7	54	46	2	1.7	−14	−13	42	34

[a] Positive values represent monetary savings while negative values represent increased costs.

Our incremental retail fuel savings in the final analysis are lower than those estimated in the NPRM due to the lower share of BEVs in the vehicle stock (roughly 42 percent in 2055 versus nearly 50 percent in the NPRM).

2. EVSE Costs

Another fueling impact included in the net benefits calculation is the EVSE costs discussed in section IV.C of this preamble and in Chapter 5 of the RIA. We present our estimated EVSE costs in Table 217. Note that the costs shown in Table 217 represent costs associated with the EVSE ports themselves and not the electricity delivered by them. Those electricity costs are included in Table 216.

TABLE 217—EVSE COSTS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars] [a]

Calendar year	EVSE costs
2027	$1.3
2028	0.55
2029	2.3
2030	2.3
2031	10
2032	10
2035	10
2040	9
2045	12
2050	13
2055	8.6
PV2	190
PV3	160
PV7	96
AV2	9
AV3	8.8
AV7	7.9

[a] Positive values represent costs.

D. Non-Emission Benefits

Table 218 presents the estimated benefits that are not a direct result of emission inventory changes. Those benefits include the drive value, reductions in refueling time, and energy security. As shown in the table, the refueling time benefits are negative, meaning they are disbenefits. This benefit category in past rules has primarily represented reduced time spent on refueling due to improved vehicle efficiency. However, in this rule we're also including an estimate of mid-trip charging for BEVs, which includes increased time for refueling compared to ICE vehicles, resulting in more refueling time overall under the final standards and, therefore, a disbenefit.

TABLE 218—NON-EMISSION BENEFITS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars] [a]

Calendar year	Drive value benefits	Refueling time benefits	Energy security benefits	Sum
2027	$0.002	$0.0022	$0.0047	$0.0089
2028	0.042	0.026	0.032	0.1
2029	0.081	−0.012	0.1	0.17
2030	0.12	−0.11	0.21	0.22
2031	0.16	−0.27	0.36	0.26
2032	0.2	−0.47	0.53	0.26
2035	1	−0.59	1.3	1.7
2040	2.3	−0.86	2.5	3.9
2045	3.3	−1.1	3.4	5.6
2050	4.2	−1.4	4	6.8
2055	4.7	−1.7	4.1	7
PV2	46	−17	47	75
PV3	38	−15	39	62
PV7	18	−7.5	20	30
AV2	2.1	−0.8	2.1	3.4
AV3	2	−0.76	2	3.2
AV7	1.5	−0.61	1.6	2.5

[a] Negative values represent disbenefits.

1. Drive Value

Mentioned briefly above and discussed in greater detail in Chapter 4 of the RIA, the rebound effect might occur when an increase in vehicle efficiency makes it possible for people to choose to drive more without spending more because of the lower cost per mile of driving. Additional driving can lead to costs and benefits that can be monetized. See RIA Chapter 4 for a discussion of our estimates of the rebound effect. In this section, we take the size of the rebound effect, as discussed in the RIA, and highlight the costs and benefits associated with additional driving.

The increase in travel associated with the rebound effect produces social and economic opportunities that become accessible with additional travel. We estimate the economic benefits from increased rebound-effect driving as the sum of the fuel costs paid to drive those miles and the owner/operator surplus from the additional accessibility that driving provides. These benefits are known as the drive value and appear in Table 218.

The economic value of the increased owner/operator surplus provided by additional driving is estimated as one half of the product of the fuel savings per mile and rebound miles.[1367] Because fuel savings differ among vehicles in response to standards, the value of benefits from increased vehicle use differs by model year and varies across our sensitivity cases and alternative standards considered.

Our incremental drive value benefits are higher in the final analysis than the NPRM due entirely to revised estimation of rebound miles used for the final analysis and as discussed in Chapter 8.3 of the RIA. As noted in section VIII.B.4 of the preamble the change in rebound miles between the final analysis and the NPRM is the result of our improved calculation approach within OMEGA and not the result of any changes to the elasticity parameter used in calculating rebound.

2. Refueling Time

In our analyses, we take into account refueling differences among liquid fuel vehicles, BEVs, and PHEVs. Provided fuel tanks on liquid fueled vehicles retain their capacity, lower fuel consumption is expected to reduce the frequency of refueling events and therefore reduce the time spent refueling resulting from less time spent seeking a refueling opportunity. OEMs may also elect to package smaller fuel tanks, leveraging lower fuel consumption to meet vehicle range, which would maintain fueling frequency but decrease the time spent refueling since it takes less time to fill a smaller fuel tank. Consistent with past analyses, we have estimated the former of these possibilities with respect to liquid fueled vehicles.

Electric vehicles are fueled via charging events. Many charging events are expected to occur at an owner's residence via a personally owned charge point or during work hours using an employer owned charge point, both of which impose very little time burden on the driver. However, charging events will also occur in public places where the burden on the driver's time may be relatively long (*e.g.,* when drivers are in the midst of an extended road trip). Thus, liquid fueling events and mid-trip charging events are the focus of our refueling time analysis. See RIA Chapter 4 for a more detailed discussion of this analysis.

The estimated incremental refueling time disbenefits are lower in the final analysis than the NPRM due largely to the updated number of miles per hour of mid-trip charging where the NPRM used a value of 100 miles per hour of charging and the final analysis uses a value of 400 miles per hour of charging. We discuss this change in more detail in Chapter 4.3 of the RIA.

3. Energy Security Impacts

In this section, we evaluate the energy security impacts of the final standards. Energy security is broadly defined as the uninterrupted availability of energy sources at affordable prices.[1368] Energy independence and energy security are distinct but related concepts, and an analysis of energy independence informs our assessment of energy security. The goal of U.S. energy independence is the elimination of all U.S. imports of petroleum and other foreign sources of energy, but more broadly, it is the elimination of U.S. sensitivity to variations in the price and supply of foreign sources of energy.[1369] Promoting energy independence and security through reducing demand for refined petroleum use by motor vehicles has long been a goal of both Congress and the Executive Branch because of both the economic and national security benefits of reduced dependence on imported oil, and was an important reason for amendments to the Clean Air Act in 1990, 2005, and 2007.[1370] See Chapter 10 of the RIA for a more detailed assessment of energy security and energy independence impacts of this final rule. See section IV.C.7.iii of this preamble and Chapter 3 of the RIA for a discussion of critical materials and PEV supply chains.

The U.S.'s oil consumption had been gradually increasing in recent years (2015–2019) before the COVID–19 pandemic in 2020 dramatically decreased U.S. and global oil consumption.[1371] By July 2021, U.S. oil consumption had returned to pre-pandemic levels and has remained fairly stable since then.[1372] The U.S. has increased its production of oil, particularly ''tight'' (*i.e.,* shale) oil, over the last decade.[1373] As a result of the recent increase in U.S. oil production, the U.S. became a net exporter of crude oil and refined petroleum products in 2020 and is projected to be a net exporter of crude oil and refined petroleum products for the foreseeable future.[1374] This is a significant reversal of the U.S.'s net export position since the U.S. has been a substantial net importer of crude oil and refined petroleum products starting in the early 1950s.[1375]

Oil is a commodity that is globally traded and, as a result, an oil price shock is transmitted globally. Given that the U.S. is projected to be a net exporter of crude oil and refined petroleum products for the time frame of this analysis (2027–2055), one could reason that the U.S. no longer has a significant energy security problem. However, U.S. refineries still rely on significant imports of heavy crude oil which could be subject to supply disruptions. Also, oil exporters with a large share of global production have the ability to raise or lower the price of oil by exerting the market power associated with the

[1367] The fuel costs of the rebound miles driven are simply the number of rebound miles multiplied by the cost per mile of driving them.

[1368] IEA, Energy Security: ensuring the uninterrupted availability of energy sources at an affordable price. 2019. December.

[1369] Greene, D. 2010. Measuring energy security: Can the United States achieve oil independence? *Energy Policy.* 38. pp. 1614–1621.

[1370] See *e.g.,* 136 Cong. Rec. 11989 (May 23, 1990) (Rep. Waxman stating that clean fuel vehicles program is ''tremendously significant as well for our national security. We are overly dependent on oil as a monopoly; we need to run our cars on alternative fuels.''); Remarks by President George W. Bush upon signing Energy Policy Act of 2005, 2005 U.S.C.C.A.N. S19, 2005 WL 3693179 (''It's an economic bill, but as [Sen. Pete Domenici] mentioned, it's also a national security bill. . . . Energy conservation is more than a private virtue; it's a public virtue''); Energy Independence and Security Act, Public Law 110–140, section 806 (finding ''the production of transportation fuels from renewable energy would help the United States meet rapidly growing domestic and global energy demands, reduce the dependence of the United States on energy imported from volatile regions of the world that are politically unstable, stabilize the cost and availability of energy, and safeguard the economy and security of the United States''); Statement by George W. Bush upon signing, 2007 U.S.C.C.A.N. S25, 2007 WL 4984165 ''One of the most serious long-term challenges facing our country is dependence on oil—especially oil from foreign lands. It's a serious challenge. . . . Because this dependence harms us economically through high and volatile prices at the gas pump; dependence creates pollution and contributes to greenhouse gas admissions [sic]. It threatens our national security by making us vulnerable to hostile regimes in unstable regions of the world. It makes us vulnerable to terrorists who might attack oil infrastructure.''

[1371] EIA. Monthly Energy Review. Table 3.1. Petroleum Overview. December 2022.

[1372] Ibid.

[1373] Ibid.

[1374] EIA. Annual Energy Outlook 2023. Table A11: Petroleum and Other Liquid Supply and Disposition (Reference Case). 2022.

[1375] U.S. EIA. Oil and Petroleum Products Explained. November 2, 2022.

Organization of Petroleum Exporting Countries (OPEC) to alter oil supply relative to demand. These factors contribute to the vulnerability of the U.S. economy to episodic oil supply shocks and price spikes, even when the U.S. is projected to be an overall net exporter of crude oil and refined products.

We anticipate that U.S. consumption and net imports of petroleum will be reduced as a result of this final rule, both from an increase in fuel efficiency of light- and medium-duty vehicles using petroleum-based fuels and from the greater use of PEVs which are fueled with electricity. A reduction of U.S. net petroleum imports reduces both the financial and strategic risks caused by potential sudden disruptions in the supply of petroleum to the U.S. and global market, thus increasing U.S. energy security. Table 219 presents the impacts on U.S. imports of oil for selected years for the final rule. For EPA's assessment of the U.S. oil impacts of a more stringent and a less stringent alternative standard, see the Chapter 8 of the RIA.

TABLE 219—U.S. OIL IMPORT IMPACTS FOR SELECTED YEARS ASSOCIATED WITH THE FINAL RULE, LIGHT-DUTY AND MEDIUM-DUTY

[Million barrels of imported oil per day in the given year] [a]

Calendar year	U.S. oil import impacts, final rule
2027	−0.0035
2030	−0.15
2032	−0.36
2040	−1.5
2050	−2.1
2055	−2.1

[a] Negative values represent reduced imports.

It is anticipated that vehicle manufacturers will choose to comply with the final standards in part with an increased penetration of PEVs. Compared to the use of petroleum-based fuels to power vehicles, electricity used in PEVs is anticipated to be generally more affordable and more stable in its price, *i.e.,* have less price volatility. See Chapter 10 of the RIA for an analysis of PEV affordability and electricity price stability compared to gasoline prices. Thus, the greater use of electricity for PEVs is anticipated to improve the U.S.'s overall energy security position. Also, since the electricity to power PEVs will likely be almost exclusively produced in the U.S., this final rule will move the U.S. towards the goal of energy independence. See Chapter 10 of the RIA for more discussion of how the final rule moves the U.S. to the goal of energy independence.

Several commenters claimed that the proposal would improve the U.S.'s energy security and independence position by increasing the wider use of electric vehicles. We agree with these commenters that the wider use of electricity in light- and medium-duty PEVs will improve the U.S.'s energy security and energy independence position. We respond to these comments in more detail in section 21 of the RTC document.

In order to understand the energy security implications of reducing U.S. oil imports, EPA has worked with Oak Ridge National Laboratory (ORNL), which has developed approaches for evaluating the social costs and energy security implications of oil use. When conducting this analysis, ORNL estimates the risk of reductions in U.S. economic output and disruption to the U.S. economy caused by sudden disruptions in world oil supply and associated price shocks (*i.e.,* labeled the avoided macroeconomic disruption/adjustment costs). These risks are quantified as ''macroeconomic oil security premiums'', *i.e.,* the extra costs of using oil besides its market price.

One commenter supported the use of the ORNL energy security methodology being used by EPA to estimate the oil security premiums in the proposed LMDV rule. Another commenter raised concerns that the ORNL oil security premium estimates that EPA is using in this proposed LMDV GHG rule are too high. This commenter claimed that the energy security methodology developed by ORNL is outdated and is no longer applicable to the current structure of global oil markets. In response, EPA notes that the ORNL model is continually updated to the current structure of global oil markets. Also, EPA and ORNL have worked together to revise the macroeconomic oil security premiums based upon the recent energy security literature. Based on the above, EPA concludes that the macroeconomic oil security premiums used in this final rulemaking are reasonable. We respond to these comments in more detail in the RTC document (see RTC section 21).

For this final rule, EPA is using macroeconomic oil security premiums estimated using ORNL's methodology, which incorporates updated oil price projections and energy market and economic trends from the U.S. Department of Energy's Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2023. To calculate the macroeconomic oil security benefits of this final rule, EPA is using the ORNL macroeconomic oil security premium methodology with: (1) estimated oil savings calculated by EPA and (2) an oil import reduction factor of 94.8 percent, which reflects our estimate of how much changes in U.S. oil consumption anticipated under the final standards will be reflected in changes in U.S. net oil imports. Based upon comments EPA received on this proposal and in consultation with DOE and NHTSA, the oil import reduction factor is being updated for this final rule to be consistent with revised estimates that U.S. refineries will operate at higher production levels than EPA estimated in the proposed rule. See Chapter 8 of the RIA and section 12 of the RTC document for more discussion of how EPA is updating its refinery throughput assumptions and, in turn, air quality impacts from refinery emissions, as a result of this rule. See Chapter 10 of the RIA and section 21 of the RTC document for EPA's discussion of how EPA is updating the oil import reduction factor to be consistent with new estimates of refinery throughput for this final rule. Below EPA presents macroeconomic oil security premiums for selected years being used for the final standards in Table 220. The energy security benefits for selected years for this final rule are presented in Table 218 and Table 9–7 in Chapter 9 of the RIA. For EPA's assessment of the energy security benefits of a more and a less stringent alternative for this final rule, see the Chapter 9.6 of the RIA.

TABLE 220—MACROECONOMIC OIL SECURITY PREMIUMS FOR SELECTED YEARS FOR THIS FINAL RULE

[2022$/barrel] [a]

Calendar year	Macroeconomic oil security premiums (range)
2027	$3.73 ($0.51–$7.02)
2030	3.92 (0.51–7.46)
2032	4.05 (0.53–7.77)
2040	4.62 (0.65–8.85)
2050	5.22 (0.91–9.89)
2055 [b]	5.22 (0.91–9.89)

[a] Top values in each cell are the mid-points; the values in parentheses are the 90 percent confidence intervals.

[b] Annual oil security premia are estimated using data from Annual Energy Outlook projections, which are only available through 2050. For the years 2051 through 2055 we use the 2050 premium estimates as a proxy.

Some commenters suggested that the proposal would reduce the demand for renewable fuels since the proposal focused on the promotion of the wider use of PEVs. These commenters asserted that EPA should instead focus upon achieving U.S. energy security and energy independence objectives by increasing the use of flexible-fueled vehicles/higher ethanol blends and the greater use of renewable fuels (*e.g.,* renewable diesel). Further, one commenter claimed that the proposed rule was at odds with the Congressional intent of the Renewable Fuel Standard Program (RFS) of mandating renewable fuels to achieve energy security/energy independence objectives. EPA agrees with the commenters that the increased use of renewable fuels in the U.S. transportation sector will improve the U.S.'s energy security/energy independence position. EPA addresses the issue of the role that renewable fuels can play in reducing GHG emissions in the U.S. transportation sector in the recently finalized RFS Set rule. On June 21, 2023, EPA announced a final rule to establish renewable fuel volume requirements and associated percentage standards for cellulosic biofuel, biomass-based diesel, advanced biofuels, and total renewable fuel for the 2023–2025 timeframe.[1376] The recently finalized RFS Set Rule and this final rule are complimentary in achieving GHG reductions in the U.S. transportation sector. We respond to these comments in more detail in the RTC document (see RTC section 21).

Many commenters asserted that while EPA focuses on the energy security benefits of reduced dependence on U.S. oil imports, EPA fails to address the energy security threats of the U.S.'s increasing dependence on imports of minerals and PEV battery supply chains as a result of this rule. For this rule, EPA distinguishes between energy security, mineral/metal security and security issues associated with the importation of PEV batteries and component parts. Since energy security, metal/mineral security and issues associated with the importation of PEV batteries and various components are distinct issues in terms of their characteristics and potential impacts, EPA separates these types of security issues in this rulemaking. We address energy security issues associated with this final rule in section 21 of the RTC document. Comments associated with wider use of PEVs impacts on the U.S.'s mineral/metal security and security issues associated with the importation of PEV batteries and their component parts are addressed in separate EPA responses in this rule's RTC document (see RTC section 15).

In light of the public comments and consideration of the information in the public record, it continues to be our assessment that the energy security benefits of the final standards are substantial and, as discussed in section IV.C.7.iii of this preamble, we do not find that compliance with the standards will lead to a long-term dependence on foreign imports of critical minerals or components that would adversely impact national security.

E. Greenhouse Gas Emission Reduction Benefits

1. Climate Benefits

EPA estimates the climate benefits of GHG emissions reductions expected from the final rule using estimates of the social cost of greenhouse gases (SC–GHG) that reflect recent advances in the scientific literature on climate change and its economic impacts and incorporate recommendations made by the National Academies of Science, Engineering, and Medicine.[1377] EPA published and used these estimates in the RIA for the Final Oil and Gas NSPS/EG Rulemaking, ''Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review'', which was signed by the EPA Administrator on December 2nd, 2023.[1378] EPA solicited public comment on the methodology and use of these estimates in the RIA for the agency's December 2022 Oil and Gas NSPS/EG Supplemental Proposal and has conducted an external peer review of these estimates, as described further below. Chapter 9.4 of the RIA lays out the details of the updated SC–GHG used within this final rule.

The SC–GHG is the monetary value of the net harm to society associated with a marginal increase in GHG emissions in a given year, or the benefit of avoiding that increase. In principle, SC–GHG includes the value of all climate change impacts (both negative and positive), including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem

[1376] Renewable Fuel Standard (RFS) Program: Standards for 2023–2025 and Other Changes. **Federal Register**/Vol. 88, No. 132/Wednesday, July 12, 2023.

[1377] National Academies of Sciences, Engineering, and Medicine (National Academies). 2017. Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide. National Academies Press.

[1378] U.S. EPA. (2023f). *Supplementary Material for the Regulatory Impact Analysis for the Final Rulemaking, ''Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review'': EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances.* Washington, DC: U.S. EPA.

services. The SC–GHG, therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton and is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect GHG emissions. In practice, data and modeling limitations restrain the ability of SC–GHG estimates to include all physical, ecological, and economic impacts of climate change, implicitly assigning a value of zero to the omitted climate damages. The estimates are, therefore, a partial accounting of climate change impacts and likely underestimate the marginal benefits of abatement.

Since 2008, EPA has used estimates of the social cost of various greenhouse gases (*i.e.,* SC–CO_2, SC–CH_4, and SC–N_2O), collectively referred to as the SC–GHG, in analyses of actions that affect GHG emissions. The values used by EPA from 2009 to 2016 and since 2021—including in the proposal for this rulemaking—have been consistent with those developed and recommended by the IWG on the SC–GHG; and the values used from 2017 to 2020 were consistent with those required by Executive Order (E.O.) 13783, which disbanded the IWG. During 2015–2017, the National Academies conducted a comprehensive review of the SC–CO_2 and issued a final report in 2017 recommending specific criteria for future updates to the SC–CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process (National Academies, 2017). The IWG was reconstituted in 2021 and E.O. 13990 directed it to develop a comprehensive update of its SC–GHG estimates, recommendations regarding areas of decision-making to which SC–GHG should be applied, and a standardized review and updating process to ensure that the recommended estimates continue to be based on the best available economics and science going forward.

EPA is a member of the IWG and is participating in the IWG's work under E.O. 13990. As noted in previous EPA RIAs—including in the proposal RIA for this rulemaking-, while that process continues, EPA is continuously reviewing developments in the scientific literature on the SC–GHG, including more robust methodologies for estimating damages from emissions, and looking for opportunities to further improve SC–GHG estimation. In the December 2022 Oil and Gas Supplemental Proposal RIA,[1379] the Agency included a sensitivity analysis of the climate benefits of that rule using a new set of SC–GHG estimates that incorporates recent research addressing recommendations of the National Academies [1380] in addition to using the interim SC–GHG estimates presented in the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990* [1381] that the IWG recommended for use until updated estimates that address the National Academies' recommendations are available.

EPA solicited public comment on the sensitivity analysis and the accompanying draft technical report, External Review Draft of Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances, which explains the methodology underlying the new set of estimates and was included as supplementary material to the RIA for the December 2022 Supplemental Oil and Gas Proposal.[1382] The response to comments document can be found in the docket for that action.[1383]

As we noted in the light- and medium-duty vehicle NPRM, to ensure that the methodological updates adopted in the technical report are consistent with economic theory and reflect the latest science, EPA also initiated an external peer review panel to conduct a high-quality review of the technical report (see 88 FR 29372, noting this peer review process was ongoing at the time of our proposal); this peer review was completed in May 2023. The peer reviewers commended the agency on its development of the draft update, calling it a much-needed improvement in estimating the SC–GHG and a significant step towards addressing the National Academies' recommendations with defensible modeling choices based on current science. The peer reviewers provided numerous recommendations for refining the presentation and for future modeling improvements, especially with respect to climate change impacts and associated damages that are not currently included in the analysis. Additional discussion of omitted impacts and other updates were incorporated in the technical report to address peer reviewer recommendations. Complete information about the external peer review, including the peer reviewer selection process, the final report with individual recommendations from peer reviewers, and EPA's response to each recommendation is available on EPA's website.[1384]

Chapter 6.1 of the RIA provides an overview of the methodological updates incorporated into the SC–GHG estimates used in this final rule. A more detailed explanation of each input and the modeling process is provided in the final technical report, EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (U.S. EPA, 2023e).

Commenters on our LMDV NPRM brought up issues regarding baseline scenarios, climate modeling (*e.g.,* equilibrium climate sensitivity) and IAMS, claiming that they all used outdated assumptions. Other commenters suggested that EPA use lower discount rates as well as utilize the latest research and values from the December 2022 Supplemental Oil and Gas Proposal. EPA's decision to use the updated SC–GHG values from U.S. EPA (2023f) addresses several of the concerns voiced within the comments. See RTC section 20 for further detail on the comments received and EPA's responses. For a detailed description of the updated modeling please see RIA Chapter 7 for the final rule as well as U.S. EPA (2023f).

Table 221 through Table 224 present the estimated annual, undiscounted climate benefits of the net GHG emissions reductions associated with the final rule, and consequently the annual quantified benefits (*i.e.,* total GHG benefits), for each of the three SC–GHG values estimated by the 2023 Report on SC–GHG for the stream of years beginning with the first year of rule implementation, 2027, through 2055. Also shown are the present values (PV) and equivalent annualized values

[1379] U.S. EPA. (2023). *Supplementary Material for the Regulatory Impact Analysis for the Final Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review": EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances.* Washington, DC: U.S. EPA.

[1380] Ibid.

[1381] Interagency Working Group on Social Cost of Carbon (IWG). 2021 (February). Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide: Interim Estimates under Executive Order 13990. United States Government.

[1382] *https://www.epa.gov/environmental-economics/scghg-tsd-peer-review.*

[1383] Supplementary Material for the Regulatory Impact Analysis for the Final Rulemaking, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review", EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances, Docket ID No. EPA–HQ–OAR–2021–0317, November 2023.

[1384] *https://www.epa.gov/environmental-economics/scghg-tsd-peer-review.*

(AV) associated with each of the three SC–GHG values. For a thorough discussion of the SC–GHG methodology, limitations and uncertainties see Chapter 9.4 of the RIA.

TABLE 221—CLIMATE BENEFITS FROM REDUCTION IN CO_2 EMISSIONS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars]

Calendar year	Near-term Ramsey discount rate		
	2.5%	2%	1.5%
2027	$0.063	$0.1	$0.17
2028	0.54	0.87	1.5
2029	1.8	3	5
2030	3.9	6.2	10
2031	6.5	10	17
2032	9.7	15	26
2035	25	40	66
2040	53	81	130
2045	76	110	180
2050	92	140	220
2055	100	150	230
PV	940	1,600	2,800
AV	46	72	120

Notes: Climate benefits are based on changes (reductions) in CO_2, CH_4, and N_2O emissions and are calculated using three different estimates of the social cost of carbon (SC–CO_2), the social cost of methane (SC–CH_4), and the social cost of nitrous oxide (SC–N_2O) (model average at 1.5-percent, 2-percent, and 2.5-percent Ramsey discount rates). See EPA's Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (EPA, 2023). We emphasize the importance and value of considering the benefits calculated using all three SC–CO_2, SC–CH_4, and SC–N_2O estimates. We use constant discount rates (1.5-percent, 2-percent, and 2.5-percent) similar to the near-term Ramsey discount rates to calculate the present and annualized value of SC–GHGs for internal consistency. Annual benefits shown are undiscounted values.

TABLE 222—CLIMATE BENEFITS FROM REDUCTION IN CH_4 EMISSIONS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars]

Calendar year	Near-term Ramsey discount rate		
	2.5%	2%	1.5%
2027	−$0.000021	−$0.000026	−$0.000035
2028	−0.000048	−0.00006	−0.00008
2029	0.000023	0.000028	0.000038
2030	0.00012	0.00015	0.0002
2031	0.00023	0.00028	0.00037
2032	0.00053	0.00065	0.00085
2035	0.0035	0.0043	0.0055
2040	0.012	0.015	0.019
2045	0.022	0.027	0.034
2050	0.03	0.036	0.045
2055	0.035	0.041	0.051
PV	0.26	0.35	0.48
AV	0.013	0.016	0.021

Notes: See prior table.

TABLE 223—CLIMATE BENEFITS FROM REDUCTION IN N_2O EMISSIONS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars]

Calendar year	Near-term Ramsey discount rate		
	2.5%	2%	1.5%
2027	$0.0003	$0.00045	$0.0007
2028	0.002	0.003	0.0047
2029	0.0081	0.012	0.019
2030	0.019	0.029	0.045
2031	0.033	0.049	0.075
2032	0.051	0.075	0.12
2035	0.14	0.2	0.31
2040	0.29	0.42	0.63
2045	0.42	0.6	0.9
2050	0.51	0.73	1.1
2055	0.57	0.8	1.2
PV	5.2	8.2	13

TABLE 223—CLIMATE BENEFITS FROM REDUCTION IN N_2O EMISSIONS ASSOCIATED WITH THE FINAL RULE—Continued

[Billions of 2022 dollars]

Calendar year	Near-term Ramsey discount rate		
	2.5%	2%	1.5%
AV	0.26	0.38	0.58

Notes: See prior table.

TABLE 224—CLIMATE BENEFITS FROM REDUCTION IN GHG EMISSIONS ASSOCIATED WITH THE FINAL RULE

[Billions of 2022 dollars]

Calendar year	Near-term Ramsey discount rate		
	2.5%	2%	1.5%
2027	$0.063	$0.1	$0.17
2028	0.54	0.87	1.5
2029	1.9	3	5
2030	3.9	6.2	10
2031	6.6	10	17
2032	9.8	15	26
2035	26	40	66
2040	53	82	130
2045	76	120	180
2050	92	140	220
2055	100	150	230
PV	950	1,600	2,800
AV	46	72	120

Notes: See prior table.

F. Criteria Pollutant Health and Environmental Benefits

The light-duty passenger cars and light trucks and medium-duty vehicles subject to the standards are significant sources of mobile source air pollution, including directly-emitted $PM_{2.5}$ as well as NO_X and VOC emissions (both precursors to ozone formation and secondarily-formed $PM_{2.5}$). The final program will reduce exhaust emissions of these pollutants from the regulated vehicles, which will in turn reduce ambient concentrations of ozone and $PM_{2.5}$. Emissions from upstream sources will likely increase in some cases (*e.g.,* power plants) and decrease in others (*e.g.,* refineries). We project that in total, the final standards will result in substantial net reductions of emissions of pollutants like $PM_{2.5}$, NO_X and VOCs. Criteria and toxic pollutant emissions changes attributable to the final standards are presented in section VII of this preamble. Exposures to ambient pollutants such as $PM_{2.5}$ and ozone are linked to adverse environmental and human health impacts, such as premature deaths and non-fatal illnesses (as explained in section II.C of this preamble). Reducing human exposure to these pollutants results in significant and measurable health benefits. Changes in ambient concentrations of ozone, $PM_{2.5}$, and air toxics that will result from the standards are expected to improve human health by reducing premature deaths and other serious human health effects, and they are also expected to result in other important improvements in public health and welfare (see section II of this preamble). Children, especially, benefit from reduced exposures to criteria and toxic pollutants because they tend to be more sensitive to the effects of these respiratory pollutants. Ozone and particulate matter have been associated with increased incidence of asthma and other respiratory effects in children, and particulate matter has been associated with a decrease in lung maturation.

This section discusses the economic benefits from reductions in adverse health and environmental impacts resulting from criteria pollutant emission reductions that can be expected to occur as a result of the final emission standards. When feasible, EPA conducts full-scale photochemical air quality modeling to demonstrate how its national mobile source regulatory actions affect ambient concentrations of regional pollutants throughout the United States. The estimation of the human health impacts of a regulatory action requires national-scale photochemical air quality modeling to conduct a full-scale assessment of $PM_{2.5}$ and ozone-related health benefits.

EPA conducted an air quality modeling analysis of a regulatory scenario in 2055 involving light- and medium-duty vehicle emission reductions and corresponding changes in ''upstream'' emission sources like EGU (electric generating unit) emissions and refinery emissions. The results of this analysis are summarized in section VII of this preamble and discussed in more detail in RIA Chapter 7. Year 2055 was selected as a year that best represents the fleet turning over to nearly full implementation of the final standards. Decisions about the emissions and other elements used in the air quality modeling were made early in the analytical process for the final rulemaking. Accordingly, the air quality analysis does not fully represent the final regulatory scenario; however, we consider the modeling results to be a fair reflection of the impact the standards will have on $PM_{2.5}$ and ozone air quality, as well as associated health impacts, in the snapshot year of 2055. Because the air quality analysis only represents projected conditions with and without the standards in 2055, we used the OMEGA-based emissions analysis (see section VII.A of this preamble) and benefit-per-ton (BPT) values to estimate the criteria pollutant ($PM_{2.5}$) health benefits of the standards for the benefit-cost analysis of the final emission standards.

The BPT approach estimates the monetized economic value of $PM_{2.5}$-related emission reductions or increases (such as direct PM, NO_X, and SO_2) due to implementation of the program. Similar to the SC–GHG approach for monetizing reductions in GHGs, the BPT approach monetizes the health benefits of avoiding one ton of $PM_{2.5}$-related emissions from a particular onroad mobile or upstream source. The value of health benefits from reductions (or increases) in $PM_{2.5}$ emissions associated with this rule were estimated by multiplying $PM_{2.5}$-related BPT values by the corresponding annual reduction (or increase) in tons of directly-emitted $PM_{2.5}$ and $PM_{2.5}$ precursor emissions (NO_X and SO_2). As explained in Chapter 6.4 in the RIA, the $PM_{2.5}$ BPT values represent the monetized value of human health benefits, including reductions in both premature mortality and morbidity.

For the analysis of the final standards, we use the same mobile sector BPT estimates that were used in the proposal, except the constant dollar year they represent has been updated from year 2020 dollars to year 2022 dollars. The mobile sector BPTs were first published in 2019 and then updated to be consistent with the suite of premature mortality and morbidity studies used by EPA for the 2023 PM NAAQS Reconsideration Proposal.[1385 1386] The upstream BPT estimates used in this final rule are also the same as those used in the proposal, and were also updated to year 2022 dollars.[1387] The health benefits Technical Support Document (Benefits TSD) that accompanied the 2023 PM NAAQS Proposal details the approach used to estimate the $PM_{2.5}$-related benefits reflected in these BPTs.[1388] For more detailed information about the benefits analysis conducted for this rule, including the BPT unit values used in this analysis, please refer to Chapter 6.4 of the RIA.

A chief limitation to using $PM_{2.5}$-related BPT values is that they do not reflect benefits associated with reducing ambient concentrations of ozone. The $PM_{2.5}$-related BPT values also do not capture the benefits associated with reductions in direct exposure to NO_2 and mobile source air toxics, nor do they account for improved ecosystem effects or visibility. The estimated benefits of this rule would be larger if we were able to monetize these unquantified benefits at this time.

Table 225 presents the annual, undiscounted $PM_{2.5}$-related health benefits estimated for the stream of years beginning with the first year of rule implementation, 2027, through 2055 for the final standards. Benefits are presented by source (onroad and upstream) and are estimated using either a 3 percent or 7 percent discount rate to account for annual avoided health outcomes that are expected to accrue over more than a single year (the ''cessation'' lag between the change in PM exposures and the total realization of changes in health effects). Because premature mortality typically constitutes the vast majority of monetized benefits in a $PM_{2.5}$ benefits assessment, we present benefits based on risk estimates reported from two different long-term exposure studies using different cohorts to account for uncertainty in the benefits associated with avoiding PM-related premature deaths.[1389 1390] Table 225 also presents the present and annualized value of $PM_{2.5}$-related health benefits using a 3-percent and 7-percent discount rate. The total annualized value of $PM_{2.5}$-related benefits for the final program between 2027 and 2055 (discounted back to 2027) is $5.3 to $10 billion assuming a 3-percent discount rate and $3.6 to $7.2 billion assuming a 7-percent discount rate. Results for the alternative scenarios estimated in support of the final standards can be found in Chapter 9.6 of the RIA.

TABLE 225—MONETIZED $PM_{2.5}$ HEALTH BENEFITS OF ONROAD AND UPSTREAM EMISSIONS REDUCTIONS ASSOCIATED WITH THE FINAL RULE, LIGHT-DUTY AND MEDIUM-DUTY

[Billions of 2022 dollars]

Calendar year	Onroad		Upstream		Total	
	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
2027	0.078 to 0.17	0.07 to 0.15	−0.0087 to −0.019	−0.0078 to −0.017	0.069 to 0.15	0.062 to 0.13
2028	0.21 to 0.45	0.19 to 0.41	−0.034 to −0.072	−0.03 to −0.064	0.18 to 0.38	0.16 to 0.34
2029	0.38 to 0.81	0.34 to 0.73	−0.064 to −0.14	−0.057 to −0.12	0.31 to 0.67	0.28 to 0.61
2030	0.74 to 1.5	0.66 to 1.4	−0.12 to −0.25	−0.11 to −0.23	0.61 to 1.3	0.55 to 1.1
2031	1 to 2.1	0.93 to 1.9	−0.2 to −0.42	−0.18 to −0.38	0.84 to 1.7	0.75 to 1.6
2032	1.3 to 2.8	1.2 to 2.5	−0.26 to −0.53	−0.23 to −0.47	1.1 to 2.2	0.98 to 2
2035	2.9 to 5.9	2.6 to 5.3	−0.28 to −0.55	−0.25 to −0.5	2.6 to 5.3	2.4 to 4.8
2040	6 to 12	5.4 to 11	0.21 to 0.43	0.19 to 0.38	6.2 to 12	5.5 to 11
2045	8.7 to 17	7.8 to 15	0.7 to 1.4	0.63 to 1.3	9.4 to 18	8.5 to 17
2050	11 to 21	9.7 to 19	0.99 to 2	0.9 to 1.8	12 to 23	11 to 21
2055	12 to 23	11 to 21	1 to 2	0.91 to 1.8	13 to 25	12 to 23
PV	97 to 190	43 to 86	4.6 to 9.3	1.3 to 2.6	100 to 200	45 to 88

[1385] Wolfe, P.; Davidson, K.; Fulcher, C.; Fann, N.; Zawacki, M.; Baker, K. R. 2019. Monetized Health Benefits Attributable to Mobile Source Emission Reductions across the United States in 2025. Sci. Total Environ. 650, 2490–2498. Available at: *https://doi.org/10.1016/J.SCITOTENV.2018.09.273.*

[1386] U.S. Environmental Protection Agency (U.S. EPA). 2022. PM NAAQS Reconsideration Proposal RIA. EPA–HQ–OAR–2019–0587.

[1387] U.S. Environmental Protection Agency (U.S. EPA). 2023. Technical Support Document: Estimating the Benefit per Ton of Reducing Directly-Emitted $PM_{2.5}$, $PM_{2.5}$ Precursors and Ozone Precursors from 21 Sectors.

[1388] U.S. Environmental Protection Agency (U.S. EPA). 2023. Estimating $PM_{2.5}$- and Ozone-Attributable Health Benefits. Technical Support Document (TSD) for the PM NAAQS Reconsideration Proposal RIA. EPA–HQ–OAR–2019–0587.

[1389] Wu, X, Braun, D, Schwartz, J, Kioumourtzoglou, M and Dominici, F (2020). Evaluating the impact of long-term exposure to fine particulate matter on mortality among the elderly. Science advances 6(29): eaba5692.

[1390] Pope III, CA, Lefler, JS, Ezzati, M, Higbee, JD, Marshall, JD, Kim, S-Y, Bechle, M, Gilliat, KS, Vernon, SE and Robinson, AL (2019). Mortality risk and fine particulate air pollution in a large, representative cohort of U.S. adults. Environmental health perspectives 127(7): 077007.

TABLE 225—MONETIZED $PM_{2.5}$ HEALTH BENEFITS OF ONROAD AND UPSTREAM EMISSIONS REDUCTIONS ASSOCIATED WITH THE FINAL RULE, LIGHT-DUTY AND MEDIUM-DUTY—Continued

[Billions of 2022 dollars]

Calendar year	Onroad		Upstream		Total	
	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate	3% Discount rate	7% Discount rate
AV	5.1 to 10	3.5 to 7	0.24 to 0.49	0.11 to 0.22	5.3 to 10	3.6 to 7.2

Notes: The benefits in this table reflect two separate but equally plausible premature mortality estimates derived from the Medicare study (Wu et al., 2020) and the NHIS study (Pope et al., 2019), respectively. All benefits estimates are rounded to two significant figures. Annual benefit values presented here are not discounted. Negative values are health disbenefits related to increases in estimated emissions. The present value of benefits is the total aggregated value of the series of discounted annual benefits that occur between 2027–2055 (in 2022 dollars) using either a 3 percent or 7 percent discount rate. The upstream impacts associated with the standards presented here include health benefits associated with reduced criteria pollutant emissions from refineries and health disbenefits associated with increased criteria pollutant emissions from EGUs. The benefits in this table also do not include the full complement of health and environmental benefits (such as health benefits related to reduced ozone exposure) that, if quantified and monetized, would increase the total monetized benefits.

We use a constant 3-percent and 7-pecent discount rate to calculate present and annualized values in Table 225, consistent with current applicable OMB Circular A–4 guidance. For the purposes of presenting total net benefits (see section VIII.A of this preamble), we also use a constant 2-percent discount rate to calculate present and annualized values. We note that we do not currently have BPT estimates that use a 2-percent discount rate to account for the value of those avoided health outcomes that are expected to accrue over more than a single year. If we discount the stream of annual benefits in Table 225 based on the 3-percent cessation lag BPT using a constant 2-percent discount rate, the present value of total $PM_{2.5}$-related benefits would be $120 to $240 billion and the annualized value of total $PM_{2.5}$-related benefits would be $6.4 to $13 billion, depending on the assumed long-term exposure study of $PM_{2.5}$-related premature mortality risk.

We believe the $PM_{2.5}$-related benefits presented here are our best estimate of benefits associated with the final standards from 2027 through 2055 absent air quality modeling and we have confidence in the BPT approach and the appropriateness of relying on BPT health estimates for this rulemaking. Please refer to RIA Chapter 6 for more information on the uncertainty associated with the benefits presented here.

G. Transfers

There are four types of transfers included in our analysis. Two of these transfers come in the form of tax credits arising from the Inflation Reduction Act to encourage investment in battery technology and the purchase of electrified vehicles. These are transfers from the government to producers of vehicles (the 45X battery production tax credits), or to purchasers of vehicles (the 30D tax credit) or to lessors or commercial purchasers (the 45W tax credit). There are also transfers from the government to individuals and businesses who install EVSE (the 30C tax credit) [1391] though we don't quantify these transfers as part of our analysis. The third, new for the final rule, is state taxes on the purchase of new, higher cost vehicles which represents transfers from purchasers to government. The fourth is fuel and electricity taxes which are transfers from purchasers of fuel and electricity to the government. The final rule results in less liquid-fuel consumed and, therefore, less money transferred from purchasers of liquid-fuel to the government while the reverse is true for electricity consumption where the increase associated with PEVs results in more money transferred from purchasers to the government. For more detail on the IRC section 45X, 30D and 45W tax credits please see section IV of this preamble and Chapter 2.6.8 of the RIA.

TABLE 226—TRANSFERS ASSOCIATED WITH THE FINAL RULE, FROM THE VEHICLE PURCHASER PERSPECTIVE

[Billions of 2022 dollars] [a]

Calendar year	Battery tax credits	Vehicle purchase tax credit	State sales taxes	Fuel taxes	Sum
2027	$0.25	$0.4	−$0.12	$0.036	$0.56
2028	1.4	2	−0.27	0.23	3.4
2029	4.1	5.4	−0.61	0.69	9.5
2030	5.1	9.2	−0.9	1.4	15
2031	5.4	15	−1.2	2.2	22
2032	3.6	20	−1.3	3.2	25
2035	0	0	−2.7	7.3	4.5
2040	0	0	−2.5	13	10
2045	0	0	−2.3	16	13
2050	0	0	−2.1	18	16
2055	0	0	−1.9	18	16
PV2	18	47	−43	230	250
PV3	17	45	−37	190	220
PV7	15	38	−22	98	130
AV2	0.83	2.2	−2	10	11
AV3	0.91	2.4	−1.9	9.9	11

[1391] The IRA extends the Internal Revenue Code 30C Alternative Fuel Refueling Property Tax Credit through Dec 31, 2032, with modifications. See section IV.C.4 of the preamble and RIA Chapter 5 for more details.

TABLE 226—TRANSFERS ASSOCIATED WITH THE FINAL RULE, FROM THE VEHICLE PURCHASER PERSPECTIVE—Continued

[Billions of 2022 dollars] [a]

Calendar year	Battery tax credits	Vehicle purchase tax credit	State sales taxes	Fuel taxes	Sum
AV7	1.2	3.1	−1.8	7.9	10

[a] Negative values reflect transfers from taxpayers to governments; positive values reflect transfers from government to taxpayers.

H. U.S. Vehicle Sales Impacts

1. Light-Duty Vehicle Sales Impacts

As discussed in section IV.A of this preamble, EPA used the OMEGA model to analyze projected impacts of this rule, including impacts on vehicle sales. The OMEGA model accounts for interactions in producer and consumer decisions in total sales and in the share of ICE and PEV vehicles in the market. As in the proposal, the sales impacts are based on a set of assumptions and inputs, including assumptions about the role of fuel consumption in vehicle purchase decisions, and assumptions on consumers' demand elasticity.[1392] Our analysis indicates that this rule will have very small impacts on light-duty vehicle sales, with minor decreases from the No Action case estimated between 2027 and 2032. However, as explained in section VIII.D.1 of this preamble above, even though there are minor decreases in sales from the No Action case, consumers will benefit from increased access to mobility due to increased vehicle efficiency.

As in the proposal, for this final rule EPA separately represents the producer's perception of the purchase decision and the consumer's purchase decision. Focusing on producers, EPA assumes that automakers believe that LD vehicle buyers account for about 2.5 years of fuel consumption in their purchase decision.[1393] This is based on the 2021 National Academy of Sciences (NAS) report,[1394] citing the 2015 NAS report, which observed that automakers ''perceive that typical consumers would pay upfront for only one to four years of fuel savings'' (pp. 9–10). However, as discussed in the proposal and in the 2021 rule,[1395] there is not a consensus around the role of fuel consumption in vehicle purchase decisions. Based on how consumers actually behave, Greene et al. (2018) estimate the mean willingness to pay for a one cent per mile reduction in fuel costs over the lifetime of the vehicle to be $1,880 with very large standard deviation, and a median of $990. For the purpose of comparison, saving one cent per mile on fuel, assuming 15,000 vehicle miles traveled per year, yields roughly $375 of savings over 2.5 years (or $150 to $600 over 1 to 4 years). Thus, automakers seem to operate under a perception of consumer willingness to pay for additional fuel economy that is substantially less than the mean and median values estimated by Greene et al. (2018), indicating that automakers do not appear to fully account for how consumers actually behave. We did not receive any public comments on the use of 2.5 years of fuel savings in our analysis.

In OMEGA, we use an estimate of demand elasticity to model the change in vehicle demand due to this rule. The demand elasticity is the percent change in quantity of vehicles demanded associated with a one percent change in vehicle price. This is explained further in Chapter 4.4.1 of the RIA. We received comment on the use of a demand elasticity of −0.4 in the proposal, with one commenter stating that it was too small. The commenter urged us to use an elasticity of at least −1.0, similar to what was used for previous rules and what NHTSA has used for previous rules. Continuing the approach in the proposal, however, EPA is using a demand elasticity for new LD vehicles of −0.4. The choice of elasticity is based on a 2021 EPA peer reviewed report, which included a literature review on and estimates of the effects of new vehicle price changes on the new vehicle market,[1396] and the commenter did not provide data that would support a shift away from the conclusions of the report. As noted in EPA's report, −0.4 appears to be the largest estimate (in absolute value) for a long-run new vehicle demand elasticity in recent studies. EPA's report examining the relationship between new and used vehicle markets shows that, for plausible values reflecting that interaction, the new vehicle demand elasticity varies from −0.15 to −0.4. We chose the larger value of this range for our analysis because it will lead to more conservative estimates (a larger change in demand for the same change in vehicle price) that are still within the range estimated within the report.

Under the final standards, there is a small change projected in total new LD vehicle sales compared to sales under the No Action scenario for each year under from MY 2027 through MY 2032.[1397] See Table 227 for total new vehicle sales impacts under the final rule. These impacts range from a decrease of about 0.18 percent in MY 2027, to a decrease of about 0.92 percent in MY 2032. These impacts are generally smaller than those estimated for the 2021 rulemaking,[1398] where sales impacts were estimated to range from a decrease of about 1 percent in 2027 to a decrease of 0.9 percent in 2032.

[1392] The demand elasticity is the percent change in quantity associated with percent increase in price. For price, we use net price, where net price is the difference in technology costs less an estimate of the change in fuel costs over the number of years we assume fuel costs are taken into account. PEV purchase incentives from the IRA are also accounted for in the net consumer prices used in OMEGA. See RIA Chapter 2.6.8 for more information.

[1393] For a discussion of the purchase decision from the perspective of the consumer, see RIA Chapter 4.1.

[1394] National Academies of Sciences, Engineering, and Medicine. 2021. Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy—2025–2035. Washington, DC: The National Academies Press. *https://doi.org/10.17226/26092.*

[1395] 86 FR 74434, December 30, 2021, ''Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards.''

[1396] U.S. EPA. 2021. The Effects of New-Vehicle Price Changes on New- and Used-Vehicle Markets and Scrappage. EPA–420–R–21–019. *https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=352754&Lab=OTAQ.*

[1397] The No Action scenario consists of the 2021 rule standards and IRA provisions as explained in section IV.B of this preamble.

[1398] 86 FR 74434, December 30, 2021, ''Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards.''

TABLE 227—TOTAL NEW LD SALES IMPACTS IN THE FINAL RULE

Year	No action	Final rule	
	Total sales	Total sales	Change from no action (%)
2027	16,046,000	16,017,000	−29,000 (−0.18)
2028	15,848,000	15,790,000	−58,000 (−0.37)
2029	15,923,000	15,840,000	−83,000 (−0.52)
2030	15,792,000	15,670,000	−122,000 (−0.78)
2031	15,669,000	15,534,000	−135,000 (−0.86)
2032	15,585,000	15,442,000	−143,000 (−0.92)

Similar to the sales impacts of the final rule, total new vehicle sales impacts under the alternative scenarios analyzed show a very small change in sales compared to the No Action scenario. For more information on the estimates of sales impacts under the more and less stringent alternatives analyzed for this final rule, see Chapter 4.4 of the RIA.

2. Medium-Duty Sales Impacts

In contrast to the light-duty market, the medium-duty vehicle market largely serves commercial applications. Thus, the assumptions in our analysis of the MD sales response are specific to that market, and do not arise from studies focused on the LD vehicle market.[1399] Commercial vehicle owners purchase vehicles based on the needs of their business, and we expect them to be less sensitive to changes in vehicle price than personal vehicle owners.[1400] These MD vehicle purchasers will not do without the MDV that meets their needs. In addition, as pointed out by commenters in section 14.2 of the RTC, there are factors that MD vehicle commercial purchasers consider more strongly in their purchase decision than consumers purchasing a light-duty vehicle, including maintenance costs, fuel efficiency, and warranty considerations. The elasticity of demand affects the sensitivity of vehicle buyers to a change in the price of vehicles: The smaller the elasticity, in absolute value, the smaller the estimated change in sales due to a change in vehicle price. Therefore, as explained in Chapter 4.4 of the RIA, the estimates of a change in sales due to this rule depend on the elasticity of demand assumptions. For this final rule, we are assuming an elasticity of 0 for the MD vehicle sales impacts estimates, and we are not projecting any differences in the number of MD vehicles sold between the No Action and the final standards. This implicitly assumes that the buyers of MD vehicles are not going to change purchase decisions if the price of the vehicle changes, all else equal. In other words, as long as the characteristics of the vehicle do not change, commercial buyers will still purchase the vehicle that fits their needs. See RIA Chapter 4.4.1 and RTC section 14.2 for more on the elasticity of demand for MD vehicle sales impacts.

A possible, though unlikely, sales effect on commercial medium-duty vehicles is pre-buy and low-buy. Pre-buy occurs when a purchaser makes a planned purchase sooner than originally intended in anticipation of EPA regulation that may make a future vehicle, under new regulations, have a higher upfront or operational cost, or have reduced reliability. Low-buy occurs when a vehicle that would have been purchased after the implementation of a regulation is either not purchased at all, or the purchase is delayed. Low-buy may occur directly as a function of pre-buy (where a vehicle was instead purchased prior to implementation of the new regulation), or due to a vehicle purchaser delaying the purchase of a vehicle due to cost or uncertainty. Pre- and low-buy are short-term effects, with research indicating that effects are seen for one year or less before and after a regulation is implemented.[1401] Current research on this phenomenon is focused on larger heavy-duty vehicles, mainly Class 8 ICE vehicles (traditional semi-trucks, for example). An EPA report on HD sales effects[1402] found no evidence of pre- or low-buy impacts of previous HD rules for Class 6 vehicles.[1403] This may be due to many reasons, including the generally lower price of smaller class vehicles and less data available to analyze. MD vehicles subject to this rule are predominantly commercial vehicles, with private purchasers representing a smaller portion of the market. In our analysis of the central case, we project an increase in electrification for both MD and LD vehicles, which is associated with operational costs savings (including fuel, maintenance and repair), as discussed in sections VII.B.3 and VII.C.1 of this preamble. In addition, it should be noted that many studies estimating how large or expensive purchases are made, purchase decisions are heavily influenced by macroeconomic factors unrelated to regulations, for example, interest rates, economic activity, and the general state of the economy.[1404] Based on this combined information, we expect any possible pre- or low-buy that may occur in the medium-duty segment as a result of this rule would be small and short lived.

In the NPRM, we asked for comment on our assumptions for MD vehicle sales impacts. One commenter stated that the assumption of an elasticity of 0 for MD vehicle sales impacts was not appropriate, suggesting that we use an elasticity of at least −1.0. The commenter did not provide research or data to support a change in our assumption for this rule, especially not to increase the price sensitivity of medium-duty vehicle buyers to be greater than that of light-duty vehicle purchasers. Though there may be impacts in the short term that are not captured by our demand assumptions, in the long term, we assume that commercial vehicle buyers will purchase the vehicle that fits their

[1399] Similarly, the literature referenced for light-duty sales impacts pertains to light-duty vehicles, primarily purchased and used as personal vehicles by individuals and households.

[1400] See RIA Chapter 4.1.1 for more information.

[1401] See the EPA report ''Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation'' at *https://cfpub.epa.gov/si/si_public_pra_view.cfm?dirEntryID=349838&Lab=OTAQ* for a literature review and EPA analysis of pre-buy and low-buy due to HD regulations.

[1402] ''Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation'' at *https://cfpub.epa.gov/si/si_public_pra_view.cfm?dirEntryID=349838&Lab=OTAQ.*

[1403] Results for Class 7 vehicles was mixed, with some results showing no evidence of pre- or low-buy, and other results indicating increased purchases after promulgation, and decreased purchases beforehand.

[1404] See the literature review found in the ERG, ''Analysis of Heavy-Duty Vehicle Sales Impacts Due to New Regulation.'' Found at *https://cfpub.epa.gov/si/si_public_pra_view.cfm?dirEntryID=349838&Lab=OTAQ* for more information.

needs, regardless of this rule, and the elasticity measures we use for our analyses are long-term elasticities.

I. Employment Impacts

In this section, we assess the employment impacts associated with this rule. As we explain in sections I and IV of this preamble, manufacturers are already rapidly shifting production away from ICE vehicles and toward PEVs, a trend that is occuring independent of this rulemaking and strongly supported by the Inflation Reduction Act. This shift is associated with decreased employment in some sectors (*e.g.,* ICE vehicle manufacturing) and increased employment in other sectors (*e.g.,* PEV and battery manufacturing). We expect manufacturers to increase their deployment of PEVs in response to this rule, which will accentuate any employment shifts that may occur due to changes in the share of PEVs produced. While it is not possible to comprehensively quantify the nature of the employment shifts, our research and estimations presented in this section indicate that there are opportunities for increased employment due to an increase in the share of PEVs produced and sold.

First, given the rapid surge in PEVs expected over the next decade, there is a tremendous opportunity for increases in domestic manufacturing and employment associated with PEVs and their components, such as batteries. Congress strongly supported these increases in domestic manufacturing through the BIL, CHIPS Act, and IRA as described further in section VIII.I.1 of this preamble, below. Consistent with Congressional policy, this rulemaking further signals strong demand for PEVs domestically to meet GHG emissions reduction targets and contributes to a favorable regulatory environment for the United States to capture the increased manufacturing and employment associated with PEVs and their components. This positive impact is consistent with the history of EPA's Clean Air Act programs, where strong emission standards have historically contributed to the U.S. being a global leader in the supply of air pollution control equipment, with corresponding benefits for U.S. global competitiveness and domestic employment. In addition, there are extensive opportunities related to PEV charging infrastructure build-out and maintenance. These opportunities are enhanced by many projects and efforts put forth by Federal and State agencies and other public and private groups, as described throughout this section, as well as in Chapter 4.5 of the RIA and section 20 of the RTC.

Second, while EPA has not been able to comprehensively quantify the net changes in employment associated with this rule, we do estimate a partial quantitative analysis of employment impacts associated with this rule. The partial analysis finds that there is greater potential for overall job growth in the sectors included in the analysis for this rule than potential job losses, and that the potential for positive employment impacts increases over time.

1. Background on Employment Effects

If the U.S. economy is at full employment, even a large-scale environmental regulation is unlikely to have a noticeable impact on aggregate net employment. Instead, labor would primarily be reallocated from one productive use to another, and net national employment effects from environmental regulation would be small and transitory (*e.g.,* as workers move from one job to another). In sectors experiencing transitory effects, some workers may retrain or relocate in anticipation of new requirements or require time to search for new jobs, while shortages in some sectors or regions could bid up wages to attract workers. These adjustment costs can lead to local labor disruptions. As of 2020, although the three largest automakers in the U.S. provide employment opportunities in the automotive supply chain in 31 states,[1405] the majority of jobs in the U.S. automotive sector are concentrated in a handful of states including Michigan, Alabama, Indiana, Ohio, and Kentucky.[1406] Even if the net change in the national workforce is small, localized reductions in employment may adversely impact individuals and communities just as localized increases may have positive impacts. If the economy is operating at less than full employment, economic theory does not clearly indicate the direction or magnitude of the net impact of environmental regulation on employment; it could cause either a short-run net increase or short-run net decrease. Research on domestic employment in the EV transition funded by the Department of Energy (DOE) indicates that a wide range of jobs in the ICE vehicle sector have a relatively high similarity in needed skill sets to jobs in the EV sector, as well as in other sectors.[1407] The research also indicates that higher-wage jobs with more specialized skills may be better positioned to transition their skill sets from ICE sectors to EV sectors, although thy are more geographically concentrated and hence dependent on co-location of EV production capacity with automotive production for transition opportunities.

Economic theory of labor demand indicates that employers affected by environmental regulation may change their demand for different types of labor in different ways. They may increase their demand for some types, decrease demand for other types, or maintain demand for still other types. The uncertain direction of labor impacts is due to the different channels by which regulations affect labor demand. A variety of conditions can affect employment impacts of environmental regulation, including baseline labor market conditions, employer and worker characteristics, industry, and region. In general, the employment effects of environmental regulation are difficult to disentangle from other economic changes (especially the state of the macroeconomy) and business decisions that affect employment, both over time and across regions and industries. In light of these difficulties, we look to economic theory to provide a constructive framework for approaching these assessments and for better understanding the inherent complexities in such assessments.

In the proposal and previous rules (for example the 2021 rule), we estimated a partial employment effect on LD ICE vehicle manufacturing due to the increase in technology costs of the rule. In addition, the increasing penetration of electric vehicles in the market is likely to affect both the number and the nature of employment in the auto and parts sectors and related sectors, such as providers of charging infrastructure. Over time, as PEVs become a greater portion of the new vehicle fleet, the kinds of jobs in auto manufacturing are expected to change. For instance, there is no need for engine and exhaust system assembly for BEVs, while many assembly tasks for BEVs involve electrical rather than mechanical fitting. In addition, batteries represent a significant portion of the manufacturing content of an electrified vehicle, both BEVs and PHEVs, and some automakers are likely to purchase the cells, if not

[1405] *https://www.americanautomakers.org/sites/default/files/AAPC%20ECR%20Q3%202020.pdf.*

[1406] Based on information on automotive industry employment, earning and hours from the Bureau of Labor Statistics: *https://www.bls.gov/iag/tgs/iagauto.htm#emp_state.*

[1407] Workforce Analytic Approaches to Find Degrees of Freedom in the EV Transition; *https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4699308.*

pre-assembled modules or packs, from suppliers. According to the U.S. Energy and Employment Report (USEER), jobs related to the energy sector increased from 2020 to 2021, and at a faster rate than the workforce overall.[1408] These energy-sector-related jobs include electric power generation; transmission, distribution and storage; fuels; energy efficiency; and motor vehicles and component parts. The report states that employment in motor vehicles and component parts increased about 2.5 percent from 2020 to 2021, and jobs in clean energy vehicles increased by almost 21 percent, with BEVs increasing by 27 percent and PHEVs increasing by 10 percent. Employment in producing, building and maintaining charging infrastructure needed to support the ever-increasing number of PEVs on the road is also expected to affect the nature of employment in automotive and related sectors. For many of these effects, there is considerable uncertainty in the data to quantitatively assess how employment might change as a function of the increased electrification expected to result under the final standards.

In comments on the proposed rule, California Air Resources Board (CARB) stated that the proposed standards present opportunities for growth in many sectors across the U.S., including auto manufacturing, electricity in general and ZEV supply chains. A report by the Economic Policy Institute suggests that U.S. employment in the auto sector could increase if the share of vehicles, or powertrains, sold in the United States that are produced in the United States increases.[1409] The BlueGreen Alliance (BGA) also states that though BEVs have fewer parts than their ICE counterparts, there is potential for job growth in electric vehicle component manufacturing, including batteries, electric motors, regenerative braking systems and semiconductors, and manufacturing those components in the United States can lead to an increase in jobs.[1410] BGA goes on to state that if the United States does not become a major producer for these components, there is risk of job loss. In addition, a recent report from the World Resources Institute indicates that if the right investments are made in manufacturing and infrastructure, autoworkers and communities will benefit from job growth, lower auto related costs, and reduced air pollution.[1411] The report focused on effects that would be felt in Michigan, which, as of 2023 has the most clean energy jobs in the Midwest, and the ranks 5th nationally.[1412] Michigan also ranks second, behind California, for the most hybrid and electric vehicle employment. Taking Michigan as an example, clean energy jobs grew by almost 4.6 percent in 2022, which was twice as fast as the overall economy. Electric vehicle-related jobs, specifically, grew by about 14 percent in the state in 2022. In addition to the 21 percent increase in employment in 2021 that USEER reported in clean energy vehicles, EDF also reports that the job growth and investment in the EV sector that has been seen nationally over the last eight years is expected to continue, with new factories or production lines for EVs, batteries, components and chargers supporting more than 125,000 jobs being announced across 26 states.[1413] EDF reports that more than 140,000 new jobs have been announced in the U.S. since 2015, with 60,000 jobs being created in U.S. battery manufacturing.[1414] They also point out that 66 percent of those job announcements were made in the time after BIL was passed, and 32 percent of those jobs were announced after the IRA was passed, and 86 percent of those jobs announcements were concentrated in ten states: Michigan, Tennessee, Georgia, Nevada, Kentucky, South Carolina, Ohio, North Carolina, Indiana and Kansas. DOE reports that more than 80,000 potential jobs in U.S. battery manufacturing and supply chain, and more than 50,000 potential jobs in U.S. EV component and assembly have been announced since 2020.[1415]

The UAW states that re-training programs will be needed to support auto workers in a market with an increasing share of electric vehicles in order to prepare workers that might be displaced by the shift to the new technology.[1416] In their comments on the proposed rule, UAW stated that job loss or creation in the auto industry depends on whether EV assembly and parts production is expanded in the U.S. or not. In 2020, Volkswagen stated that labor requirements for ICE vehicles are about 70 percent higher than their electric counterpart, but these changes in employment intensities in the manufacturing of the vehicles can be offset by shifting to the production of new components, for example batteries or battery cells.[1417] More recently, Volkswagen announced it will start construction of a new electric vehicle battery gigafactory supporting up to 3,000 direct jobs in Canada, as well as supporting a new EV manufacturing plant in South Carolina.[1418] Research from the Seattle Jobs Initiative indicates that employment in a collection of sectors related to both PEV and ICE vehicle manufacturing is expected to grow slightly through 2029.[1419] Climate Nexus also states that the increasing penetration of electric vehicles will lead to a net increase in jobs, a claim that is partially supported by the rising investment in batteries, vehicle manufacturing and charging stations.[1420]

This expected private investment is also supported by recent Federal investment which will encourage increased investment along the vehicle supply chain, including domestic critical minerals, materials processing, battery manufacturing, charging infrastructure, and vehicle assembly and vehicle component manufacturing. This investment includes the BIL, the CHIPS Act, and the IRA. The BIL was signed in November 2021 and provides over $24 billion in investment in electric vehicle chargers, critical minerals, and battery components needed by domestic manufacturers of EV batteries and for

[1408] *https://www.energy.gov/sites/default/files/2022-06/USEER%202022%20Fact%20Sheet_0.pdf.*

[1409] *https://www.epi.org/publication/ev-policy-workers.*

[1410] BGA stated this in a report found *at https://www.bluegreenalliance.org/wp-content/uploads/2021/04/Backgrounder-EVs-Are-Coming.-Will-They-Be-Made-in-the-USA-vFINAL.pdf* as well as in their public comments on the proposed rule found in Section 20 of the RTC.

[1411] *https://www.wri.org/insights/michigan-electric-vehicle-job-creation, https://www.wri.org/research/michigan-ev-future-assessment-employment-just-transition.*

[1412] *https://www.governing.com/work/michigan-leads-electric-vehicle-jobs-but-lags-in-sales#:~:text=More%20than%2032%2C000%20Michigan%20workers,involved%20%E2%80%9Cin%20this%20ecosystem.%E2%80%9D.*

[1413] EDF. (2023). New climate laws drive boom in electric vehicle jobs. Retrieved November 1, 2023 from *https://vitalsigns.edf.org/story/new-climate-laws-drive-boom-electric-vehicle-jobs.*

[1414] EDF. (2023). U.S. Electric Vehicle Manufacturing Investments and Jobs. *https://www.edf.org/sites/default/files/2023-03/State-Electric-Vehicle-Policy-Landscape.pdf.*

[1415] *https://www.energy.gov/invest.*

[1416] *https://uaw.org/wp-content/uploads/2019/07/190416-EV-White-Paper-REVISED-January-2020-Final.pdf.*

[1417] *https://www.volkswagenag.com/presence/stories/2020/12/frauenhofer-studie/6095_EMDI_VW_Summary_um.pdf.*

[1418] Volkswagen-backed PowerCo SE reaches significant milestone in St. Thomas gigafactory project: *https://www.volkswagen-group.com/en/press-releases/volkswagen-backed-powerco-se-reaches-significant-milestone-in-st-thomas-gigafactory-project-17962*; South Carolina Offers $1.3B to new Scout Electric SUV maker: *https://apnews.com/article/scout-electric-vehicle-plant-south-carolina-07c565669e13985738db503a86e323b0.*

[1419] *https://www.seattle.gov/Documents/Departments/OSE/ClimateDocs/TE/EV%20Field%20in%20OR%20and%20WA_February20.pdf.*

[1420] *https://climatenexus.org/climate-issues/energy/ev-job-impacts/.*

clean transit and school buses.[1421] The CHIPS and Science Act, signed in August, 2022, invests in expanding America's manufacturing capacity for the semiconductors used in electric vehicles and chargers.[1422] The IRA provides incentives for producers to expand domestic manufacturing of PEVs and domestic sourcing of components and critical minerals needed to produce them. The Act also provides incentives for consumers to purchase both new and used PEVs. These laws create domestic employment opportunities along the full automotive sector supply chain, from components and equipment manufacturing and processing to final assembly, as well as incentivize the development of reliable EV battery supply chains, as indicated by the evidence we present in section VIII.I.1 of the preamble.[1423]

In addition, the IRA is expected to lead to increased demand for PEVs through tax credits for purchasers of PEVs. The BlueGreen Alliance and the Political Economy Research Institute estimate that IRA will create over 9 million jobs over the next decade, with about 400,000 of those jobs being attributed directly to the battery and fuel cell vehicle provisions in the act.[1424] Additional studies find similar results: the IRA and BIL have the potential to lead to significant job increases in transportation, electricity and manufacturing, with some estimates almost 700,000 new jobs through 2030. EDF reports that more than 46,000 jobs in EV manufacturing have already been announced since the passage of the IRA.

It is important to note that investments from the IRA have, so far, been focused in more economically disadvantages counties. The U.S. Department of Treasury states that as of November 2023, 70 percent of post-IRA investments in clean energy have happened in counties with a smaller share of the population employed than the U.S. average; almost 80 percent have happened in counties with below-average medium household incomes; more than 80 percent of have happened in counties with below-average wages; and more than 85 percent have gone to counties with below-average college graduation rates.[1425]

It is also important to note that though the majority of this discussion focuses on possible direct impacts these Federal Acts may have on jobs along the vehicle supply chain (including domestic critical minerals, materials processing, battery manufacturing, charging infrastructure, and vehicle assembly and vehicle component manufacturing), there may also be indirect job creation and support, for example, in constructing the new manufacturing facilities.[1426]

In the proposal, we asked for comment on our employment analysis. Some commenters, including the UAW, BlueGreen Alliance and the United Steelworkers Union, provided comments on possible impacts on both job quality and geographic impacts of the rule making the point that not all jobs should be treated as equal. The commenters stated that the rule will lead to a reduction in job quality, citing current differences in job quality for those working in plants manufacturing ICE vehicles, and those working in plants manufacturing BEVs or vehicle batteries. Commenters stated that the BEV and battery plant workers receive lower pay, fewer benefits, and are not unionized in comparison to those working at ICE manufacturing plants. In addition, commenters state that even if the number of jobs at the national level does not change, there will be local community level impacts due to the location of those jobs changing. For example, employment at an ICE plant in one community might be reduced while employment at a BEV or battery plant in another community might increase. Though the number of jobs might not change, employment in the ''losing'' community will decrease, or workers from that community might have to relocate if they are able. The UAW, in comments on the proposed rule stated support for emission reductions, though they also indicate a slower phase in of ZEVs into the market than that projected in the proposal would better support employees in auto manufacturing and supporting industries.

Even with expected increases in employment in component production and new domestic jobs related to ZEVs, these shifts in production may negatively affect workers currently employed in production of ICE vehicles. We acknowledge the possibility of geographically localized effects, and that there may be job quality impacts associated with this rule, especially in the short term. We note that there are Federal programs to assist workers in the transition to low or zero emitting vehicles, including a DOE funding package which makes $2 billion in grants, and up to $10 billion in loans available to support projects converting existing automotive manufacturing facilities to support electric vehicle production.[1427] The funding package is expected to result in retention of high-quality, high-paying jobs in communities that currently host these manufacturing facilities, and along the full supply chain for the automotive sector, from components to assembly. The grants available give priority to refurbishing and retooling manufacturing facilities, especially for those likely to retain collective bargaining agreements and/or an existing higher-quality, high-wage hourly production workforce.[1428] The program aims to support a just transition for workers and communities in the transition to electrified transportation, and to strengthen domestic supply chains and support disadvantaged communities. DOE has also announced funding to support clean energy supply chains, with the funding going toward projects to support domestic clean energy manufacturing (including projects supporting battery production) in, or near, nine communities that were formerly tied to coal mining, and are expected to create almost 1,500 jobs.[1429]

[1421] The Bipartisan Infrastructure Law is officially titled the Infrastructure Investment and Jobs Act. More information can be found at *https://www.fhwa.dot.gov/bipartisan-infrastructure-law.*

[1422] The CHIPS and Science Act was signed by President Biden in August, 2022 to boost investment in, and manufacturing of, semiconductors in the U.S. The fact sheet can be found at *https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china.*

[1423] ''Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action.'' January 2023. *Whitehouse.gov. https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf.*

[1424] Political Economy Research Institute. (2022). *Job Creation Estimates Through Proposed Inflation Reduction Act.* University of Massachusetts Amherst. Retrieved from *https://www.bluegreenalliance.org/site/9-million-good-jobs-from-climate-action-the-inflation-reduction-act.*

[1425] The Inflation Reduction Act: A Place-Based Analysis: *https://home.treasury.gov/news/featured-stories/the-inflation-reduction-act-a-place-based-analysis.*

[1426] The U.S. Department of Treasury reports that manufacturing spending has increased significantly since the BIL, IRA and CHIPS Act were passed. Unpacking the Boom in U.S. Construction of Manufacturing Facilities: *https://home.treasury.gov/news/featured-stories/unpacking-the-boom-in-us-construction-of-manufacturing-facilities.*

[1427] *https://www.energy.gov/articles/biden-harris-administration-announces-155-billion-support-strong-and-just-transition.*

[1428] U.S. Department of Energy Office of Manufacturing and Energy Supply Chains Inflation Reduction Act Domestic Manufacturing Conversion Grants Funding Opportunity Announcement. DE–FOA–0003106_FOA Doc_Amendment 000006_IRA 50143. *https://infrastructure-exchange.energy.gov/Default.aspx#FoaIdf9eb1c8a-9922-46b6-993e-78972d823cb2.*

[1429] *https://www.energytech.com/energy-efficiency/article/21278185/doe-announces-275m-for-7-projects-to-strengthen-clean-energy-supply-*

Continued

We also note that during and after the comment period, several major U.S. automakers were negotiating new labor contracts, with an emphasis on workers in facilities that support the production of electrified vehicles.[1430] The negotiations resulted in many workers in EV production, including EV battery workers, becoming newly eligible to join the union, as well as in raising wages for those employed by unionized automakers, and those employed by non-unionized automakers.[1431] Research from the Economic Policy Institute indicates the U.S. auto sector and its employees would benefit from increasing electrification if there are policies to support domestic manufacturing, to automotive supply chain, and workers throughout the sector.[1432] As discussed in RTC section 20, there are many existing and planned projects focused on training new and existing employees in fields related to green jobs, and specifically green jobs associated with electric vehicle production, maintenance and repair, and the associated charging infrastructure. This includes work by the Joint Office of Energy and Transportation (JOET), created by the BIL, which supports efforts related to deploying infrastructure, chargers and zero emission vehicles. In addition, the IRA is expected to lead to increased demand in PEVs through tax credits for purchasers of PEVs. These ongoing actions supporting green jobs, including those by DOE, the Department of Labor (DOL), the Office of Energy Jobs, and others, are particularly focused on jobs with high standards and the right to collective bargaining. Additional programs are described in RIA Chapter 4.5, including programs and initiatives focused on community-level impacts. Jobs that may be lost due to reductions in ICE vehicle production may transition to fields related to EV production, but may also transition to other sectors. As mentioned above, a 2023 study funded by DOE indicates that there is a wide range of ICE automotive production jobs with similar skill sets to those required for jobs in EV automotive production and other industries, including the heat pump, solar panel manufacturing and transformer industry.[1433] Also, we point out that even though vehicle manufacturing and battery manufacturing may create more localized employment effects, infrastructure work is, and will continue to be, a nation-wide effort.

We do not have data to estimate current or future job quality. Nor are we able to determine the future location of vehicle manufacturing and supporting industries beyond the public announcements made as of the publication of this rule. We note that, compared to the proposal, we are finalizing standards that extend flexibilities and provide a slower increase in the stringency of the standards in the early years of the program. The more gradual shift allows for a more moderate pace in the industry's scale up to the battery supply chain and manufacturing, which in turn should help to reduce any potential impacts in employment across all sectors impacted by this rule. In addition, as illustrated by the range of sensitivity analyses which demonstrate alternative technology pathways manufacturers might choose to comply with the standards, as shown in sections IV.E and F of the preamble, there are multiple ways OEMs can choose to meet the standards, including through a wide range of BEV and PHEV technologies. These pathways continue to provide ICE technologies including base ICE, advanced ICE and HEVs in addition to PHEVs and BEVs.

2. Factor Shift, Demand, and Cost Effect on Employment

Consistent with the proposal, in RIA Chapter 4.5 we describe three ways employment at the firm level might be affected by changes in a firm's production costs due to environmental regulation: A factor-shift effect, in which post-regulation production technologies may have different labor intensities than their pre-regulation counterparts; a demand effect, caused by higher production costs increasing market prices and decreasing demand; and a cost effect, caused by additional environmental protection costs leading regulated firms to increase their use of inputs.[1434] [1435] Due to data limitations, EPA is not quantifying the impacts of the final regulation on firm-level employment for affected companies, although we acknowledge these potential impacts. Instead, we discuss factor-shift, demand, and cost employment effects for the regulated sector at the industry level.

Factor-shift effects are due to changes in labor intensity of production due to the standards. We do not have data on how the regulation might affect labor intensity of production within ICE vehicle production. There is ongoing research on the different labor intensity of production between BEV and ICE vehicle production, with inconsistent results. Some research indicates that the labor hours needed to produce a BEV are fewer than those needed to produce an ICE vehicle, while other research indicates there are no real differences. EPA worked with a research group to produce a peer-reviewed tear-down study of a BEV (Volkswagen ID.4) to its comparable ICE vehicle counterpart (Volkswagen Tiguan).[1436] Peer reviewed study results were delivered in May 2023. Included in this study are estimates of labor intensity needed to produce each vehicle under three different assumptions of vertical integration of manufacturing scenarios ranging from a scenario where most of the assemblies and components are sourced from outside suppliers to a scenario where most of the assemblies and components are assembled in house. Under the low and moderate levels of vertical integration, results indicate that assembly time of the BEV at the plant is reduced compared to assembly time of the ICE vehicle. Under a scenario of high vertical integration, which includes the BEV battery assembly, results show an increase in time needed to assemble the BEV. When powertrain systems are ignored (battery, drive units, transmission and engine assembly), the BEV requires more time to assemble under all three vertical integration scenarios. The results

chains-and-manufacturing-in-former-coal-communities.

[1430] UAW: Bargaining 2023 UAW–GM, *https://uaw.org/gm2023/*; UAW: UAW National Negotiators Reach Tentative Agreement with Ford on Record Contract, *https://uaw.org/uaw-national-negotiators-reach-tentative-agreement-with-ford-on-record-contract/#:~:text=Some%20of%20our%20lower-tier%20members%20at%20Sterling%20Axle,workers%20will%20receive%20an%20immediate%2011%25%20wage%20increase.*; UAW: UAW reaches a Tentative Agreement with Stellantis, *https://uaw-newsroom.prgloo.com/press-release/uaw-reaches-a-tentative-agreement-with-stellantis.*

[1431] Bloomberg: UAW Scores Victory in EV Worker Battle Even with Wage Compromise, *https://news.bloomberglaw.com/daily-labor-report/uaw-scores-victory-in-ev-worker-battle-even-with-wage-compromise*; The Washington Post: UAW members ratify record contracts with Big 3 automakers, *https://www.washingtonpost.com/business/2023/11/20/uaw-contract-ford-general-motors-stellantis.*

[1432] Economic Policy Institute: The stakes for workers in how policymakers manage the coming shift to all-electric vehicles, *https://www.epi.org/publication/ev-policy-workers.*

[1433] See footnote 106.

[1434] Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih (2002). ''Jobs Versus the Environment: An Industry-Level Perspective.'' Journal of Environmental Economics and Management 43: 412–436.

[1435] Berman and Bui have a similar framework in which they consider output and substitution effects that are similar to Morgenstern et al.'s three effect (Berman, E. and L. T. M. Bui (2001). ''Environmental Regulation and Labor Demand: Evidence from the South Coast Air Basin.'' Journal of Public Economics 79(2): 265–295).

[1436] See RIA Chapter 2.5.2.2.3 for more information.

indicate that the largest difference in assembly comes from the building of the battery pack assembly. When the battery cells are built in-house, the BEV will require more hours to build at the assembly plant. It also indicates that if the labor input to manufacture batteries is included in the estimated labor needs to build a BEV, regardless of the vertical integration decisions to build batteries in-house, BEVs will require more labor to build.

Data on the labor intensity of PHEV production compared to ICE vehicle production is also very sparse. PHEVs share features with both ICE vehicles, including engines and exhaust assemblies, and BEVs, including motors and batteries. If labor is a function of the number of components, PHEVs might have a higher labor intensity of production compared to both BEV and ICE vehicles, and if they are produced in the U.S. may provide labor demand. The labor needs of battery production are also a factor of the total labor needs to build a PHEV.

Given the current lack of data and inconsistency in the existing literature, we are unable to estimate a quantitative factor-shift effect of increasing relative PEV production as a function of this rule. However, we can say, generally, that research indicates that if production of PEVs and their power supplies are done in the U.S. at the same rates as ICE vehicles, we do not expect employment to fall, and it may likely increase. Electric vehicle manufacturing plants and battery plants are being built and announced in the U.S., as discussed in section IV of this preamble. In addition, states are making efforts to support increasing domestic production of electric vehicles and batteries, including support for the workforce. An Executive Order issued in South Carolina prioritized implementing a strategic initiative to explore opportunities related to ongoing economic development, business support and recruitment efforts with electric vehicle and automotive manufacturers.[1437] A study from Ohio estimates that there will be more than 25,000 new jobs in EV manufacturing and maintenance, battery development and charging station installation and operations in the state by 2030.[1438] California has a Workforce Development Board that has been focused on furthering the development of an equitable ZEV industry, including high quality jobs and access to them, since at least 2021.[1439] Illinois has invested in EV training programs, research and development in the EV industry, and in workforce development and community support in the clean energy sector.[1440] The Nevada Battery Coalition is tasked with identifying gaps in, and developing solutions for, workforce and economic development supporting the lithium industry in Nevada.[1441] Kentucky has been the location for at least two recent automotive sector development projects, and it is providing resources toward upgrading industrial sites throughout the state, with funding evaluated based on factors including workforce availability.[1442] Tennessee is co-locating a new Tennessee College of Applied Technology with a new EV manufacturing facility Ford is building in the state to provide specialized technical training.[1443] In Michigan, the Department of Labor and Economic Opportunity created the Electric Vehicle Jobs Academy to assist with tuition and other supportive services for those training to be in the advanced automotive mobility and electrification industry, and the University of Michigan contracted with the state to open the University of Michigan Electric Vehicle Center focusing on research and development and developing a highly skilled workforce.[1444] [1445]

Factor shift effects do not account for a change in the total number of vehicles sold. Demand effects on employment are due to changes in labor due to changes in demand. In general, if the regulation causes total sales of new vehicles to increase, more workers will be needed to assemble vehicles and manufacture their components. However, if BEVs, PHEVs and ICE vehicles have different labor intensities of production, the relative change in BEV, PHEV, and ICE vehicles sales will impact the demand effect on employment. As a simple example, assume that sales of BEV, PHEV and ICE vehicles increase. This would mean that the change in employment due to an increase demand will depend on the labor intensity of BEV, PHEV and ICE vehicle production and the increase in their respective sales. Now assume that PEV sales increased while ICE vehicle sales decreased. If total sales increase, that would indicate that PEVs replaced ICE vehicles, but there was new sales demand as well. For ease of illustration, ignore PHEVs for now, and assume that all PEV vehicles in this scenario are BEVs. The change in employment under this scenario would depend on the factor shift effect (the relative BEV and ICE vehicle labor intensity) for the replaced ICE vehicles, and the demand effect (labor intensity of BEVs) for the new sales demand. Under this same scenario (PEV sales are increasing while ICE sales are decreasing, with increased total sales) where PEVs are both replacing ICE vehicles, and there is new sales demand for PEVs, there is additional complexity when those PEVs are broken up unto BEVs and PHEVs. The factor shift effect for the replaced ICE vehicles would depend on whether PHEVs or BEVs are replacing them. In addition, there may be situations where BEVs are being replaced by PHEVs, or vice versa, and that effect would depend on the relative labor intensities of BEV and PHEV production. The demand effect for the new sales will depend on the labor intensity of the new BEVs and the new PHEVs, as well as the share of each that are being introduced into the market each model year.

For the same reason we cannot estimate a factor-shift effect, namely that we do not know the labor intensity of BEV or PHEV vs ICE vehicle production, we are not currently able to estimate a demand-shift effect on employment.

The cost effects on employment are due to changes in labor associated with increases in costs of production. BEVs, PHEVs and ICE vehicles require different inputs and have different costs of production, though there are interchangeable, common, parts as well. In previous LD and HD rules, we have estimated a partial employment effect due to the change in costs of production. We estimated the cost effect using the historic share of labor in the cost of production to extrapolate future estimates of impacts on labor due to new compliance activities in response to the regulations. Specifically, we multiplied the share of labor in

[1437] SCpowersEV: State support—Driving the Future, *https://scpowersev.com/state-support.*

[1438] Accelerating Ohio's Auto & Advanced Mobility Workforce, Auto and Advanced Mobility Workforce Strategy, 2023. *https://workforce.ohio.gov/wps/wcm/connect/gov/2e9f6e52-a4bc-4ef6-9080-e6b06f067a1a/Ohio%27s+Electric+Vehicle+Workforce+Strategy.pdf?MOD=AJPERES.*

[1439] California Workforce Development Board, 2021. *https://business.ca.gov/wp-content/uploads/2021/03/CWDB_ZEV-Plan.pdf.*

[1440] Illinois Drive Electric: Abundant Workforce, *https://ev.illinois.gov/grow-your-business/abundant-workforce.html.*

[1441] Nevada Battery Coalition: *https://nevadabatterycoalition.com/about.*

[1442] Kentucky: Leading the Charge, *https://ced.ky.gov/Newsroom/Article/20230816_Leading_th.*

[1443] Area Development: Tennessee: A growing Capital of Electric Vehicle Production, *https://www.areadevelopment.com/ContributedContent/Q4-2021/tennessee-growing-capital-of-electric-vehicle-production.shtm.*

[1444] MI Labor and Economic Opportunity: Electric Vehicle Jobs Academy, *https://www.michigan.gov/leo/bureaus-agencies/wd/industry-business/mobility/electric-vehicle-jobs-academy.*

[1445] Michigan Engineering News, $130M Electric Vehicle Center launches at U-Michigan, *https://news.engin.umich.edu/2023/04/130m-electric-vehicle-center-launches-at-u-michigan.*

production costs by the production cost increase estimated as an impact of the rule. This provided a sense of the magnitude of potential impacts on employment.

As described in Chapter 4.6 of the RIA, we used historical data on the number of employees per $1 million in expenditures from the Employment Requirements Matrix (ERM) provided by the U.S. Bureau of Labor Statistics (BLS) to examine labor needs of six manufacturing sectors related to ICE and BEV vehicle production to determine trends over time. Three of these sectors (Electrical equipment and manufacturing, Other electrical equipment and component manufacturing and Semiconductor and other electronic component manufacturing) are more closely related to battery electric production, while the other three (Motor vehicle manufacturing, Motor vehicle body and trailer manufacturing, and Motor vehicle parts manufacturing) are sectors that are more generally related to both battery electric and ICE vehicle production.

Over time, the amount of labor needed in the motor vehicle industry has changed: Automation and improved methods have led to significant productivity increases, which is reflected in the estimates from the BLS ERM. For example, in 1997 about 1.2 workers in the Motor vehicle manufacturing sector were needed per $1 million, but only 0.7 workers by 2022 (in 2022$).[1446] Though two sectors mainly associated with BEV manufacturing, Electrical equipment manufacturing, and Other electrical equipment and component manufacturing, show an increase in recent years.

3. Partial Employment Effect

We attempt to estimate partial employment effects of this rule by separating out costs mainly associated with electrified portions of vehicle production (for example, batteries) and the ICE vehicle portion of production (for example, engines), as well as the costs that are common between them (for example, gliders.[1447]) We apply the electrified portions of cost changes only to sectors primarily focused on electrified portions of vehicle production, the ICE vehicle portion of costs only to sectors primarily focused on the ICE vehicle portions of production, and the costs common to both the electrified portions and ICE portions of vehicle production to sectors that are common to the electrified and ICE portions of vehicle production.[1448] For more information on how we estimated this partial employment effect, see RIA Chapter 4.5.4.

In previous rules, we have estimated the cost effect, which is done while keeping sales constant. However, OMEGA estimates costs and changes in sales concurrently. Therefore, as we did in the proposal, the partial employment effect we estimate here is a combined cost and demand effect, and is meant to give a sense of possible partial employment effects, including directionality and relative magnitude. The estimate includes effects due to both LD and MD cost changes, as the costs used in the analysis were the combined estimated costs for the light- and medium-duty sectors, as well as the change in new vehicle sales in the LD market.[1449] It does not include economy-wide labor effects, possible factor intensity effects, or effects from possible changes to domestic production.

Table 228 shows our estimates of partial employment results for the final rule for each year for the three sector groups. See Chapter 4.5.4 of the RIA for more information on the employment analysis.

TABLE 228—ESTIMATED PARTIAL EMPLOYMENT EFFECTS FOR SECTORS FOCUSED ON THE ELECTRIFIED, ICE, AND COMMON PORTIONS OF VEHICLE PRODUCTION

Year	Common portions		Electrified portion		ICE portion	
	Smallest effect	Largest effect	Smallest effect	Largest effect	Smallest effect	Largest effect
2027	−370	−3,600	3,000	6,900	2,200	2,900
2028	−900	−8,600	15,700	36,600	−800	−1,100
2029	−1,300	−13,000	36,800	89,100	−7,600	−9,800
2030	−1,900	−19,800	54,800	140,200	−13,600	−17,500
2031	−2,100	−22,600	67,700	182,600	−18,800	−24,200
2032	−2,600	−27,700	75,100	213,900	−23,200	−29,900

These results show negative employment effects in the ICE focused sectors (except for 2027) and the sectors common to the ICE and electrified portions of production. There are positive employment effects in the sectors focused on the electrified portions of production.

Table 229 shows the range from the smallest estimated employment gain across the combination of sector groups to the largest estimated potential employment gain across the combination of sector groups. This is not a straight sum of the smallest and largest effects as seen in Table 228 above, which are based on absolute value (closest to and furthest from zero) and are not affected by the direction of the effect, but a sum of the minimum and maximum estimated effects, which include direction of the effect. The estimated range shows an expected increase in employment from 2027 through 2032. In addition, these estimates indicate that possible job growth over time in PEV related sectors will be greater than possible job loss in ICE or common sectors, and those gains are increasing over time.

[1446] *http://www.bls.gov/emp/ep_data_emp_requirements.htm*; this analysis used data for the sectors electrical equipment and manufacturing, other electrical equipment and component manufacturing, motor vehicle manufacturing, motor vehicle body and trailer manufacturing, and motor vehicle parts manufacturing from ‘‘Chain-weighted (2012 dollars) real domestic employment requirements tables;’’ see the excel file ‘‘Final Cost Effect Employment Impacts Calculation’’ in the docket.

[1447] In this context, a glider is a vehicle without a powertrain. It includes the body, chassis, interior and non-propulsion related electrical components.

[1448] A report from the Seattle Jobs Initiative examined how electrification in the automotive industry might advance workforce development in Oregon and Washington. As part of that study, the authors identified the sectors classified by the North American Industry Classification System (NAICS) codes most strongly associated with automotive production in general, those exclusive to ICE vehicles, and those primarily associated with electrified portions of vehicle production. The report can be found at: *https://www.seattle.gov/Documents/Departments/OSE/ClimateDocs/TE/EV%20Field%20in%20OR%20and%20WA_February20.pdf.*

[1449] We do not estimate a change in new medium-duty vehicle sales. See section VIII.C of this preamble, or RIA Chapter 4.4.2 for more information on the change in sales estimated due to this rule.

TABLE 229—ESTIMATED MAXIMUM COMBINED RANGE OF ESTIMATED PARTIAL EMPLOYMENT EFFECTS ACROSS ALL SECTORS

Year	Maximum combined range	
2027	1,600	9,400
2028	6,000	34,900
2029	14,000	80,200
2030	17,600	124,700
2031	20,800	161,700
2032	17,400	188,100

These results are consistent with the results of the FEV tear-down study, discussed in section VIII.I.2 of this preamble, and indicate that even if fewer labor hours are needed at the assembly plant, increased labor hours will be needed elsewhere in the supply chain for the electrified portions of production, for example in building and assembling battery packs.

4. Employment in Related Sectors

With respect to possible employment effects in other sectors, economy-wide impacts on employment are generally driven by broad macroeconomic effects. However, employment impacts, both positive and negative, in sectors upstream and downstream from the regulated sector, or in sectors producing substitute or complementary products, may also occur as a result of this rule. For example, changes in electricity generation may have consequences for labor demand in those upstream industries. Lower per-mile fuel costs could lead to labor effects in ride-sharing or ride-hailing services through an increase in demand for those services. Increased mobility related to the lower cost per mile of driving, as discussed in section VIII.D.1 of this preamble may also benefit drivers or owner/operators in other ways, including through MD fleets being able to service a greater range of customers, or consumers having access to a larger geographic area for employment opportunities. Reduced demand for gasoline may lead to impacts on demand for labor in the gas station sector, although the fact that many gas stations provide other goods, such as food and car washes, will moderate possible losses in this sector. There may also be an increase in demand for labor in sectors that manufacture, build and maintain charging stations. To that end, the BIL is investing in the build out of EV chargers along America's major roads, freeways and interstates, focusing on domestically produced iron and steel, and domestically manufactured chargers.[1450] The magnitude of all of these impacts depends on a variety of factors including the labor intensities of the related sectors, as well as the nature of the linkages (which can be reflected in measures of elasticity) between them and the regulated firms.

Electrification of the vehicle fleet is likely to affect both the number and the nature of employment in the auto and parts sectors and related sectors, such as providers of charging infrastructure and utilities supporting grid enhancements. ICCT estimated that charging infrastructure growth in the U.S. could create about 160,000 jobs by 2032, in sectors ranging from electrical installation, maintenance and repair, charger assembly, general construction, software maintenance and repair, planning and design, and administration and legal.[1451] As mentioned above, JOET has funded initiatives related to job training for many sectors related to charging resiliency and performance, including those in the electrical industry.[1452] In addition, the type and number of jobs related to vehicle maintenance are expected to change as well, though we expect this to happen over a longer time span due to the nature of fleet turnover. Given the timeline, we expect opportunities for workers to retrain from ICE vehicle maintenance to other positions, for example within PEV maintenance, charging station infrastructure, or elsewhere in the economy.

Reduced consumption of petroleum fuel represents fuel savings for purchasers of fuel, as well as a potential loss in value of output for the petroleum refining industry, fuel distributors, and gasoline stations, which may result in reduced employment in these sectors. These impacts may also pass up the supply chain to, for example, pipeline construction, operation and maintenance, and domestic oil production. However, because the fuel production sector is material-intensive, and we estimate that only part of the reduction in liquid fuel consumption will be met by reduced refinery production in the U.S. (see RIA Chapter 10), the employment effect is not expected to be large. In addition, it may be difficult to distinguish these effects from other trends, such as increases in petroleum sector labor productivity that may also lower labor demand.

As discussed in section I of this preamble, there have been several legislative and administrative efforts enacted since 2021 aimed at improving the domestic supply chain for electric vehicles, including electric vehicle chargers, critical minerals, and components needed by domestic manufacturers of EV batteries. These actions are also expected to provide opportunities for domestic employment in these associated sectors.

The standards may affect employment for auto dealers through a change in vehicles sold, with increasing sales being associated with an increase in labor demand. However, vehicle sales are also affected by macroeconomic effects, and it is difficult to separate out the effects of the standards on sales from effects due to macroeconomic conditions. In addition, auto dealers may also be affected by changes in maintenance and service costs, as well as through changes in the maintenance needs of the vehicles sold. For example, reduced maintenance needs of BEVs would lead to reduced demand for maintenance labor.

Commenters on the proposal stated concerns about a lack of available technicians qualified to service electric vehicles and charging infrastructure. We do not agree that there will be a significant lack of technicians in the timeframe of this rule given investments and programs focused on training for EV sector positions (including those

[1450] The White house: Full Charge: The Economics of Building a National EV Charging Network, *https://www.whitehouse.gov/briefing-room/blog/2023/12/11/full-charge-the-economics-of-building-a-national-ev-charging-network*.

[1451] ICCT: Charging Up America, *https://theicct.org/wp-content/uploads/2024/01/ID-28-%E2%80%93-U.S.-infra-jobs-report-letter-70112-ALT-v6.pdf*.

[1452] JOET: New Funding Enhances EV Charging Resiliency, Reliability, Equity and Workforce Development, *https://driveelectric.gov/news/workforce-development-ev-projects*.

discussed in section VIII.I.1 of this preamble and section 20 of the RTC, as well as other programs, including those at many community colleges, supporting jobs related to EV technology, including technicians).[1453] Additionally, the phase-in of this final rule, described in section III of this preamble, will allow time for technicians to be trained. Commenters also stated that refinery jobs and gas station employees are at risk if the share of BEVs in the market increases as projected in the proposal. However, traditional gas stations and liquid fuel providers are already incorporating electric vehicle charging into their business plans. For example, investments by Chevron have been made to expand reliable, profitable EV charging stations to existing convenience stores and gas stations across the county; [1454] Shell is offering ''Shell Recharge,'' which is focused on providing charging solutions for electric vehicle fleets; [1455] and Love's Travel Stops, a national travel stop network, is working with Electrify America to provide ultra-fast EV charging at seven existing travel stops, which also have helped Electrify America to complete a cross-country charging route from LA to DC [1456] In addition, some gas stations have converted from providing liquid fuel to electric charging.[1457] Overall, nearly three quarters of existing gas stations are located in census tracts eligible for the Alternative Fuel Vehicle Refueling Tax Credit (Internal Revenue Code 30C), encouraging the continuation of private sector employment in these communities.[1458]

Commenters discussed possible transitory effects on impacted industries, noting that there will not be a one-to-one job replacement, in part because battery processing operations are largely conducted overseas and workers trained in one field may not necessarily be able to move into another field, stating that the U.S. labor pool supporting the automotive industry will be redefined. As noted earlier in this section, and in section VIII.I.1 of this preamble, there are many programs and targeted investments through federal, state and private programs to support and enhance employment opportunities in the U.S. related to the automotive industry, battery manufacturing, and charging infrastructure and support across the supply chains.[1459] Commenters stated that moving to BEVs will result in loss of jobs due to increased automation and fewer components in a BEV compared to an ICE vehicle, and that jobs in the specialty aftermarket industry will be lost. One commenter stated that there will be reduced demand due to higher upfront vehicle costs, which will lead to job losses across the industry.

Some commenters appear to ignore that the market share of new PEVs sold is increasing over time, while other commenters point out that the IRA has already led to new jobs in the automotive industry, including in battery manufacturing, and additional research shows job creation in charging infrastructure industry. We agree that a shift in the automotive industry is already underway and, as reflected in our No Action scenario modeling, this shift is occurring independent of this rule.[1460] Also, the PEV share of the total on-road fleet will change more slowly than new vehicle shares. In 2032, over 80 percent of the on-road fleet will use an internal combustion engine, and even in 2055 such vehicles will be a majority of the fleet.[1461] In addition, we are finalizing standards that incorporate additional flexibilities and a slower increase in the stringency of the standards compared to the proposal. We recognize that the ongoing transition in the vehicles market will result in shifts of patterns of employment, with increases in employment in component production and new domestic jobs related to PEVs offset at least in part by losses in production of ICE vehicles. We also recognize that commenters are concerned about job quality and geographic location. However, for the reasons discussed above, we think the net effects of the rule are likely to be positive and we see no basis for concluding that these final standards will cause significant economic dislocation.

J. Environmental Justice

1. Overview

Communities with environmental justice concerns, which can include a range of communities and populations, face relatively greater cumulative impacts associated with environmental exposures of multiple types, as well as impacts from non-chemical stressors. Numerous studies have found that environmental hazards such as air pollution are more prevalent in areas where people of color and low-income populations represent a higher fraction of the population compared with the general population.[1462] [1463] [1464] [1465] [1466] [1467] [1468] [1469] [1470] As described in section II.C.8 of this preamble, there is some literature to suggest that different sociodemographic factors may increase susceptibility to the effects of traffic-associated air pollution. In addition, compared to non-Hispanic Whites, some other racial groups experience greater levels of health problems during some life stages. For example, in 2018–2020,

[1453] For a list of some of the community college and other programs that support the electric vehicle industry, see the Community College and Other EV Training Programs memo to the docket.

[1454] Businesswire: Electric Era Announces Investment from Chevron Technology Ventures to Scale Adoption of it PowerNode Electric Vehicle Charging Stations.*https://www.businesswire.com/news/home/20231003932625/en/Electric-Era-Announces-Investment-from-Chevron-Technology-Ventures-to-Scale-Adoption-of-its-PowerNode%E2%84%A2-Electric-Vehicle-Charging-Stations.*

[1455] Shell Recharge: *https://www.shell.us/business-customers/shell-fleet-solutions/shell-recharge?msclkid=b112711a7f16131508b614da1ed439cf&utm_source=bing&utm_medium=cpc&utm_campaign=US_RCG_EN_NB_PM_BNG_Fleet_Recharge_Product&utm_term=ev%20charging&utm_content=Recharge%20Solution#iframe=L0xlYWRfR2VuX0Zvcm0_SUQ9VUhKdlpIVmpkRDFUWld4bUlITmxiR1ZqZEdWa0preGxZV1JUYjNWeVkyVTlUM0puWVc1cFl3PT0.*

[1456] Love's: Electrify America Announces Collaboration with Love's Travel Stops:*https://www.loves.com/en/news/2020/august/electrify-america-announces-collaboration-with-loves-travel-stops.*

[1457] NPR: Gas Station Converts to Electric Charging Station and Speeds Ahead of Curve.*https://www.npr.org/2019/10/26/773446805/gas-station-converts-to-electric-charging-station-and-speeds-ahead-of-curve.*

[1458] Gohlke, David, Zhou, Yan, and Wu, Xinyi. 2024. ''Refueling Infrastructure Deployment in Low-Income and Non-Urban Communities''. United States. *https://doi.org/10.2172/2318956. https://www.osti.gov/servlets/purl/2318956.*

[1459] DOE: Biden-Harris Administration announces $3.5 Billion to strengthen domestic battery manufacturing, *https://www.energy.gov/articles/biden-harris-administration-announces-35-billion-strengthen-domestic-battery-manufacturing*; White House: Fact Sheet: Biden-Harris Administration Driving U.S. Battery Manufacturing and Good-Paying Jobs,*https://www.whitehouse.gov/briefing-room/statements-releases/2022/10/19/fact-sheet-biden-harris-administration-driving-u-s-battery-manufacturing-and-good-paying-jobs.*

[1460] For more information on the No Action case, see section IV.B of the preamble.

[1461] See Figure 8–5: Share of ICE (including HEV), PHEV, and BEV in the total light- and medium-duty stock under the Final standards in Chapter 8.2 in the RIA.

[1462] Rowangould, G.M. (2013) A census of the near-roadway population: public health and environmental justice considerations. Trans Res D 25: 59–67. *http://dx.doi.org/10.1016/j.trd.2013.08.003.*

[1463] Marshall, J.D. (2000) Environmental inequality: Air pollution exposures in California's South Coast Air Basin. Atmos Environ 21: 5499–5503. *https://doi.org/10.1016/j.atmosenv.2008.02.005.*

[1464] Marshall, J.D. (2008) Environmental inequality: air pollution exposures in California's South Coast Air Basin. Atmos Environ 21: 5499–5503. *https://doi.org/10.1016/j.atmosenv.2008.02.005.*

[1465] Mohai, P.; Pellow, D.; Roberts Timmons, J. (2009) Environmental justice. Annual Reviews 34: 405–430. *https://doi.org/10.1146/annurev-environ82508-094348.*

about 12 percent of non-Hispanic Black; 9 percent of non-Hispanic American Indian/Alaska Native; and 7 percent of Hispanic children were estimated to currently have asthma, compared with 6 percent of non-Hispanic White children.[1471] Nationally, on average, non-Hispanic Black and non-Hispanic American Indian or Alaska Native people also have lower than average life expectancy based on 2019 data.[1472]

EPA's 2016 ''Technical Guidance for Assessing Environmental Justice in Regulatory Analysis'' provides recommendations on conducting the highest quality analysis feasible of environmental justice (EJ) issues associated with a given regulatory decision, though it is not prescriptive, recognizing that data limitations, time and resource constraints, and analytic challenges will vary by media and regulatory context. Where applicable and practicable, the Agency endeavors to conduct such an EJ analysis. There is evidence that communities with EJ concerns are disproportionately and adversely impacted by vehicle emissions.[1473]

In section VIII.J.2 of the preamble, we discuss the EJ impacts of this final rule's GHG emission standards from the anticipated reduction of GHGs. We also discuss in section VIII.J.3 of the preamble the potential additional EJ impacts from the non-GHG (criteria pollutant and air toxic) emissions changes we estimate would result from compliance with the emission standards, including impacts near roadways and from upstream sources. EPA did not consider potential adverse disproportionate impacts of vehicle emissions in selecting the emission standards, but we provide information about adverse impacts of vehicle emissions for the public's understanding of this rulemaking, which addresses the need to protect public health consistent with CAA section 202(a)(1)–(2). When assessing the potential for disproportionate and adverse health or environmental impacts of regulatory actions on populations with potential EJ concerns, EPA strives to answer the following three broad questions, for purposes of the EJ analysis. (1) Is there evidence of potential EJ concerns in the baseline (the state of the world absent the regulatory action)? Assessing the baseline will allow EPA to determine whether pre-existing disparities are associated with the pollutant(s) under consideration (*e.g.,* if the effects of the pollutant(s) are more concentrated in some population groups); (2) Is there evidence of potential EJ concerns for the regulatory option(s) under consideration? Specifically, how are the pollutant(s) and its effects distributed for the regulatory options under consideration?; and (3) Do the regulatory option(s) under consideration exacerbate or mitigate EJ concerns relative to the baseline? It is not always possible to provide quantitative answers to these questions.

EPA received several comments related to the environmental justice impacts of light- and medium-duty vehicles in general and the impacts of the proposal specifically. We summarize and respond to those comments in section 9 of the RTC document that accompanies this rulemaking. After consideration of comments, EPA updated our review of the literature, while maintaining our general approach to the environmental justice analysis. We note that the analyses in this section are based on data that was the most appropriate recent data at the time we undertook the analyses. We intend to continue analyzing data concerning disproportionate impacts of pollution in the future, using the latest available data. We also note that after consideration of comments, we conducted an analysis of how human exposure to future air quality varies with sociodemographic characteristics relevant to potential environmental justice concerns in scenarios with and without the rule in place. The results of this analysis are presented in section VII.D of this preamble and in RIA Chapter 7.6

2. GHG Impacts on Environmental Justice and Vulnerable or Overburdened Populations

In the 2009 Endangerment Finding, the Administrator considered how climate change threatens the health and welfare of the U.S. population. As part of that consideration, she also considered risks to various populations and communities, finding that certain parts of the U.S. population may be especially vulnerable based on their characteristics or circumstances. These groups include economically and socially disadvantaged communities; individuals at vulnerable life stages, such as the elderly, the very young, and pregnant or nursing women; those already in poor health or with comorbidities; the disabled; those experiencing homelessness, mental illness, or substance abuse; and Indigenous or other populations dependent on limited resources for subsistence due to factors including but not limited to geography, access, and mobility.

Scientific assessment reports produced over the past decade by the USGCRP,[1474] [1475] [1476] the IPCC,[1477] [1478] [1479] [1480] the National

[1466] Jbaily A, Zhou X, Liu J, Lee TH, Kamareddine L, Verguet S, Dominici F. Air pollution exposure disparities across US population and income groups. Nature. 2022 Jan;601(7892):228–233.''

[1467] Collins TW, Grineski SE. Racial/Ethnic Disparities in Short-Term $PM_{2.5}$ Air Pollution Exposures in the United States. Environ Health Perspect. 2022 Aug;130(8):87701.

[1468] Weaver GM, Gauderman WJ. Traffic-Related Pollutants: Exposure and Health Effects Among Hispanic Children. Am J Epidemiol. 2018 Jan 1;187(1):45–52.

[1469] C.W. Tessum, D.A. Paolella, S.E. Chambliss, J.S. Apte, J.D. Hill, J.D. Marshall, $PM_{2.5}$ polluters disproportionately and systemically affect people of color in the United States. Sci. Adv. 7, eabf4491 (2021)).

[1470] Valencia, A.; Cerre, M.; Arunachalam, S. A hyperlocal hybrid data fusion near-road $PM_{2.5}$ and NO2 annual risk and environmental justice assessment across the United States, 18 PLOS ONE 1 (2023).

[1471] Current Asthma Prevalence by Race and Ethnicity (2018–2020). Online at *https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm*.

[1472] Arias, E. Xu, J. (2022) United States Life Tables, 2019. National Vital Statistics Report, Volume 70, Number 19. Online at *https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-19.pdf*.

[1473] Demetillo, M.A.; Harkins, C.; McDonald, B.C.; et al. (2021) Space-based observational constraints on NO_2 air pollution inequality from diesel traffic in major US cities. Geophys Res Lett 48, e2021GL094333.

[1474] USGCRP, 2018: *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II* [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi:10.7930/NCA4.2018.

[1475] USGCRP, *Impacts in the United States: Assessment* C..E. M.C. U.S. Global Change Research Program, Washington, DC.

[1476] Jay, A.K., A.R. Crimmins, C.W. Avery, T.A. Dahl, R.S. Dodder, B.D. Hamlington, A. Lustig, K. Marvel, P.A. Méndez-Lazaro, M.S. Osler, A. Terando, E.S. Weeks, and A. Zycherman, 2023: Ch. 1. Overview: Understanding risks, impacts, and responses. In: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. *https://doi.org/10.7930/NCA5.2023.CH1*.

[1477] Oppenheimer, M., M. Campos, R. Warren, J. Birkmann, G. Luber, B. O'Neill, and K. Takahashi, 2014: *Emergent risks and key vulnerabilities.* In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1039–1099.

[1478] Porter, J.R., L. Xie, A.J. Challinor, K. Cochrane, S.M. Howden, M.M. Iqbal, D.B. Lobell, and M.I. Travasso, 2014: *Food security and food production systems. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of*

Continued

Academies of Science, Engineering, and Medicine,[1481] [1482] and EPA [1483] add more evidence that the impacts of climate change raise potential EJ concerns. These reports conclude that less-affluent, traditionally marginalized and predominantly non-White communities can be especially vulnerable to climate change impacts because they tend to have limited resources for adaptation, are more dependent on climate-sensitive resources such as local water and food supplies or have less access to social and information resources. Some communities of color, specifically populations defined jointly by ethnic/racial characteristics and geographic location (*e.g.,* African-American, Black, and Hispanic/Latino communities; Native Americans, particularly those living on tribal lands and Alaska Natives), may be uniquely vulnerable to climate change health impacts in the U.S., as discussed below. In particular, the 2016 scientific assessment on the Impacts of Climate Change on Human Health [1484] found with high confidence that vulnerabilities are place- and time-specific, lifestages and ages are linked to immediate and future health impacts, and social determinants of health are linked to greater extent and severity of climate change-related health impacts. The GHG emission reductions from this final rule would contribute to efforts to reduce the probability of severe impacts related to climate change.

Effects on Specific Communities and Populations

Per the Fourth National Climate Assessment (NCA4), ''Climate change affects human health by altering exposures to heat waves, floods, droughts, and other extreme events; vector-, food- and waterborne infectious diseases; changes in the quality and safety of air, food, and water; and stresses to mental health and well-being.'' [1485] Many health conditions such as cardiopulmonary or respiratory illness and other health impacts are associated with and exacerbated by an increase in GHGs and climate change outcomes, which is problematic as these diseases occur at higher rates within vulnerable communities. Importantly, negative public health outcomes include those that are physical in nature, as well as mental, emotional, social, and economic.

The scientific assessment literature, including the aforementioned reports, demonstrates that there are myriad ways in which these particular communities and populations may be affected at the individual and community levels. Individuals face differential exposure to criteria pollutants, in part due to the proximities of highways, trains, factories, and other major sources of pollutant-emitting sources to less-affluent residential areas. Outdoor workers, such as construction or utility crews and agricultural laborers, who frequently are comprised of already at-risk groups, are exposed to poor air quality and extreme temperatures without relief. Furthermore, people in communities with EJ concerns face greater housing, clean water, and food insecurity and bear disproportionate and adverse economic impacts and health burdens associated with climate change effects. They have less or limited access to healthcare and affordable, adequate health or homeowner insurance.[1486] Finally, resiliency and adaptation are more difficult for economically vulnerable communities; these communities have less liquidity, individually and collectively, to move or to make the types of infrastructure or policy changes to limit or reduce the hazards they face. They frequently are less able to self-advocate for resources that would otherwise aid in building resilience and hazard reduction and mitigation.

The assessment literature cited in EPA's 2009 and 2016 Endangerment and Cause or Contribute Findings, as well as Impacts of Climate Change on Human Health, also concluded that certain populations and life stages, including children, are most vulnerable to climate-related health effects.[1487] The assessment literature produced from 2016 to the present strengthens these conclusions by providing more detailed findings regarding related vulnerabilities and the projected impacts youth may experience. These assessments—including the NCA5 and The Impacts of Climate Change on Human Health in the United States (2016)—describe how children's unique physiological and developmental factors contribute to making them particularly vulnerable to climate change. Impacts to children are expected from heat waves, air pollution, infectious and waterborne illnesses, and mental health effects resulting from extreme weather events. In addition, children are among those especially susceptible to allergens, as well as health effects associated with heat waves, storms, and floods. Additional health concerns may arise in low-income households, especially those with children, if climate change reduces food availability and increases prices, leading to food insecurity within households. More generally, these reports note that extreme weather and flooding can cause or exacerbate poor health outcomes by affecting mental health because of stress; contributing to or worsening existing conditions, again due to stress or also as a consequence of exposures to water and air pollutants; or by impacting hospital and emergency services operations.[1488] Further, in

Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 485–533.

[1479] Smith, K.R., A. Woodward, D. Campbell-Lendrum, D.D. Chadee, Y. Honda, Q. Liu, J.M. Olwoch, B. Revich, and R. Sauerborn, 2014: Human health: impacts, adaptation, and co-benefits. In: Climate Change 2014: *Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 709–754.

[1480] IPCC, 2018: Global Warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

[1481] National Research Council. 2011. *America's Climate Choices.* Washington, DC: The National Academies Press. *https://doi.org/10.17226/12781.*

[1482] National Academies of Sciences, Engineering, and Medicine. 2017. *Communities in Action: Pathways to Health Equity.* Washington, DC: The National Academies Press. *https://doi.org/10.17226/24624.*

[1483] EPA. 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430–R–21–003.

[1484] USGCRP, 2016: *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.*

[1485] Ebi, K.L., J.M. Balbus, G. Luber, A. Bole, A. Crimmins, G. Glass, S. Saha, M.M. Shimamoto, J. Trtanj, and J.L. White-Newsome, 2018: Human Health. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 539–571. doi: 10.7930/NCA4.2018.CH14.

[1486] USGCRP, 2016: *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.*

[1487] 74 FR 66496, December 15, 2009; 81 FR 54422, August 15, 2016.

[1488] Ebi, K.L., J.M. Balbus, G. Luber, A. Bole, A. Crimmins, G. Glass, S. Saha, M.M. Shimamoto, J. Trtanj, and J.L. White-Newsome, 2018: Human Health. In Impacts, Risks, and Adaptation in the urban areas in particular, flooding can have significant economic consequences due to effects on infrastructure, pollutant exposures, and drowning dangers. The ability to withstand and recover from flooding is dependent in part on the social vulnerability of the affected population and individuals experiencing an event.[1489] In addition, children are among those especially susceptible to allergens, as well as health effects associated with heat waves, storms, and floods. Additional health concerns may arise in low-income households, especially those with children, if climate change reduces food availability and increases prices, leading to food insecurity within households.

The Impacts of Climate Change on Human Health [1490] also found that some communities of color, low-income groups, people with limited English proficiency, and certain immigrant groups (especially those who are undocumented) are subject to many factors that contribute to vulnerability to the health impacts of climate change. While difficult to isolate from related socioeconomic factors, race appears to be an important factor in vulnerability to climate-related stress, with elevated risks for mortality from high temperatures reported for Black or African American individuals compared to White individuals after controlling for factors such as air conditioning use. Moreover, people of color are disproportionately more exposed to air pollution based on where they live, and disproportionately vulnerable due to higher baseline prevalence of underlying diseases such as asthma. As explained earlier, climate change can exacerbate local air pollution conditions so this increase in air pollution is expected to have disproportionate and adverse effects on these communities. Locations with greater health threats include urban areas (due to, among other factors, the ''heat island'' effect where built infrastructure and lack of green spaces increases local temperatures), areas where airborne allergens and other air pollutants already occur at higher levels, and communities experienced depleted water supplies or vulnerable energy and transportation infrastructure.

The recent EPA report on climate change and social vulnerability [1491] examined four socially vulnerable groups (individuals who are low income, minority, without high school diplomas, and/or 65 years and older) and their exposure to several different climate impacts (air quality, coastal flooding, extreme temperatures, and inland flooding). This report found that Black and African-American individuals were 40 percent more likely to currently live in areas with the highest projected increases in mortality rates due to climate-driven changes in extreme temperatures, and 34 percent more likely to live in areas with the highest projected increases in childhood asthma diagnoses due to climate-driven changes in particulate air pollution. The report found that Hispanic and Latino individuals are 43 percent more likely to live in areas with the highest projected labor hour losses in weather-exposed industries due to climate-driven warming, and 50 percent more likely to live in coastal areas with the highest projected increases in traffic delays due to increases in high-tide flooding. The report found that American Indian and Alaska Native individuals are 48 percent more likely to live in areas where the highest percentage of land is projected to be inundated due to sea level rise, and 37 percent more likely to live in areas with high projected labor hour losses. Asian individuals were found to be 23 percent more likely to live in coastal areas with projected increases in traffic delays from high-tide flooding. Persons with low income or no high school diploma are about 25 percent more likely to live in areas with high projected losses of labor hours, and 15 percent more likely to live in areas with the highest projected increases in asthma due to climate-driven increases in particulate air pollution, and in areas with high projected inundation due to sea level rise.

In a more recent 2023 report, Climate Change Impacts on Children's Health and Well-Being in the U.S., EPA considered the degree to which children's health and well-being may be impacted by five climate-related environmental hazards—extreme heat, poor air quality, changes in seasonality, flooding, and different types of infectious diseases.[1492] The report found that children's academic achievement is projected to be reduced by 4–7 percent per child, as a result of moderate and higher levels of warming, impacting future income levels. The report also projects increases in the numbers of annual emergency department visits associated with asthma, and that the number of new asthma diagnoses increases by 4–11 percent due to climate-driven increases in air pollution relative to current levels. In addition, more than 1 million children in coastal regions are projected to be temporarily displaced from their homes annually due to climate-driven flooding, and infectious disease rates are similarly anticipated to rise, with the number of new Lyme disease cases in children living in 22 states in the eastern and midwestern U.S. increasing by approximately 3,000–23,000 per year compared to current levels. Overall, the report confirmed findings of broader climate science assessments that children are uniquely vulnerable to climate-related impacts and that in many situations, children in the U.S. who identify as Black, Indigenous, and People of Color, are limited English-speaking, do not have health insurance, or live in low-income communities may be disproportionately more exposed to the most severe adverse impacts of climate change.

Tribes and Indigenous communities face disproportionate and adverse risks from the impacts of climate change, particularly those communities impacted by degradation of natural and cultural resources within established reservation boundaries and threats to traditional subsistence lifestyles. Indigenous communities whose health, economic well-being, and cultural traditions depend upon the natural environment will likely be affected by the degradation of ecosystem goods and services associated with climate change. The IPCC indicates that losses of customs and historical knowledge may cause communities to be less resilient or adaptable.[1493] The NCA4 noted that while Tribes and Indigenous Peoples are diverse and will be impacted by the climate changes universal to all Americans, there are several ways in which climate change uniquely

United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 539–571. doi:10.7930/NCA4.2018.CH14.

[1489] National Academies of Sciences, Engineering, and Medicine 2019. Framing the Challenge of Urban Flooding in the United States. Washington, DC: The National Academies Press. *https://doi.org/10.17226/25381.*

[1490] USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp. *http://dx.doi.org/10.7930/J0R49NQX.*

[1491] EPA. 2021. Climate Change and Social Vulnerability in the United States: A Focus on Six Impacts. U.S. Environmental Protection Agency, EPA 430–R–21–003.

[1492] EPA. 2023. Climate Change Impacts on Children's Health and Well-Being in the U.S., EPA EPA 430–R–23–001.

[1493] Porter, *et al.,* 2014: Food security and food production systems.

threatens Tribes and Indigenous Peoples' livelihoods and economies.[1494] In addition, as noted in the following paragraph, there can be institutional barriers (including policy-based limitations and restrictions) to their management of water, land, and other natural resources that could impede adaptive measures.

For example, Indigenous agriculture in the Southwest is already being adversely affected by changing patterns of flooding, drought, dust storms, and rising temperatures leading to increased soil erosion, irrigation water demand, and decreased crop quality and herd sizes. The Confederated Tribes of the Umatilla Indian Reservation in the Northwest have identified climate risks to salmon, elk, deer, roots, and huckleberry habitat. Housing and sanitary water supply infrastructure are vulnerable to disruption from extreme precipitation events. Additionally, NCA4 noted that Tribes and Indigenous Peoples generally experience poor infrastructure, diminished access to quality healthcare, and greater risk of exposure to pollutants. Consequently, Native Americans often have disproportionately higher rates of asthma, cardiovascular disease, Alzheimer's disease, diabetes, and obesity. These health conditions and related effects (disorientation, heightened exposure to $PM_{2.5}$, etc.) can all contribute to increased vulnerability to climate-driven extreme heat and air pollution events, which also may be exacerbated by stressful situations, such as extreme weather events, wildfires, and other circumstances.

NCA4 and IPCC's Fifth Assessment Report[1495] also highlighted several impacts specific to Alaskan Indigenous Peoples. Coastal erosion and permafrost thaw will lead to more coastal erosion, rendering winter travel riskier and exacerbating damage to buildings, roads, and other infrastructure—impacts on archaeological sites, structures, and objects that will lead to a loss of cultural heritage for Alaska's Indigenous people. In terms of food security, the NCA4 discussed reductions in suitable ice conditions for hunting, warmer temperatures impairing the use of traditional ice cellars for food storage, and declining shellfish populations due to warming and acidification. While the NCA4 also noted that climate change provided more opportunity to hunt from boats later in the fall season or earlier in the spring, the assessment found that the net impact was an overall decrease in food security. In addition, the U.S. Pacific Islands and the Indigenous communities that live there are also uniquely vulnerable to the effects of climate change due to their remote location and geographic isolation. They rely on the land, ocean, and natural resources for their livelihoods, but they face challenges in obtaining energy and food supplies that need to be shipped in at high costs. As a result, they face higher energy costs than the rest of the nation and depend on imported fossil fuels for electricity generation and diesel. These challenges exacerbate the climate impacts that the Pacific Islands are experiencing. NCA4 notes that Tribes and Indigenous Peoples of the Pacific are threatened by rising sea levels, diminishing freshwater availability, and negative effects to ecosystem services that threaten these individuals' health and well-being.

3. Non-GHG Impacts

In section VII of this preamble, in addition to GHG emissions impacts, we also discuss potential additional emission changes of non-GHGs (*i.e.,* criteria and air toxic pollutants) that we project from compliance with the final emission standards. This section describes evidence that communities with EJ concerns are disproportionately and adversely impacted by relevant non-GHG emissions. We discuss the potential impact of non-GHG emissions for two specific contexts: near-roadway (section VIII.J.3.i of the preamble) and upstream sources (section VIII.J.3.ii of the preamble).

i. Near-Roadway Analysis

As described in section II.C.8 of this preamble, concentrations of many air pollutants are elevated near high-traffic roadways. We recently conducted an analysis of the populations within the continental U.S. living in close proximity to truck freight routes as identified in USDOT's FAF4.[1496] FAF4 is a model from the USDOT's Bureau of Transportation Statistics and Federal Highway Administration, which provides data associated with freight movement in the United States.[1497] Relative to the rest of the population, people living near FAF4 truck routes are more likely to be people of color and have lower incomes than the general population. People living near FAF4 truck routes are also more likely to live in metropolitan areas. Even controlling for region of the country, county characteristics, population density, and household structure, race, ethnicity, and income are significant determinants of whether someone lives near a FAF4 truck route.

We additionally analyzed other national databases that allowed us to evaluate whether homes and schools were located near a major road and whether disparities in exposure may be occurring in these environments. Until 2009, the U.S. Census Bureau's American Housing Survey (AHS) included descriptive statistics of over 70,000 housing units across the nation and asked about transportation infrastructure near respondents' homes every two years.[1498] [1499] We also analyzed the U.S. Department of Education's Common Core of Data, which includes enrollment and location information for schools across the United States.[1500]

In analyzing the 2009 AHS, we focused on whether a housing unit was located within 300 feet of a ''4-or-more lane highway, railroad, or airport'' (this distance was used in the AHS analysis).[1501] We analyzed whether there were differences between households in such locations compared with those in locations farther from these transportation facilities.[1502] We

[1494] Jantarasami, L.C., R. Novak, R. Delgado, E. Marino, S. McNeeley, C. Narducci, J. Raymond-Yakoubian, L. Singletary, and K. Powys Whyte, 2018: Tribes and Indigenous Peoples. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 572–603. doi:10.7930/NCA4. 2018. CH15.

[1495] Porter, *et al.,* 2014: Food security and food production systems.

[1496] U.S. EPA (2021). Estimation of Population Size and Demographic Characteristics among People Living Near Truck Routes in the Conterminous United States. Memorandum to the Docket.

[1497] FAF4 includes data from the 2012 Commodity Flow Survey (CFS), the Census Bureau on international trade, as well as data associated with construction, agriculture, utilities, warehouses, and other industries. FAF4 estimates the modal choices for moving goods by trucks, trains, boats, and other types of freight modes. It includes traffic assignments, including truck flows on a network of truck routes. *https://ops.fhwa.dot.gov/freight/freight_analysis/faf.*

[1498] U.S. Department of Housing and Urban Development, & U.S. Census Bureau. (n.d.). Age of other residential buildings within 300 feet. In American Housing Survey for the United States: 2009 (pp. A–1). Retrieved from *https://www.census.gov/programs-surveys/ahs/data/2009/ahs-2009-summary-tables0/h150-09.html.*

[1499] The 2013 AHS again included the ''etrans'' question about highways, airports, and railroads within half a block of the housing unit but has not maintained the question since then.

[1500] *http://nces.ed.gov/ccd.*

[1501] This variable primarily represents roadway proximity. According to the Central Intelligence Agency's World Factbook, in 2010, the United States had 6,506,204 km of roadways, 224,792 km of railways, and 15,079 airports. Highways thus represent the overwhelming majority of transportation facilities described by this factor in the AHS.

[1502] Bailey, C. (2011) Demographic and Social Patterns in Housing Units Near Large Highways and included other variables, such as land use category, region of country, and housing type. We found that homes with a non-White householder were 22–34 percent more likely to be located within 300 feet of these large transportation facilities than homes with White householders. Homes with a Hispanic householder were 17–33 percent more likely to be located within 300 feet of these large transportation facilities than homes with non-Hispanic householders. Households near large transportation facilities were, on average, lower in income and educational attainment and more likely to be a rental property and located in an urban area compared with households more distant from transportation facilities.

In examining schools near major roadways, we used the Common Core of Data from the U.S. Department of Education, which includes information on all public elementary and secondary schools and school districts nationwide.[1503] To determine school proximities to major roadways, we used a geographic information system to map each school and roadways based on the U.S. Census's TIGER roadway file.[1504] We estimated that about 10 million students attend schools within 200 meters of major roads, about 20 percent of the total number of public school students in the United States.[1505] About 800,000 students attend public schools within 200 meters of primary roads, or about 2 percent of the total. We found that students of color were overrepresented at schools within 200 meters of primary roadways, and schools within 200 meters of primary roadways had a disproportionately greater population of students eligible for free or reduced-price lunches.[1506] Black students represent 22 percent of students at schools located within 200 meters of a primary road, compared to 17 percent of students in all U.S. schools. Hispanic students represent 30 percent of students at schools located within 200 meters of a primary road, compared to 22 percent of students in all U.S. schools.

We also reviewed existing scholarly literature examining the potential for disproportionately high exposure to these pollutants among people of color and people with low socioeconomic status (SES). Numerous studies evaluating the demographics and socioeconomic status of populations or schools near roadways have found that they include a greater percentage of residents of color, as well as lower SES populations (as indicated by variables such as median household income). Locations in these studies include Los Angeles, CA; Seattle, WA; Wayne County, MI; Orange County, FL; Tampa, FL; the State of California; the State of Texas; and nationally.[1507 1508 1509 1510 1511 1512 1513 1514 1515 1516 1517 1518] Such disparities may be due to multiple factors, such as historic segregation, redlining, residential mobility, and daily mobility.[1519 1520 1521 1522 1523 1524]

[1511] Wu, Y; Batterman, S.A. (2006) Proximity of schools in Detroit, Michigan to automobile and truck traffic. J Exposure Sci & Environ Epidemiol. doi:10.1038/sj.jes.7500484.

[1512] Su, J.G.; Jerrett, M.; de Nazelle, A.; Wolch, J. (2011) Does exposure to air pollution in urban parks have socioeconomic, racial, or ethnic gradients? Environ Res 111: 319–328.

[1513] Jones, M.R.; Diez-Roux, A.; Hajat, A.; et al. (2014) Race/ethnicity, residential segregation, and exposure to ambient air pollution: The Multi-Ethnic Study of Atherosclerosis (MESA). Am J Public Health 104: 2130–2137. Online at: *https://doi.org/10.2105/AJPH.2014.302135*.

[1514] Stuart A.L., Zeager M. (2011) An inequality study of ambient nitrogen dioxide and traffic levels near elementary schools in the Tampa area. Journal of Environmental Management. 92(8): 1923–1930. *https://doi.org/10.1016/j.jenvman.2011.03.003*.

[1515] Stuart A.L., Mudhasakul S., Sriwatanapongse W. (2009) The Social Distribution of Neighborhood-Scale Air Pollution and Monitoring Protection. Journal of the Air & Waste Management Association. 59(5): 591–602. *https://doi.org/10.3155/1047-3289.59.5.591*.

[1516] Willis M.D., Hill E.L., Kile M.L., Carozza S., Hystad P. (2020) Assessing the effectiveness of vehicle emission regulations on improving perinatal health: a population-based accountability study. International Journal of Epidemiology. 49(6): 1781–1791. *https://doi.org/10.1093/ije/dyaa137*.

[1517] Collins, T.W., Grineski, SE, Nadybal, S. (2019) Social disparities in exposure to noise at public schools in the contiguous United States. Environ. Res. 175, 257–265. *https://doi.org/10.1016/j.envres.2019.05.024*.

[1518] Kingsley S., Eliot M., Carlson L., Finn J., MacIntosh D.L., Suh H.H., Wellenius G.A. (2014) Proximity of US schools to major roadways: a nationwide assessment. J Expo Sci Environ Epidemiol. 24: 253–259. *https://doi.org/10.1038/jes.2014.5*./ FTNT≤

Several publications report nationwide analyses that compare the demographic patterns of people who do or do not live near major roadways.[1525 1526 1527 1528 1529 1530] Three

other Transportation Sources. Memorandum to docket.

[1503] *http://nces.ed.gov/ccd*.

[1504] Pedde, M.; Bailey, C. (2011) Identification of Schools within 200 Meters of U.S. Primary and Secondary Roads. Memorandum to the docket.

[1505] Here, ''major roads'' refer to those TIGER classifies as either ''Primary'' or ''Secondary.'' The Census Bureau describes primary roads as ''generally divided limited-access highways within the Federal interstate system or under state management.'' Secondary roads are ''main arteries, usually in the U.S. highway, state highway, or county highway system.''

[1506] For this analysis we analyzed a 200-meter distance based on the understanding that roadways generally influence air quality within a few hundred meters from the vicinity of heavily traveled roadways or along corridors with significant trucking traffic. See U.S. EPA, 2014. Near Roadway Air Pollution and Health: Frequently Asked Questions. EPA–420–F–14–044.

[1507] Marshall, J.D. (2008) Environmental inequality: air pollution exposures in California's South Coast Air Basin. Atmos Environ 42: 5499–5503. doi:10.1016/j.atmosenv.2008.02.00.

[1508] Su, J.G.; Larson, T.; Gould, T.; Cohen, M.; Buzzelli, M. (2010) Transboundary air pollution and environmental justice: Vancouver and Seattle compared. GeoJournal 57: 595–608. doi:10.1007/s10708–009–9269–6.

[1509] Chakraborty, J.; Zandbergen, P.A. (2007) Children at risk: measuring racial/ethnic disparities in potential exposure to air pollution at school and home. J Epidemiol Community Health 61: 1074–1079. doi:10.1136/jech.2006.054130.

[1510] 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. doi:10.1289/ehp.6566.

[1519] Depro, B.; Timmins, C. (2008) Mobility and environmental equity: do housing choices determine exposure to air pollution? Duke University Working Paper.

[1520] Rothstein, R. The Color of Law: A Forgotten History of How Our Government Segregated America. New York: Liveright, 2018.

[1521] Lane, H.J.; Morello-Frosch, R.; Marshall, J.D.; Apte, J.S. (2022) Historical redlining is associated with present-day air pollution disparities in US Cities. Environ Sci & Technol Letters 9: 345–350. DOI: Online at: *https://doi.org/10.1021/acs.estlett.1c01012*.

[1522] Ware, L. (2021) Plessy's legacy: the government's role in the development and perpetuation of segregated neighborhoods. RSF: The Russel Sage Foundation Journal of the Social Sciences, 7:92–109. DOI: DOI: 10.7758/

[1525] Rowangould, G.M. (2013) A census of the U.S. near-roadway population: public health and environmental justice considerations. Transportation Research Part D; 59–67.

[1526] Tian, N.; Xue, J.; Barzyk. T.M. (2013) Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach. J Exposure Sci Environ Epidemiol 23: 215–222.

[1527] CDC (2013) Residential proximity to major highways—United States, 2010. Morbidity and Mortality Weekly Report 62(3): 46–50.

[1528] Clark, L.P.; Millet, D.B.; Marshall, J.D. (2017) Changes in transportation-related air pollution exposures by race-ethnicity and socioeconomic status: outdoor nitrogen dioxide in the United States in 2000 and 2010. Environ Health Perspect *https://doi.org/10.1289/EHP959*.

Continued

of these studies found that people living near major roadways are more likely to be people of color or of low SES.[1531] [1532] [1533] They also found that the outcomes of their analyses varied between regions within the United States. However, only one such study looked at whether such conclusions were confounded by living in a location with higher population density and looked at how demographics differ between locations nationwide.[1534] That study generally found that higher density areas have higher proportions of low-income residents and people of color. In other publications assessing a city, county, or state, the results are similar.[1535] [1536] [1537]

Overall, there is substantial evidence that people who live or attend school near major roadways are more likely to be of a non-White race, Hispanic, and/or have a low SES. As described in section II.C.8 of the preamble, traffic-related air pollution may have disproportionate and adverse impacts on health across racial and sociodemographic groups. We expect communities near roads will benefit from the reduced vehicle emissions of PM, NO_X, SO_2, VOC, CO, and mobile source air toxics projected to result from this final rule. Although we were not able to conduct air quality modeling of the estimated emission reductions, we believe it a fair inference that because vehicular emissions affect communities with environmental justice concerns disproportionately and adversely due to roadway proximity, and because we project this rule will result in significant reductions in vehicular emissions, these communities' exposures to non-GHG air pollutants will be reduced. EPA is considering how to better estimate the near-roadway air quality impacts of its regulatory actions and how those impacts are distributed across populations.

ii. Upstream Source Impacts

As described in Chapter 4.5 of the RIA, we expect some non-GHG emissions reductions from sources related to refining petroleum fuels and increases in emissions from EGUs, both of which would lead to changes in exposure for people living in communities near these facilities. The EGU emissions increases become smaller over time because of changes in the projected power generation mix as electricity generation uses less fossil fuels.

Analyses of communities in close proximity to EGUs have found that a higher percentage of communities of color and low-income communities live near these sources when compared to national averages.[1538] EPA compared the percentages of people of color and low-income populations living within three miles of fossil fuel-fired power plants regulated under EPA's Acid Rain Program and/or EPA's Cross-State Air Pollution Rule to the national average and found that there is a greater percentage of people of color and low-income individuals living near these power plants than in the rest of the country on average.[1539] According to 2020 Census data, on average, the U.S. population is comprised of 40 percent people of color and 30 percent low-income individuals. In contrast, the population living near fossil fuel-fired power plants is comprised of 53 percent people of color and 34 percent low-income individuals.[1540] Historically redlined neighborhoods are more likely to be downwind of fossil fuel power plants and to experience higher levels of exposure to relevant emissions than non-redlined neighborhoods.[1541] Analysis of populations near refineries and oil and gas wells also indicates there may be potential disparities in pollution-related health risk from these sources.[1542] [1543] [1544] [1545] Section VII.B of the preamble and RIA Chapter 7.4 discuss the air quality impacts of the emissions changes associated with the rule. See also section VII.A of this preamble, discussing issues pertaining to lifecycle emissions more generally.

K. Additional Non-Monetized Considerations Associated With Benefits and Costs

1. Energy Efficiency Gap

The topic of the ''energy paradox'' or ''energy efficiency gap'' has been extensively discussed in many previous vehicle GHG standards' analyses.[1546] The idea of the energy efficiency gap is that existing technologies that reduce fuel consumption enough to pay for themselves in short periods were not widely adopted, even though conventional economic principles suggest that, because the benefits to vehicle buyers would outweigh the costs to those buyers of the new technologies, automakers would provide

[1529] Mikati, I.; Benson, A.F.; Luben, T.J.; Sacks, J.D.; Richmond-Bryant, J. (2018) Disparities in distribution of particulate matter emission sources by race and poverty status. Am J Pub Health *https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2017.304297?journalCode=ajph.*

[1530] Alotaibi, R.; Bechle, M.; Marshall, J.D.; Ramani, T.; Zietsman, J.; Nieuwenhuijsen, M.J.; Khreis, H. (2019) Traffic related air pollution and the burden of childhood asthma in the continuous United States in 2000 and 2010. Environ International 127: 858–867. *https://www.sciencedirect.com/science/article/pii/S0160412018325388.*

[1531] Tian, N.; Xue, J.; Barzyk. T.M. (2013) Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach. J Exposure Sci Environ Epidemiol 23: 215–222.

[1532] Rowangould, G.M. (2013) A census of the U.S. near-roadway population: public health and environmental justice considerations. Transportation Research Part D; 59–67.

[1533] CDC (2013) Residential proximity to major highways—United States, 2010. Morbidity and Mortality Weekly Report 62(3): 46–50.

[1534] Rowangould, G.M. (2013) A census of the U.S. near-roadway population: public health and environmental justice considerations. Transportation Research Part D; 59–67.

[1535] Pratt, G.C.; Vadali, M.L.; Kvale, D.L.; Ellickson, K.M. (2015) Traffic, air pollution, minority, and socio-economic status: addressing inequities in exposure and risk. Int J Environ Res Public Health 12: 5355–5372. *http://dx.doi.org/10.3390/ijerph120505355.*

[1536] Sohrabi, S.; Zietsman, J.; Khreis, H. (2020) Burden of disease assessment of ambient air pollution and premature mortality in urban areas: the role of socioeconomic status and transportation. Int J Env Res Public Health doi:10.3390/ijerph17041166.

[1537] Aizer A., Currie J. (2019) Lead and Juvenile Delinquency: New Evidence from Linked Birth, School, and Juvenile Detention Records. The Review of Economics and Statistics. 101 (4): 575–587. *https://doi.org/10.1162/rest_a_00814.*

[1538] See 80 FR 64662, 64915–64916 (October 23, 2015).

[1539] U.S. EPA (2023) 2021 Power Sector Programs—Progress Report. *https://www3.epa.gov/airmarkets/progress/reports.*

[1540] U.S. EPA (2023) 2021 Power Sector Programs—Progress Report. *https://www3.epa.gov/airmarkets/progress/reports.*

[1541] Cushing L.J., Li S., Steiger B.B., Casey J.A. (2023) Historical red-lining is associated with fossil fuel power plant siting and present-day inequalities in air pollutant emissions. Nature Energy. 8: 52–61. *https://doi.org/10.1038/s41560-022-01162-y.*

[1542] U.S. EPA (2014). Risk and Technology Review—Analysis of Socio-Economic Factors for Populations Living Near Petroleum Refineries. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. January.

[1543] Carpenter, A., and M. Wagner. Environmental justice in the oil refinery industry: A panel analysis across United States counties. J. Ecol. Econ. V. 159 (2019).

[1544] Gonzalez, J.X., et al. Historic redlining and the siting of oil and gas wells in the United States. J. Exp. Sci. & Env. Epi. V. 33. (2023). p. 76–83.

[1545] In comparison to the national population, the EPA publication reports higher proportions of the following population groups in block groups with higher cancer risk associated with emissions from refineries: ''minority,'' ''African American,'' ''Other and Multiracial,'' ''Hispanic or Latino,'' ''Ages 0–17,'' ''Ages 18–64,'' ''Below the Poverty Level,'' ''Over 25 years old without a HS diploma,'' and ''Linguistic isolations.''

[1546] For two of the most recent examples, see 86 FR 74434, December 30, 2021, ''Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards'' and 85 FR 24174, April 30, 2020, ''The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks,'' and the respective RIAs. Although there are differences between personal consumption and commercial purchases, we have also identified an energy efficiency gap for vehicles used in commercial applications. See 81 FR at 73859–62 (HD Phase 2 rule discussing the gap as it relates to HD vehicles and also discussing related findings in the HD Phase 1 rule).

them and people would buy them. However, as described in previous EPA GHG vehicle rules (most recently in the 2021 rulemaking) engineering analyses identified technologies, such as downsized-turbocharged engines, gasoline direct injection, and improved aerodynamics, where the additional cost of the technology is quickly covered by the fuel savings it provides, but they were not widely adopted until after the issuance of EPA vehicle standards. As explained in detail in previous rulemakings, research suggests the presence of fuel-saving technologies does not lead to adverse effects on other vehicle attributes, such as performance and noise.[1547] Additionally, research shows that there are technologies that exist that provide improvements in both performance and fuel economy, or at least in improved fuel economy without hindering performance.

While evidence exists to substantiate agreement upon the existence of the efficiency gap, there is less agreement on the reasons for its existence and its magnitude. There are a number of hypotheses in the literature that attempt to explain the existence of the energy efficiency gap, including both consumer and producer side reasons.[1548] For example, some researchers posit that consumers take up-front costs into account in purchase decisions more than future fuel savings, consumers may not fully understand potential cost savings, or they may not prioritize fuel consumption in their set of important attributes in the vehicle purchase process. On the producer side, suggested explanations include shifting of priorities from a long-standing product mix to a new product or mix, fixed costs in switching to new technologies and the uncertainty involved in technological innovation and adoption. Broadly, these explanations encompass constraints on access to capital for investment, imperfect or asymmetrical information about the new technology (for example, real-world operational cost savings, durability, or performance), and uncertainty about supporting infrastructure (for example, ease of charging a PEV).

Part of the uncertainty surrounding reasons behind the energy efficiency gap is that most of the technologies applied to existing ICE vehicles were ''invisible'' to the consumer, both literally and also possibly in effect. For example, the technology itself was not something the mainstream consumer would know about, or the technology was applied to a vehicle at the same time as multiple other changes, making it unclear to the consumer what changes in vehicle attributes, if any, could be attributed to a specific technology. At the first purchase of a PEV, the energy efficiency technology is clearly apparent to the consumer (*i.e.,* consumer-facing), in which case the above ''invisibility'' rationale does not apply. However, as PEV technology continues to evolve and as precedent with ICE vehicle technology suggests, technologies that improve PEV efficiency may again become invisible to the consumer, making the value of those improvements less apparent at the time of purchase, even if operating savings are.

Though the energy paradox is likely to persist for the reasons discussed above, including future fuel and electricity prices, uncertainty about charging infrastructure and availability, perceptions of comparisons of quality and durability of different powertrains, and other factors discussed in this section and in RIA Chapter 4.4, there are factors that may mitigate it. Uncertainties will be resolved over time (*e.g.,* growing familiarity with PEVs and EVSE, durability), systems will evolve (*e.g.,* infrastructure growth and expansion, fuel and electricity prices, supply chains), and the nature and balance of information will change Another factor that may reduce the magnitude of an energy efficiency gap are the incentives provided in the BIL and IRA which provide support for the development, production and purchase of PEVs and the supporting infrastructure. For more information, see RIA Chapter 4.4.

2. Safety Impacts

EPA has long considered the safety implications of its emission standards. Section 202(a)(4) of the CAA specifically prohibits the use of an emission control device, system or element of design that will cause or contribute to an unreasonable risk to public health, welfare, or safety. With respect to its light-duty greenhouse gas emission regulations, EPA has historically considered the potential impacts of GHG standards on safety in its light-duty GHG rulemakings.

The potential relationship between GHG emissions standards and safety is multi-faceted, and can be influenced not only by control technologies, but also by consumer decisions about vehicle ownership and use. EPA has estimated the impacts of this rule on safety by accounting for changes in new vehicle purchase, fleet turnover and VMT, and changes in vehicle weight that occur either as an emissions control strategy or as a result of the adoption of emissions control technologies such as vehicle electrification. Safety impacts related to changes in the use of vehicles in the fleet, relative mass changes, and the turnover of fleet to newer and safer vehicles have been estimated and analyzed as part of the standard setting process.

The GHG emissions standards are attribute-based standards, using vehicle footprint as the attribute. 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. The standards are therefore generally based on a vehicle's size: larger vehicles have numerically higher GHG emissions targets and smaller vehicles have numerically lower GHG emissions targets. Footprint-based standards help to distribute the burden of compliance across all vehicle footprints and across all manufacturers. Manufacturers are not compelled to build vehicles of any particular size or type, and each manufacturer has its own fleetwide standard for its car and truck fleets in each year that reflects the light-duty vehicles it chooses to produce. EPA has evaluated the relationship between vehicle footprint and GHG emissions targets and is finalizing GHG standards that are intended to minimize incentives to change footprint as a compliance strategy. EPA is not projecting any changes in vehicle safety due to changes in footprint as a result of this rule.

While EPA has not conducted new studies on the safety implications of electrified vehicles, we have consulted with NHTSA on potential safety issues and they have provided a number of studies to us. NHTSA's Office of Crashworthiness Standards has also informed us that NHTSA is not aware of differences in crash outcomes between electric and non-electric vehicles, although NHTSA is closely monitoring and conducting extensive research on this topic closely. EPA notes there is strong reason to believe that PEVs are at least as safe as ICE vehicles,[1549] if not more so. For example, the PEV architecture often lends itself to the addition of a ''frunk'' or front trunk. The frunk can provide additional crush space and occupant protection in frontal or front offset impacts. In addition, high

[1547] For example, as seen in Figure 3.8 of the 2023 EPA Automotive Trends Report, average new vehicle horsepower has increased by 88 percent since MY 1975. *https://www.epa.gov/system/files/documents/2023-12/420r23033.pdf.*

[1548] Note that the literature surrounding the energy efficiency gap in LD vehicles is based on historical data, which is focused on ICE vehicles.

[1549] *https://www.iihs.org/news/detail/with-more-electric-vehicles-comes-more-proof-of-safety.*

voltage, large capacity batteries are often packaged under the vehicle and are integral to the vehicle construction. The increase in mass low in the vehicle provides additional vehicle stability and could reduce the propensity for vehicle rollover, especially in vehicles with a higher ride height, such as SUVs. In addition, the battery is typically an integral part of the body design and can provide additional side impact protection. For each of these reasons EPA believes that applying the historical relationship between mass and safety is appropriate for this rulemaking and may be conservative given the potential safety improvements provided by vehicle electrification.

Consistent with previous light-duty GHG analyses, EPA conducted a quantitative assessment of the potential of the standards to affect vehicle safety. EPA applied the same historical relationships between mass, size, and fatality risk that were established and documented in NHTSA's 2023 proposed rulemaking. These relationships are based on the statistical analysis of historical crash data, which included an analysis performed by using the most recently available crash studies based on data for model years 2007 to 2011. EPA used these findings to estimate safety impacts of the modeled adoption of mass reduction as technology to reduce emissions, and the adoption of PEVs that result in some vehicle weights that are higher than comparable ICE vehicles due to the addition of the battery. Based on the findings of our safety analysis, we concluded there are no changes to the vehicles themselves, nor the combined effects of fleet composition and vehicle design, that will have a statistically significant impact on safety.[1550] The only fatality projections presented here that are statistically significant are due to changes in use (VMT) rather than changes to the vehicles themselves. When including non-significant effects, EPA estimates that the final standards have no impact on the annual fatalities per billion miles driven in the 27-year period from 2027 through 2055 (4.599 fatalities per billion miles under both the final standards and the No Action case.)

EPA has also estimated, over the same 27-year period, that total fatalities will increase by 2,602, with all of those attributed to increased driving. Our analysis projects that there will be an increase in vehicle miles traveled (VMT) under the standards of 567 billion miles compared to the No Action case in 2027 through 2055 (an increase of under 0.6 percent). As noted, the only statistically significant changes in the fatalities projected are the result from the projected increased driving—*i.e.,* people choosing to drive more due to the lower operating costs of more efficient vehicles. Our cost-benefit analysis accounts for the value of this additional driving, which we assume is an important consideration in the decision to drive.

On the whole, EPA considers safety impacts in the context of all projected health impacts from the rule including public health benefits from the projected reductions in air pollution. Considering these estimates in the context of public health benefits anticipated from the final standards, EPA notes that the estimated annualized value of monetized health benefits of reduced $PM_{2.5}$ through 2055 is between $3.6 billion and $10 billion (depending on study and discount rate), and that the air quality modeling which, as discussed further in Chapter 7.5 of the RIA, assesses a regulatory scenario with lower rates of PEV penetration than EPA is projecting for the final rule, estimates that in 2055 such a scenario would prevent between 1,000 and 2,000 premature deaths associated with exposure to $PM_{2.5}$ and prevent between 25 and 550 premature deaths associated with exposure to ozone. By comparison, the safety analysis estimates 118 more highway fatalities in calendar year 2055, far fewer than the decrease estimated from exposure to $PM_{2.5}$. We expect that the cumulative number of premature deaths avoided that would occur during the entire period from 2027 to 2055 would be much larger than the estimate of deaths avoided projected to occur in 2055.

3. Other Non-Monetized Considerations

In addition to the energy paradox, safety, and the effects that we monetize, we also look more closely into, but do not monetize, the effects of the standards on low-income households, on consumers of low-priced new vehicles and used vehicles, and on PEV consumers without access to home or work charging. These effects depend, in large part, on three elements of vehicle ownership, namely (a) the purchase prices of vehicles, (b) fueling expenditures, and (c) maintenance and repair. Typically, the introduction of more stringent standards leads to higher purchase prices and lower fuel expenditures, on average. These standards also yield reductions on average in vehicle maintenance and repair costs, especially among buyers of PEVs. The net effect varies across households. Regarding purchase price, the IRA provides tax credits for both new and used PEVs. The reduction in fuel expenditures may be especially beneficial for low-income households and consumers in the used and low-priced new vehicle markets. First, fuel expenditures are a larger portion of expenses for low-income households compared to higher income households. Second, lower-priced new vehicles have historically been more fuel efficient. Third, fuel economy and therefore fuel savings do not decline as vehicles age even though the price paid for vehicles typically declines as vehicles age and are resold. Fourth, low-income households are more likely to purchase lower-priced new vehicles and used vehicles, capturing their associated fuel savings.[1551] In addition, savings on maintenance and repair costs may also be especially beneficial for consumers in the used vehicle market. Finally, EPA expects that automakers will continue to produce a wide variety of vehicles, including price points, technologies, and body styles, to satisfy diverse vehicle consumers.

Furthermore, for many vehicle consumers, access to credit for vehicle purchases is essential and may be of particular concern for low-income households. The effects of the standards on access to credit is influenced by the potentially countervailing forces of vehicle purchase costs and fuel costs. However, the degree of influence and the net effect is not clear (see RIA Chapter 8.4.3 of the 2021 rule). Increased purchase prices and presumably higher loan principal may, in some cases, discourage lending, while reduced fuel expenditures may, in some cases, improve lenders' perceptions of borrowers' repayment reliability.

Finally, while access to gasoline and diesel can be assumed for the most part, the number and density of charging stations varies considerably.[1552] Public and private charging infrastructure has been expanding alongside PEV adoption and is generally expected to continue to grow, particularly in light of public and private investments and consistent with local level priorities.[1553] [1554] This

[1550] None of the mass-safety coefficients that were developed for the 2020 and 2021 Rulemakings are statistically significant at the 95th percentile confidence level. EPA is including the presentation of non-significant changes in fatality rate here for the purpose of comparison with previous rulemaking assessments.

[1551] Hutchens, A., Cassidy, A., Burmeister, G., Helfand, G. (2021). ''Impacts of Light-Duty Greenhouse Gas Emission Standards on Vehicle Affordability.''

[1552] *https://afdc.energy.gov/fuels/electricity_locations.html,* accessed 3/8/2022.

[1553] Bui, Anh, Peter Slowik, and Nic Lutsey. 2020. Update on electric vehicle adoption across U.S.

includes home charging events, which are likely to continue to grow with PEV adoption but are also expected to represent a declining proportion of charging events as PEV share increases and more drivers without easy access to home charging adopt PEVs and therefore use public charging.[1555] Thus, publicly accessible charging is an important consideration, especially for some renters and among residents of multi-family housing and others who charge away from home.[1556] Households without access to charging at home or the workplace may incur additional charging costs, though there is ongoing interest in and development of alternative charging solutions (*e.g.,* curbside charging or use of mobile charging units) and business models (*e.g.,* providing charging as an amenity or as a subscription service for multi-family housing).[1557] Though the higher price of public charging is important, especially among consumers who rely upon public charging, improvements in access and availability to both public and private charging are expected, bolstered by private and public investment in charging infrastructure, including the recent Federal investments provided by the CHIPS Act, the BIL and the IRA, which will allow for increased investment along the vehicle supply chain, including charging infrastructure.[1558] Please see section IV.C.4 of this preamble and Chapter 5 of the RIA for a more detailed discussion of public and private investments in charging infrastructure, and our assessment of infrastructure needs and costs under this rulemaking.

IX. Statutory and Executive Order Reviews

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 14094: Modernizing Regulatory Review

This action is a ''significant regulatory action,'' as defined under section 3(f)(1) of Executive Order 12866, as amended by Executive Order 14094. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for Executive Order 12866 review. Documentation of any changes made in response to the Executive Order 12866 review is available in the docket. EPA prepared an analysis of the potential costs and benefits associated with this action. This analysis is in the Regulatory Impact Analysis, which can be found in the docket for this rule and is briefly summarized in section VIII of this preamble.

B. Paperwork Reduction Act (PRA)

The information collection activities in this rule have been submitted for approval to the Office of Management and Budget (OMB) under the PRA. The Information Collection Request (ICR) document that EPA prepared has been assigned EPA ICR number 2750.02. You can find a copy of the ICR in the docket for this rule, and it is briefly summarized here. The information collection requirements are not enforceable until OMB approves them.

The Agency is adopting 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 CAA requires that vehicle manufacturers provide information the Administrator may reasonably require to determine compliance with the regulations; submission of the information is therefore mandatory. We will consider confidential all information meeting the requirements of section 208(c) of the CAA for confidentiality.

Many of the information activities associated with the rule are covered by existing emission certification and reporting requirements for EPA's light-duty and medium-duty vehicle emission control program. Therefore, this ICR only covers the incremental burden associated with the updated regulatory requirements as described in this rule.

The total annual reporting burden associated with this rule is about 40,136 hours and $(6,213) million, based on a projection of 35 respondents. The estimated burden for vehicle manufacturers is a total estimate for new reporting requirements incremental to the current program. 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; modify existing technology and systems for the purposes of collecting, validating, and verifying newly required 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.

Respondents/affected entities: Light- and medium-duty vehicle manufacturers, alternative fuel converters, and independent commercial importers.

Respondent's obligation to respond: Manufacturers must respond as part of their annual model year vehicle certification under section 208(a) of the CAA which is required prior to entering vehicles into commerce. Participation in some programs is voluntary; but once a manufacturer has elected to participate, it must submit the required information.

Estimated number of respondents: 35.

Frequency of response: Annually or on occasion, depending on the type of response.

Total estimated burden: 40,136 hours (per year). Burden is defined at 5 CFR 1320.3(b).

Total estimated cost: $(6,212,838) per year, which is a net burden reduction because the total new burden measures are offset by burden reduction measures and reduced light- and medium duty vehicle testing and reporting due to the switch from ICE to EVs. The total estimated cost includes an estimated $(6,483,593) annualized capital or operation & maintenance cost savings.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are listed in 40 CFR part 9. When OMB approves this ICR, the Agency will announce that approval in the **Federal Register** and publish a technical amendment to 40 CFR part 9 to display the OMB control

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cities. International Council on Clean Transportation. *https://theicct.org/wp-content/uploads/2021/06/EV-cities-update-aug2020.pdf.*

[1554] Greschak, Tressa, Matilda Kreider, and Nathan Legault. 2022. ''Consumer Adoption of Electric Vehicles: An Evaluation of Local Programs in the United States.'' School for Environment and Sustainability, University of Michigan, Ann Arbor, MI. *https://deepblue.lib.umich.edu/handle/2027.42/172221.*

[1555] Ge, Yanbo, Christina Simeone, Andrew Duvall, and Andrew Wood. 2021. There's No Place Like Home: Residential Parking, Electrical Access, and Implications for the Future of Electric Vehicle Charging Infrastructure. NREL/TP–5400–81065, Golden, CO: National Renewable Energy Laboratory. *https://www.nrel.gov/docs/fy22osti/81065.pdf.*

[1556] *https://advocacy.consumerreports.org/wp-content/uploads/2022/09/EV-Demographic-Survey-English-final.pdf.*

[1557] Matt Alexander, Noel Crisostomo, Wendell Krell, Jeffrey Lu, Raja Ramesh, ''Assembly Bill 2127: Electric Vehicle Charging Infrastructure Assessment,'' July 2021, California Energy Commission. Accessed March 9, 2023, at *https://www.energy.ca.gov/programs-and-topics/programs/electric-vehicle-charging-infrastructure-assessment-ab-2127.*

[1558] More information on these three acts can be found in the January, 2023 White House publication ''Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action.'' found online at *https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf.*

number for the approved information collection activities contained in this final rule.

C. Regulatory Flexibility Act

I certify that this action will not have a significant economic impact on a substantial number of small entities (SISNOSE) under the Regulatory Flexibility Act (RFA).

EPA has focused its assessment of potential small business impacts on three key aspects of the standards, including GHG emissions standards, criteria pollutant standards (including $NMOG+NO_X$ fleet-average standards and PM emissions standards), and EV battery warranty and durability. Details of EPA's No SISNOSE assessment are included in RIA Chapter 11.

There are three types of small entities under the RFA that could potentially be impacted by the GHG standards: (1) small entity vehicle manufacturers; (2) alternative fuel converters, which are companies that take a vehicle for which an OEM has already accounted for GHG compliance and convert it to operate on a cleaner fuel such as natural gas or propane; and (3) independent commercial importers (ICIs), which are firms that import vehicles from other countries for individual vehicle purchasers.

Under the current light-duty GHG program, small entities are exempt from the GHG standards. EPA is continuing the current exemption for all three types of small entities, including small entity manufacturers, alternate fuel converters, and ICIs. In contrast, current regulations require small entities making new medium-duty vehicles to meet the same GHG emission standards that apply for other companies. In this rule, we are not adopting new or revised GHG emission standards for medium-duty vehicles for small entities. As a result, medium-duty vehicles produced by small entities will continue to be subject to the MY 2026 standards indefinitely, instead of being subject to the new GHG emission standards for MY 2027 and later vehicles that we are adopting in this rule. However, EPA is finalizing its proposal to add some environmental protections for imported vehicles, as described below in this paragraph. EPA is continuing the current provision allowing small entity manufacturers to opt into the GHG program to earn credits, which they can then choose to sell in the credit market. The small entity vehicle manufacturers in the market at this time produce only electric vehicles. EPA received comments that there were small entity manufacturers that made internal combustion engine vehicles. EPA had previously reviewed those entities and determined that they did not qualify for consideration under the RFA (for further details see the Response to Comments document.) EPA requested comment on the potential need for small entity light-duty and medium-duty manufacturers to have an annual production cap (*e.g.,* 200–500 vehicles per year) on vehicles eligible for the exemption. EPA noted that this cap could be an important environmental safeguard. It balances eliminating GHG compliance burdens for small manufacturers with safeguards to avoid undermining the environmental benefits of the standards. A group of small OEMs opposed the imposition of such a cap, although the group did not provide data or explanation as to why such a cap would not be a reasonable means of ensuring environmental benefits without restricting small manufacturers from producing volumes consistent with what they have produced in the past. EPA is finalizing an annual limit of the first 500 vehicles produced by a small business being exempted from the light- and medium-duty GHG standards.

Under existing EPA regulations, each ICI is currently limited to importing 50 vehicles per year. EPA is finalizing, as proposed, a reduced limit of 25 vehicles per year, which is well above historical sales, as a means of limiting the potential environmental impact of importing vehicles with potentially high GHG emissions. Importing of BEVs and fuel cell vehicles would not count against the 25 vehicles limit. EPA believes this lower vehicle limit is important for capping the potential for high-emitting imported vehicles, because unlike with criteria pollutant emissions, there are very limited add-on emissions control options for reducing the GHG emissions of an imported vehicle. To ease the burden required for ICIs to certify electric vehicles, EPA is finalizing its proposal to remove the requirement that the vehicle have a fuel economy label. Production electric vehicles do not normally have high voltage wiring accessible, so it is not practical for ICIs to measure the energy in and out of the battery, which is necessary when measuring energy for the fuel economy label.

EPA also has evaluated the potential impacts on small businesses for criteria pollutant emissions standards, including both the $NMOG+NO_X$ standard and the PM standard. EPA's $NMOG+NO_X$ standards should have no impact on the existing RFA qualified small entity manufacturers, which currently produce only electric vehicles. The standards are expected to have minimal impact on both the alternate fuel converters and ICIs, as discussed in RIA Chapter 11. EPA estimates that the PM standard will have no significant financial impact on any of the three types of RFA qualified small entities. Existing small entity manufacturers all produce only battery electric vehicles, which have no tailpipe emissions and therefore would be able to comply with the PM standard without any additional burden. Alternative fuel vehicles are exempted from cold temperature testing requirements under existing EPA regulations, and EPA is continuing this exemption for the final rule; as such there is no impact on alternative fuel converters. To minimize the testing burden on ICIs, EPA is finalizing the exemption for ICIs from measuring PM during cold testing; ICIs would only need to comply with the new PM levels on the FTP75 and US06 tests. EPA also notes that it is finalizing an extended phase-in for ICI's in meeting the new $NMOG+NO_X$ and PM standards.

The final aspect of the final rule that could have potential impacts on small entities is battery durability (section III.G.2 of the preamble). EPA finds it appropriate to exempt small entities from battery durability requirements at this time while we implement the requirement for larger manufacturers. Based on our experience with larger manufacturers we will be in a better position to judge whether the requirements are appropriate to extend to smaller manufacturers in a future rulemaking.

D. Unfunded Mandates Reform Act

This action contains Federal mandates under UMRA, 2 U.S.C. 1531–1538, that may result in expenditures of $100 million or more for state, local, and Tribal governments, in the aggregate, or the private sector in any one year. Accordingly, EPA has prepared a written statement of the costs and benefits associated with this action as required under section 202 of UMRA. This is discussed in section VIII of this preamble and Chapter 10 of the RIA. This action is not subject to the requirements of section 203 of UMRA because it contains no regulatory requirements that might significantly or uniquely affect small governments.

E. Executive Order 13132: ''Federalism''

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

F. Executive Order 13175: ''Consultation and Coordination With Indian Tribal Governments''

This action does not have tribal implications as specified in Executive Order 13175. Thus, Executive Order 13175 does not apply to this action. However, EPA has engaged with our Tribal stakeholders in the development of this rulemaking by offering a Tribal workshop and offering government-to-government consultation upon request.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

This action is subject to Executive Order 13045 because it is a significant regulatory action under section 3(f)(1) of Executive Order 12866, and EPA believes that the environmental health or safety risks of the pollutants addressed by this action may have a disproportionate effect on children. The 2021 Policy on Children's Health also applies to this action.[1559] Accordingly, we have evaluated the environmental health or safety effects of air pollutants affected by this final rule on children. The results of this evaluation are described in section II of this preamble. The protection offered by these standards may be especially important for children because childhood represents a life stage associated with increased susceptibility to air pollutant-related health effects.

Children make up a substantial fraction of the U.S. population, and often have unique factors that contribute to their increased risk of experiencing a health effect from exposures to ambient air pollutants because of their continuous growth and development. Children are more susceptible than adults to many air pollutants because they have (1) a developing respiratory system, (2) increased ventilation rates relative to body mass compared with adults, (3) an increased proportion of oral breathing, particularly in boys, relative to adults, and (4) behaviors that increase chances for exposure. Even before birth, the developing fetus may be exposed to air pollutants through the mother that affect development and permanently harm the individual when the mother is exposed.

GHG emissions contribute to climate change and the GHG emissions reductions described in section VI of this preamble resulting from this rule will contribute to mitigation of climate change. The assessment literature cited in EPA's 2009 and 2016 Endangerment Findings concluded that certain populations and life stages, including children, the elderly, and the poor, are most vulnerable to climate-related health effects. The assessment literature since 2016 strengthens these conclusions by providing more detailed findings regarding these groups' vulnerabilities and the projected impacts they may experience. These assessments describe how children's unique physiological and developmental factors contribute to making them particularly vulnerable to climate change. Impacts to children are expected from heat waves, air pollution, infectious and waterborne illnesses, and mental health effects resulting from extreme weather events. In addition, children are among those especially susceptible to most allergic diseases, as well as health effects associated with heat waves, storms, and floods. Additional health concerns may arise in low-income households, especially those with children, if climate change reduces food availability and increases prices, leading to food insecurity within households. More detailed information on the impacts of climate change to human health and welfare is provided in section II of this preamble.

In addition to reducing GHGs, this final rule will also reduce onroad emissions of criteria pollutants and air toxics. section VII of this preamble presents the estimated onroad emissions reductions from the rule. Certain motor vehicle emissions present greater risks to children. Early lifestages (*e.g.,* children) are thought to be more susceptible to tumor development than adults when exposed to carcinogenic chemicals that act through a mutagenic mode of action.[1560] Exposure at a young age to these carcinogens could lead to a higher risk of developing cancer later in life. Section II.C.8 of this preamble describes a systematic review and meta-analysis conducted by the U.S. Centers for Disease Control and Prevention that reported a positive association between proximity to traffic and the risk of leukemia in children. Also, section II.C.8 of this preamble discusses a number of childhood health outcomes associated with proximity to roadways, including evidence for exacerbation of asthma symptoms and suggestive evidence for new onset asthma.

In addition to reduced onroad emissions of criteria pollutants and air toxics, we expect the rule will also lead to reductions in petroleum-sector emissions and increases in pollutant emissions from EGUs (see section VII of the preamble). As described in section II of this preamble, the Integrated Science Assessments for a number of pollutants affected by this rule, including those for SO_2, NO_2, PM, ozone and CO, describe children as a group with greater susceptibility.

There is substantial evidence that people who live or attend school near major roadways are more likely to be people of color, Hispanic ethnicity, and/or low socioeconomic status. Analyses of communities in close proximity to sources such as EGUs and refineries have also found that a higher percentage of communities of color and low-income communities live near these sources when compared to national averages. Within these highly exposed groups, children's exposure and susceptibility to health effects is greater than adults due to school-related and seasonal activities, behavior, and physiological factors.

Children are not expected to experience greater ambient concentrations of air pollutants compared to the general population. However, because of their greater susceptibility to air pollution, including the impacts of a changing climate, and their increased time spent outdoors, it is likely that these standards will have particular benefits for children's health.

H. Executive Order 13211: Energy Effects

This action is not a ''significant energy action'' because it is not likely to have a significant adverse effect on the supply, distribution, or use of energy. EPA has outlined the energy effects in Table 8–8 in Chapter 8 of the RIA, which is available in the docket for this action and is briefly summarized here.

This action reduces CO_2 emissions for light-duty and medium-duty vehicles under revised GHG standards, which will result in significant reductions of the consumption of petroleum, increase electricity consumption, achieve energy security benefits, and have no adverse energy effects. Because the GHG emission standards result in significant fuel savings, this rule encourages more efficient use of fuels. As shown in Table 8–8 in the RIA, EPA projects that through 2055 these standards will result in a reduction of 780 billion gallons of retail gasoline consumption (about 15 billion barrels of oil) and an increase of

[1559] U.S. Environmental Protection Agency (2021). 2021 Policy on Children's Health. Washington, DC. *https://www.epa.gov/system/files/documents/2021-10/2021-policy-on-childrens-health.pdf.*

[1560] U.S. Environmental Protection Agency (2005). Supplemental guidance for assessing susceptibility from early-life exposure to carcinogens. Washington, DC: Risk Assessment Forum. EPA/630/R–03/003F. *https://www3.epa.gov/airtoxics/childrens_supplement_final.pdf.*

6,100 Terawatt hours (TWh) of electricity consumption. As discussed in section IV.C.5 of this preamble, we do not expect the increased electricity consumption under this rule to have significant adverse impacts on the electric grid.

I. National Technology Transfer and Advancement Act (NTTAA) and 1 CFR Part 51

This rulemaking involves technical standards. Except for the standards discussed in this section, the standards included in the regulatory text as incorporated by reference were all previously approved for incorporation by reference (IBR) and no change is included in this action.

In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference the use of standards and test methods from the California Air Resources Board (CARB). The referenced standards and test methods may be obtained through the CARB website (*www.arb.ca.gov*) or by calling (916) 322–2884. We are incorporating by reference the following CARB documents:

Standard or test method	Regulation	Summary
CARB's 2022 OBD regulation—13 CCR 1968.2, Malfunction and Diagnostic System Requirements—2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines; operative November 22, 2022.	40 CFR 86.1 and 86.1806–27 ..	The CARB standards establish updated requirements for manufacturers to design their light-duty and medium-duty vehicles with onboard diagnostic systems that detect malfunctions in emission controls. This is a newly referenced standard.
California 2026 and Subsequent Model Year Criteria Pollutant Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, And Medium-Duty Vehicles (''CARB's LMDV Test Procedures''); adopted August 25, 2022.	40 CFR 1066.801 and 1066.1010.	The CARB regulation establishes test procedures for measuring emissions from light-duty and medium-duty vehicles that are not plug-in hybrid electric vehicles. This is a newly referenced standard.
California Test Procedures for 2026 and Subsequent Model Year Zero-Emission Vehicles and Plug-In Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes (''CARB's PHEV Test Procedures''); adopted August 25, 2022.	40 CFR 1066.801 and 1066.1010.	The CARB regulation establishes test procedures for measuring emissions from plug-in hybrid electric vehicles. This is a newly referenced standard.
CARB's battery durability standards—13 CCR 1962.5 Data Standardization Requirements for 2026 and Subsequent Model Year Light-Duty Zero Emission Vehicles and Plug-in Hybrid Electric Vehicles; operative November 30, 2022.	40 CFR 86.1 and 86.1815–27 ..	The CARB regulation describes a standardized protocol for retrieving and evaluating data related to monitor accuracy and battery durability for electric vehicles and plug-in hybrid electric vehicles. This is a newly referenced standard.
CARB's battery durability standards—13 CCR 1962.7 In-Use Compliance, Corrective Action and Recall Protocols for 2026 and Subsequent Model Year Zero-Emission and Plug-in Hybrid Electric Passenger Cars and Light-Duty Trucks; operative November 30, 2022.	40 CFR 86.1 and 86.1815–27 ..	The CARB regulation establishes performance requirements and testing procedures related to monitor accuracy and battery durability for electric vehicles and plug-in hybrid electric vehicles. This is a newly referenced standard.

In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference the use of standards and test methods from the United Nations. The referenced standards and test methods may be obtained from the UN Economic Commission for Europe, Information Service at Palais des Nations, CH–1211 Geneva 10, Switzerland; *unece_info@un.org; www.unece.org.* We are incorporating by reference the following UN Economic Commission for Europe document:

Standard or test method	Regulation	Summary
Addendum 22: United Nations Global Technical Regulation No. 22, United Nations Global Technical Regulation on In-vehicle Battery Durability for Electrified Vehicles, April 14, 2022.	40 CFR 86.1 and 86.1815–27 ..	GTR No. 22 establishes design protocols and procedures for measuring durability and performance for batteries used with electric vehicles and plug-in hybrid-electric vehicles.

In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference the use of standards and test methods from SAE International. The referenced standards and test methods may be obtained from SAE International, 400 Commonwealth Dr., Warrendale, PA 15096–0001, (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada), or *www.sae.org.* We are incorporating by reference the following documents from SAE International:

Standard or test method	Regulation	Summary
SAE J1711 FEB2023, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles, revised February 2023.	40 CFR 86.1, 86.1866–12, 600.011, 600.114–12, 600.116–12, 600.311–12, 1066.501, and 1066.1010.	This updated document specifies emission measurement procedures for hybrid electric vehicles.
SAE J2727 SEP2023, Mobile Air Conditioning System Refrigerant Emissions Estimate for Mobile Air Conditioning Refrigerants, revised September 2023.	40 CFR 86.1, 86.1819–14, 86.1867–12, and 86.1867–31.	This updated document describes a methodology for calculating leakage rates from automotive air conditioning systems.
SAE J2807 FEB2020, Performance Requirements for Determining Tow-Vehicle Gross Combination Weight Rating and Trailer Weight Rating, revised February 2020.	40 CFR 86.1 and 86.1845–04 ..	This newly referenced document includes specifications for trailers and describes how to determine a vehicle's gross combination weight rating.

In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference the use of standards and test methods from ASTM International. The referenced standards and test methods may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (610) 832–9585, or *www.astm.org.* We are incorporating by reference the following standards from ASTM International:

Standard or test method	Regulation	Summary
ASTM D86–23, Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure, approved March 1, 2023.	40 CFR 600.011 and 600.113–12.	This newly referenced standard describes procedures for measuring fuel distillation parameters.
ASTM D1319–20a, Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption, approved August 1, 2020.	40 CFR 600.011 and 600.113–12.	This newly referenced standard describes procedures for measuring aromatic content of gasoline.
ASTM D3338/D3338M–20a, Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels, approved December 1, 2020.	40 CFR 600.011 and 600.113–12.	This updated standard describes procedures for measuring the net heat of combustion for gasoline.
ASTM D3343–22, Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels, approved November 1, 2022.	40 CFR 600.011 and 600.113–12.	This updated standard describes procedures for measuring the hydrogen and carbon mass fractions of gasoline.
ASTM D4052–22, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter, approved May 1, 2022.	40 CFR 600.011 and 600.113–12.	This newly referenced standard describes procedures for measuring the specific gravity of gasoline.
ASTM D4815–22, Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography, approved April 1, 2022.	40 CFR 600.011 and 600.113–12.	This newly referenced standard describes procedures for measuring ethanol concentrations in gasoline.
ASTM D5599–22, Standard Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection, approved April 1, 2022.	40 CFR 600.011 and 600.113–12.	This newly referenced standard describes procedures for measuring ethanol concentrations in gasoline.
ASTM D5769–22, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry, approved July 1, 2022.	40 CFR 600.011 and 600.113–12.	This newly referenced standard describes procedures for measuring aromatic content of gasoline.

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations and Executive Order 14096: Revitalizing Our Nation's Commitment to Environmental Justice for All

EPA believes that the human health or environmental conditions that exist prior to this action result in or have the potential to result in disproportionate and adverse human health or environmental effects on communities with environmental justice concerns.

EPA provides a summary of the evidence for potentially disproportionate and adverse effects among various populations analyzed prior to implementation of the action in sections II.C.8, VII.D, and VIII.J of the preamble for this rule.

EPA believes that this action is likely to reduce existing disproportionate and adverse effects on many communities with environmental justice concerns. The air pollutant emission reductions that will be achieved by this rule will improve air quality for the people who reside in close proximity to major roadways and who are disproportionately represented by people of color and people with low income, as described in section II.C.8 and section VIII.J of this preamble. We expect that localized increases in criteria and toxic pollutant emissions from EGUs and reductions in petroleum-sector emissions could lead to changes in exposure to these pollutants for people living in the communities near these facilities. Analyses of communities in close proximity to these sources (such as EGUs and refineries) have found that a higher percentage of communities of color and low-income communities live near these sources when compared to national averages.

Section VIII.J.2 of this preamble discusses the environmental justice issues associated with climate change. People of color, low-income populations and/or indigenous peoples may be especially vulnerable to the impacts of climate change. The GHG emission reductions from this action will contribute to efforts to reduce the probability of severe impacts related to climate change.

EPA is additionally identifying and addressing environmental justice concerns by providing just treatment and meaningful involvement with Environment Justice groups in developing this action and soliciting input for this rulemaking.

The information supporting this impacts review is contained in sections II.C.8, VII.D, and VIII.J of the preamble for this rule, and all supporting documents have been placed in the public docket for this action.

K. Congressional Review Act (CRA)

This action is subject to the CRA, and EPA will submit a rule report to each House of Congress and to the Comptroller General of the United States. This action meets the criteria set forth in 5 U.S.C. 804(2).

L. Judicial Review

This final action is ''nationally applicable'' within the meaning of CAA section 307(b)(1) because it is expressly listed in the section (*i.e.,* ''any standard under section [202] of this title''). Under section 307(b)(1) of the CAA, petitions for judicial review of this action must be filed in the U.S. Court of Appeals for the District of Columbia Circuit within 60 days from the date this final action is published in the **Federal Register**. Filing a petition for reconsideration by the Administrator of this final action does not affect the finality of the action for the purposes of judicial review, nor does it extend the time within which a petition for judicial review must be filed and shall not postpone the effectiveness of such rule or action.

M. Severability

This final rule includes new and revised requirements for numerous provisions under various aspects of the highway on-road emission control program, including revised standards for both criteria pollutants and GHG, test procedures, emission-related warranty, and other requirements. Therefore, this final rule is a multifaceted rule that addresses many separate things for independent reasons, as detailed in each respective portion of this preamble. We intend each portion of this rule to be severable from each other, though we took the approach of including all the parts in one rulemaking rather than promulgating multiple rules to ensure the changes are properly coordinated, even though the changes are not inter-dependent. We have noted the independence of various pieces of this package both in the proposal and in earlier sections of the preamble but we reiterate it here for clarity.

For example, as EPA noted in the proposal, although we are coordinating the GHG and criteria pollutant standards we are setting in this rulemaking, and although some of the available control technologies for GHG also control criteria pollutants, we are establishing GHG standards separately (*i.e.,* for separate reasons based on a separate assessment of available control technologies and their feasibility in light of lead time and cost), from the standards we are setting for criteria pollutants. Furthermore, although EPA believes it is appropriate to offer a small A/C credit to encourage low GWP refrigerants and the low leakage designs, EPA does not consider the small A/C credit as integral to selection of the GHG standards. Similarly, although EPA is establishing both light-duty and medium-duty standards in this rulemaking, these are based on distinct statutory authorities (applicable based on the vehicle and pollutant). The two sets of standards are set with consideration of these statutory authorities and the distinct purposes of these classes of vehicles. Even within these classes, EPA notes that our judgments regarding feasibility of the standards for earlier years largely reflect anticipated changes in the motor vehicle market (which are driven by other factors, such as the IRA, consumer demand and manufacturers' global market plans), while our judgment regarding feasibility of the standards in later years reflects those trends plus the additional lead time for further adoption of control technologies. Accordingly, EPA finds that the standards for each individual year are severable from standards for each of the other years.

Finally, EPA notes that there are a host of issues which are significant for implementation of any standards. For example, EPA is making changes to compliance testing (including requirements for fuels) and other certification procedures, as well as establishing battery durability and battery warranty provisions. Each of these issues has been considered and adopted independently of the level of the standards, and indeed of each other.

Thus, EPA has independently considered and adopted each of these portions of the final rule (including but not limited to the standards for LD GHG, LD NMOG+NO_X, LD PM, LD CO, LD HCHO, MD GHG, MD NMOG+NO_X, MD PM, MD CO, MD HCHO; in-use standards for high-GCWR MDV; trading and A/C credits; compliance testing and certification procedures; battery durability; and battery warranty) and each is severable should there be judicial review. If a court were to invalidate any one of these elements of the final rule, we intend the remainder of this action to remain effective, as we have designed the program to function sensibly and find each portion appropriate even if one or more other parts of the rule has been set aside. For example, if a reviewing court were to invalidate any of the criteria or GHG standards, we intend the other regulatory amendments, including not only the other pollutant standards but also the changes to certification procedures, and battery durability and warranty, to remain effective. Moreover, this list is not intended to be exhaustive, and should not be viewed as an intention by EPA to consider other parts of the rule not explicitly listed here as not severable from other parts of the rule.

X. Statutory Provisions and Legal Authority

Statutory authority for this final rule is found at 42 U.S.C. 7401–7675 and 49 U.S.C. 32901–32919q.

List of Subjects

40 CFR Part 85

Environmental protection, Confidential business information, Greenhouse gases, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 86

Environmental protection, Administrative practice and procedure, Confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 600

Environmental protection, Administrative practice and procedure, Electric power, Fuel economy, Incorporation by reference, Labeling, Reporting and recordkeeping requirements.

40 CFR Part 1036

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Greenhouse gases, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1037

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1066

Environmental protection, Air pollution control, Incorporation by reference, Reporting and recordkeeping requirements.

40 CFR Part 1068

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements, Warranties.

Michael S. Regan,

Administrator.

For the reasons set out in the preamble, EPA is amending title 40, chapter I of the Code of Federal Regulations as set forth below.

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.

■ 2. Amend § 85.505 by revising paragraph (f) to read as follows:

§ 85.505 Overview.

* * * * *

(f) If you have previously used small volume conversion manufacturer or qualified small volume test group/engine family procedures and you may exceed the volume thresholds using the sum described in § 85.535(f) to determine small volume status in 40 CFR 86.1838–01 or 1036.150(d), as appropriate, you must satisfy the requirements for conversion manufacturers who do not qualify for small volume exemptions or your exemption from tampering is no longer valid.

* * * * *

■ 3. Revise and republish § 85.510 to read as follows:

§ 85.510 Exemption provisions for new and relatively new vehicles/engines.

(a) You are exempted from the tampering prohibition with respect to new and relatively new vehicles/engines if you certify the conversion system to the emission standards specified in § 85.525 as described in paragraph (b) in this section; you meet the labeling and packaging requirements in § 85.530 before you sell, import or otherwise facilitate the use of a clean alternative fuel conversion system; and you meet the liability, recordkeeping, and end of year reporting requirements in § 85.535.

(b) Certification under this section must be based on the certification procedures such as those specified in 40 CFR part 86, subparts A, B, and S, and 40 CFR part 1065, as applicable, subject to the following exceptions and special provisions:

(1) Test groups and evaporative/refueling families for light-duty and heavy-duty chassis certified vehicles.

(i) Small volume conversion manufacturers and qualified small volume test groups.

(A) If criteria for small volume manufacturer or qualified small volume test groups are met as defined in 40 CFR 86.1838–01, you may combine light-duty vehicles or heavy-duty vehicles which can be chassis certified under 40 CFR part 86, subpart S using good engineering judgment into conversion test groups if the following criteria are satisfied instead of those specified in 40 CFR 86.1827–01.

(*1*) Same OEM and OEM model year.

(*2*) Same OBD group.

(*3*) Same vehicle classification (*e.g.,* light-duty vehicle, heavy-duty vehicle).

(*4*) Engine displacement is within 15% of largest displacement or 50 CID, whichever is larger.

(*5*) Same number of cylinders or combustion chambers.

(*6*) Same arrangement of cylinders or combustion chambers (*e.g.,* in-line, v-shaped).

(*7*) Same combustion cycle (*e.g.,* two stroke, four stroke, Otto-cycle, diesel-cycle).

(*8*) Same engine type (*e.g.,* piston, rotary, turbine, air cooled vs. water cooled).

(*9*) Same OEM fuel type (except otherwise similar gasoline and E85 flexible-fuel vehicles may be combined into dedicated alternative fuel vehicles).

(*10*) Same fuel metering system (*e.g.,* throttle body injection vs. port injection).

(*11*) Same catalyst construction (*e.g.,* metal vs. ceramic substrate).

(*12*) All converted vehicles are subject to the most stringent emission standards used in certifying the OEM test groups within the conversion test group.

(B) EPA-established scaled assigned deterioration factors for both exhaust and evaporative emissions may be used for vehicles with over 10,000 miles if the criteria for small volume manufacturer or qualified small volume test groups are met as defined in 40 CFR 86.1838–01. This deterioration factor will be adjusted according to vehicle or engine miles of operation. The deterioration factor is intended to predict the vehicle's emission levels at the end of the useful life. EPA may adjust these scaled assigned deterioration factors if we find the rate of deterioration non-constant or if the rate differs by fuel type.

(C) As part of the conversion system description provided in the application for certification, conversion manufacturers using EPA assigned deterioration factors must present detailed information to confirm the durability of all relevant new and existing components and to explain why the conversion system will not harm the emission control system or degrade the emissions.

(ii) Conversion evaporative/refueling families are identical to the OEM evaporative/refueling families unless the OEM evaporative emission system is no longer functionally necessary. You must create any new evaporative families according to 40 CFR 86.1821–01.

(2) Engine families and evaporative/refueling families for heavy-duty engines.

(i) Small volume conversion manufacturers and qualified small volume heavy-duty engine families.

(A) If criteria for small volume manufacturer or qualified small volume engine families are met as defined in 40 CFR 1036.150(d), you may combine heavy-duty engines using good engineering judgment into conversion engine families if the following criteria are satisfied instead of those specified in 40 CFR 1036.230.

(*1*) Same OEM.

(*2*) Same OBD group after MY 2013.

(*3*) Same service class (*e.g.,* light heavy-duty diesel engines, medium heavy-duty diesel engines, heavy heavy-duty diesel engines).

(*4*) Engine displacement is within 15% of largest displacement or 50 CID, whichever is larger.

(*5*) Same number of cylinders.

(*6*) Same arrangement of cylinders.

(*7*) Same combustion cycle.

(*8*) Same method of air aspiration.

(*9*) Same fuel type (*e.g.,* diesel/gasoline).

(*10*) Same fuel metering system (*e.g.,* mechanical direct or electronic direct injection).

(*11*) Same catalyst/filter construction (*e.g.,* metal vs. ceramic substrate).

(*12*) All converted engines are subject to the most stringent emission standards. For example, 2005 and 2007 heavy-duty diesel engines may be in the same family if they meet the most stringent (2007) standards.

(*13*) Same emission control technology (*e.g.,* internal or external EGR).

(B) EPA-established scaled assigned deterioration factors for both exhaust and evaporative emissions may be used for engines with over 10,000 miles if the criteria for small volume manufacturer or qualified small volume engine families are met as defined in 40 CFR 1036.150(d). This deterioration factor will be adjusted according to vehicle or engine miles of operation. The deterioration factor is intended to predict the engine's emission levels at the end of the useful life. EPA may adjust these scaled assigned deterioration factors if we find the rate of deterioration non-constant or if the rate differs by fuel type.

(C) As part of the conversion system description provided in the application for certification, conversion manufacturers using EPA assigned deterioration factors must present detailed information to confirm the durability of all relevant new and existing components and to explain why the conversion system will not harm the emission control system or degrade the emissions.

(ii) Conversion evaporative/refueling families are identical to the OEM evaporative/refueling families unless the OEM evaporative emission system is no longer functionally necessary. You must create any new evaporative families according to 40 CFR 86.1821.

(3) Conversion test groups/engine families for small volume conversion manufacturers and qualified small volume test groups/engine families may include vehicles/engines that are subject to different OEM emission standards; however, all the vehicles/engines certified under this subpart in a single conversion test group/engine family are subject to the most stringent standards that apply for vehicles/engines included in the conversion test group/engine family. For example, if OEM vehicle test groups originally certified to Tier 2, Bin 4 and Bin 5 standards are in the same conversion test group for purposes of fuel conversion, all the vehicles certified in the conversion test group under this subpart are subject to the Tier 2, Bin 4 standards. Conversion manufacturers may choose to certify a conversion test group/engine family to a more stringent standard than the OEM did. The optional, more stringent standard would then apply to all OEM test groups/engine families within the conversion test group/engine family. This paragraph (b)(3) does not apply to conversions to dual-fuel/mixed-fuel vehicles/engines, as provided in paragraph (b)(7) of this section.

(4)–(5) [Reserved]

(6) Durability testing is required unless the criteria for small volume manufacturer or qualified small volume test groups/engine families are met as defined in 40 CFR 86.1838–01 or 1036.150(d), as applicable.

(7) Conversion test groups/engine families for conversions to dual-fuel or

mixed-fuel vehicles/engines cannot include vehicles/engines subject to different emission standards unless applicable exhaust and OBD demonstrations are also conducted for the original fuel(s) demonstrating compliance with the most stringent standard represented in the test group. However, for small volume conversion manufacturers and qualified small volume test groups/engine families the data generated from exhaust emission testing on the new fuel for dual-fuel or mixed-fuel test vehicles/engines may be carried over to vehicles/engines which otherwise meet the test group/engine family criteria and for which the test vehicle/engine data demonstrate compliance with the application vehicle/engine standard. Clean alternative fuel conversion evaporative families for dual-fuel or mixed-fuel vehicles may not include vehicles/engines which were originally certified to different evaporative emissions standards unless evaporative/refueling demonstrations are also conducted for the original fuel(s) demonstrating compliance with the most stringent standard represented in the evaporative/refueling family.

(8) The vehicle/engine selected for testing must qualify as a worst-case vehicle/engine under 40 CFR 86.1828–01 or 1036.235(a)(2), as applicable.

(9) The following requirements apply for OBD systems:

(i) The OBD system must properly detect and identify malfunctions in all monitored emission-related powertrain systems or components including any new monitoring capability necessary to identify potential emission problems associated with the new fuel.

(ii) Conduct OBD testing as needed to demonstrate that the vehicle/engine continues to comply with emission thresholds and other requirements that apply based on the original certification.

(iii) Submit the applicable OBD reporting information for vehicles as set forth in 40 CFR 86.1806–17. Submit the applicable OBD reporting information for engines as set forth in 40 CFR 86.010–18 or 1036.110, as appropriate. Submit the following statement of compliance if the OEM vehicles/engines were required to be OBD-equipped:

The test group/engine family converted to an alternative fuel has fully functional OBD systems and therefore meets the OBD requirements specified in [40 CFR part 86 or part 1036, as applicable] when operating on the alternative fuel.

(10) In lieu of specific certification test data, you may submit the following attestations for the appropriate statements of compliance, if you have sufficient basis to prove the statement is valid.

(i) The test group/engine family converted to an alternative fuel has properly exercised the optional and applicable statements of compliance or waivers in the certification regulations. Attest to each statement or waiver in your application for certification.

(ii) The test group/engine family converted to dual-fuel or mixed-fuel operation retains all the OEM fuel system, engine calibration, and emission control system functionality when operating on the fuel with which the vehicle/engine was originally certified.

(iii) The test group/engine family converted to dual fuel or mixed-fuel operation retains all the functionality of the OEM OBD system (if so equipped) when operating on the fuel with which the vehicle/engine was originally certified.

(iv) The test group/engine family converted to dual-fuel or mixed-fuel operation properly purges hydrocarbon vapor from the evaporative emission canister when the vehicle/engine is operating on the alternative fuel.

(11) Certification fees apply as described in 40 CFR part 1027.

(12) A certificate issued under this section is valid starting with the indicated effective date and expires on December 31 of the conversion model year for which it is issued. You may apply for a certificate of conformity for the next conversion model year using the applicable provisions for carryover certification. Even after the certificate expires, your exemption from the prohibition on tampering remains valid for the applicable conversion test group/engine family and/or evaporative/refueling family, as long as the conditions under which the certificate was issued remain unchanged, such as small volume manufacturer or qualified small volume test group/engine family status. Your exemption from tampering is valid only if the conversion is installed on the OEM test groups/engine families and/or evaporative emissions/refueling families listed on the certificate. For example, if you have received a clean alternative fuel conversion certificate of conformity in conversion model year 2011 for converting a 2010 model year OEM test group/evaporative/refueling family, your exemption from tampering continues to apply for the conversion of the same 2010 model year OEM test group/evaporative/refueling family as long as the conditions under which the certificate was issued remain unchanged, such as small volume manufacturer status.

(13) Conversion systems must be properly installed and adjusted such that the vehicle/engine operates consistent with the principles of good engineering judgment and in accordance with all applicable regulations.

■ 4. Revise and republish § 85.515 to read as follows:

§ 85.515 Exemption provisions for intermediate age vehicles/engines.

(a) You are exempted from the tampering prohibition with respect to intermediate age vehicles/engines if you properly test, document and notify EPA that the conversion system complies with the emission standards specified in § 85.525 as described in paragraph (b) of this section; you meet the labeling requirements in § 85.530 before you sell, import or otherwise facilitate the use of a clean alternative fuel conversion system; and you meet the liability, recordkeeping, and end of year reporting requirements in § 85.535. You may also meet the requirements under this section by complying with the requirements in § 85.510.

(b) Documenting and notifying EPA under this section includes demonstrating compliance with all the provisions in this section and providing all notification information to EPA. You may notify us as described in this section instead of certifying the clean alternative fuel conversion system. You must demonstrate compliance with all exhaust and evaporative emissions standards by conducting all exhaust and evaporative emissions and durability testing as required for OEM certification subject to the exceptions and special provisions permitted in § 85.510. This paragraph (b) provides additional special provisions applicable to intermediate age vehicles/engines. Paragraph (b) is applicable to all conversion manufacturers unless otherwise specified.

(1) Conversion test groups for light-duty and heavy-duty chassis certified vehicles may be grouped together into an exhaust conversion test group using the criteria described in § 85.510(b)(1)(i)(A), except that the same OBD group is not a criterion. Evaporative/refueling families may be grouped together using the criteria described in § 85.510(b)(1)(ii).

(2) Conversion engine families for heavy-duty engines may be grouped together into an exhaust conversion engine family using the criteria described in § 85.510(b)(2)(i)(A), except that the same OBD group is not a criterion. Evaporative/refueling families may be grouped together using the criteria described in § 85.510(b)(2)(ii).

(3) Conversion test groups/engine families may include vehicles/engines that are subject to different OEM emission standards; however, all vehicles/engines in a single conversion test group/engine family are subject to the most stringent standards that apply for vehicles/engines included in the conversion test group/engine family. For example, if OEM vehicle test groups originally certified to Tier 2, Bin 4 and Bin 5 standards are in the same conversion test group for purposes of fuel conversion, all the vehicles in the conversion test group under this subpart are subject to the Tier 2, Bin 4 standards. This paragraph (b)(3) does not apply to conversions to dual-fuel/mixed-fuel vehicles/engines, as provided in paragraph (b)(7).

(4) EPA-established scaled assigned deterioration factors for both exhaust and evaporative emissions may be used for vehicles/engines with over 10,000 miles if the criteria for small volume manufacturer or qualified small volume test groups/engine families are met as defined in 40 CFR 86.1838–01 or 40 CFR 1036.150(d), as appropriate. This deterioration factor will be adjusted according to vehicle/engine miles or hours of operation. The deterioration factor is intended to predict the vehicle/engine's emission level at the end of the useful life. EPA may adjust these scaled assigned deterioration factors if we find the rate of deterioration non-constant or if the rate differs by fuel type.

(5) As part of the conversion system description required by paragraph (b)(10)(i) of this section, small volume conversion manufacturers and qualified small volume test groups/engine families using EPA assigned deterioration factors must present detailed information to confirm the durability of all relevant new and existing components and explain why the conversion system will not harm the emission control system or degrade the emissions.

(6) Durability testing is required unless the criteria for small volume manufacturer or qualified small volume test groups/engine families are met as defined in 40 CFR 86.1838–01 or 40 CFR 1036.150(d), as applicable. Durability procedures for large volume conversion manufacturers of intermediate age light-duty and heavy-duty chassis certified vehicles that follow provisions in 40 CFR 86.1820–01 may eliminate precious metal composition and catalyst grouping statistic when creating clean alternative fuel conversion durability groupings.

(7) Conversion test groups/engine families for conversions to dual-fuel or mixed-fuel vehicles/engines may not include vehicles/engines subject to different emissions standards unless applicable exhaust and OBD demonstrations are also conducted for the original fuel(s) demonstrating compliance with the most stringent standard represented in the test group/engine family. However, the data generated from testing on the new fuel for dual-fuel or mixed/fuel test vehicles/engines may be carried over to vehicles/engines that otherwise meet the conversion test group/engine family criteria and for which the test vehicle/engine data demonstrate compliance with the applicable vehicle/engine standards. Clean alternative fuel conversion evaporative families for dual-fuel or mixed-fuel vehicles/engines cannot include vehicles/engines that were originally certified to different evaporative emissions standards unless evaporative/refueling demonstrations are also conducted for the original fuel(s) demonstrating compliance with the most stringent standard represented in the evaporative/refueling family.

(8) You must conduct all exhaust and all evaporative and refueling emissions testing with a worst-case vehicle/engine to show that the conversion test group/engine family complies with exhaust and evaporative/refueling emission standards, based on the certification procedures.

(9)(i) The OBD system must properly detect and identify malfunctions in all monitored emission-related powertrain systems or components including any new monitoring capability necessary to identify potential emission problems associated with the new fuel. These include but are not limited to: Fuel trim lean and rich monitors, catalyst deterioration monitors, engine misfire monitors, oxygen sensor deterioration monitors, EGR system monitors, if applicable, and vapor leak monitors, if applicable. No original OBD system monitor that is still applicable to the vehicle/engine may be aliased, removed, bypassed, or turned-off. No MILs shall be illuminated after the conversion. Readiness flags must be properly set for all monitors that identify any malfunction for all monitored components.

(ii) Subsequent to the vehicle/engine fuel conversion, you must clear all OBD codes and reset all OBD monitors to not-ready status using an OBD scan tool appropriate for the OBD system in the vehicle/engine in question. You must operate the vehicle/engine with the new fuel on representative road operation or chassis dynamometer/engine dynamometer testing cycles to satisfy the monitors' enabling criteria. When all monitors have reset to a ready status, you must submit an OBD scan tool report showing that with the vehicle/engine operating in the key-on/engine-on mode, all supported monitors have reset to a ready status and no emission related ''pending'' (or potential) or ''confirmed'' (or MIL-on) diagnostic trouble codes (DTCs) have been set. The MIL must not be commanded ''On'' or be illuminated. A MIL check must also be conducted in a key-on/engine-off mode to verify that the MIL is functioning properly. You must include the VIN/EIN number of the test vehicle/engine. If necessary, the OEM evaporative emission readiness monitor may remain unset for dedicated gaseous fuel conversion systems.

(iii) In addition to conducting OBD testing described in this paragraph (b)(9), you must submit to EPA the following statement of compliance if the OEM vehicles/engines were required to be OBD-equipped:

> The test group/engine family converted to an alternative fuel has fully functional OBD systems and therefore meets the OBD requirements specified in [40 CFR part 86 or part 1036, as applicable] when operating on the alternative fuel.

(10) You must notify us by electronic submission in a format specified by the Administrator with all required documentation. The following must be submitted:

(i) You must describe how your conversion system qualifies as a clean alternative fuel conversion. You must include emission test results from the required exhaust, evaporative emissions, and OBD testing, applicable exhaust and evaporative emissions standards and deterioration factors. You must also include a description of how the test vehicle/engine selected qualifies as a worst-case vehicle/engine under 40 CFR 86.1828–01 or 1036.235(a)(2), as applicable.

(ii) You must describe the group of vehicles/engines (conversion test group/conversion engine family) that are covered by your notification based on the criteria specified in paragraph (b)(1) or (b)(2) of this section.

(iii) In lieu of specific test data, you may submit the following attestations for the appropriate statements of compliance, if you have sufficient basis to prove the statement is valid.

(A) The test group/engine family converted to an alternative fuel has properly exercised the optional and applicable statements of compliance or waivers in the certification regulations. Attest to each statement or waiver in your notification.

(B) The test group/engine family converted to dual-fuel or mixed-fuel operation retains all the OEM fuel system, engine calibration, and emission control system functionality when operating on the fuel with which the vehicle/engine was originally certified.

(C) The test group/engine family converted to dual-fuel or mixed-fuel operation retains all the functionality of the OEM OBD system (if the OEM vehicles/engines were required to be OBD equipped) when operating on the fuel for which the vehicle/engine was originally certified.

(D) The test group/engine family converted to dual-fuel or mixed-fuel operation properly purges hydrocarbon vapor from the evaporative emission canister when the vehicle/engine is operating on the alternative fuel.

(iv) Include any other information as the Administrator may deem appropriate to establish that the conversion system is for the purpose of conversion to a clean alternative fuel and meets applicable emission standards.

(11) [Reserved]

(12) Your exemption from the prohibition on tampering remains valid for the applicable conversion test group/engine family and/or evaporative/refueling family, as long as the conditions under which you previously complied remain unchanged, such as small volume manufacturer or qualified small volume test group/engine family status. Your exemption from tampering is valid only if the conversion is installed on the OEM test groups/engine families and/or evaporative emissions/refueling families listed on the notification. For example, if you have complied properly with the provisions in this section in calendar year 2011 for converting a model year 2006 OEM test group/evaporative/refueling family, your exemption from tampering continues to apply for the conversion of the same model year 2006 OEM test group/evaporative/refueling family as long as the conditions under which the notification was submitted remain unchanged.

(13) Conversion systems must be properly installed and adjusted such that the vehicle/engine operates consistent with the principles of good engineering judgment and in accordance with all applicable regulations.

■ 5. Amend § 85.520 by revising and republishing paragraphs (b)(4) and (6) to read as follows:

§ 85.520 Exemption provisions for outside useful life vehicles/engines.

* * * * *

(b) * * *

(4) The following requirements apply for OBD systems:

(i) The OBD system must properly detect and identify malfunctions in all monitored emission-related powertrain systems or components, including any new monitoring capability necessary to identify potential emission problems associated with the new fuel. These include but are not limited to: Fuel trim lean and rich monitors, catalyst deterioration monitors, engine misfire monitors, oxygen sensor deterioration monitors, EGR system monitors, if applicable, and evaporative system leak monitors, if applicable. No original OBD system monitor that is still applicable to the vehicle/engine may be aliased, removed, bypassed, or turned-off. No MILs shall be illuminated after the conversion. Readiness flags must be properly set for all monitors that identify any malfunction for all monitored components.

(ii) Subsequent to the vehicle/engine fuel conversion, you must clear all OBD codes and reset all OBD monitors to not-ready status using an OBD scan tool appropriate for the OBD system in the vehicle/engine in question. You must operate the vehicle/engine with the new fuel on representative road operation or chassis dynamometer/engine dynamometer testing cycles to satisfy the monitors' enabling criteria. When all monitors have reset to a ready status, you must submit an OBD scan tool report showing that with the vehicle/engine operating in the key-on/engine-on mode, all supported monitors have reset to a ready status and no emission related ''pending'' (or potential) or ''confirmed'' (or MIL-on) diagnostic trouble codes (DTCs) have been stored. The MIL must not be commanded ''On'' or be illuminated. A MIL check must also be conducted in a key-on/engine-off mode to verify that the MIL is functioning properly. You must include the VIN/EIN of the test vehicle/engine. If necessary, the OEM evaporative emission readiness monitor may remain unset for dedicated gaseous fuel conversion systems.

(iii) In addition to conducting OBD testing described in this paragraph (b)(4), you must submit to EPA the following statement of compliance if the OEM vehicles/engines were required to be OBD-equipped:

The test group/engine family converted to an alternative fuel has fully functional OBD systems and therefore meets the OBD requirements specified in [40 CFR part 86 or 40 CFR part 1036, as applicable] when operating on the alternative fuel.

* * * * *

(6) You must notify us by electronic submission in a format specified by the Administrator with all required documentation. The following must be submitted.

(i) You must describe how your conversion system complies with the good engineering judgment criteria in paragraph (b)(3) of this section and/or other requirements under this subpart or other applicable subparts such that the conversion system qualifies as a clean alternative fuel conversion. The submission must provide a level of technical detail sufficient for EPA to confirm the conversion system's ability to maintain or improve on emission levels in a worst-case vehicle/engine. The submission of technical information must include a complete characterization of exhaust and evaporative emissions control strategies, the fuel delivery system, durability, and specifications related to OBD system functionality. You must present detailed information to confirm the durability of all relevant new and existing components and to explain why the conversion system will not harm the emission control system or degrade the emissions. EPA may ask you to supply additional information, including test data, to support the claim that the conversion system does not increase emissions and involves good engineering judgment that is being applied for purposes of conversion to a clean alternative fuel.

(ii) You must describe the group of vehicles/engines (conversion test group/conversion engine family) that is covered by your notification based on the criteria specified in paragraph (b)(2) of this section.

(iii) In lieu of specific test data, you may submit the following attestations for the appropriate statements of compliance, if you have sufficient basis to prove the statement is valid.

(A) The test group/engine family converted to an alternative fuel has properly exercised the optional and applicable statements of compliance or waivers in the certification regulations. Attest to each statement or waiver in your notification.

(B) The test group/engine family converted to dual-fuel or mixed-fuel operation retains all the OEM fuel system, engine calibration, and emission control system functionality when operating on the fuel with which the vehicle/engine was originally certified.

(C) The test group/engine family converted to dual-fuel or mixed-fuel operation retains all the functionality of the OEM OBD system (if the OEM vehicles/engines were required to be OBD equipped) when operating on the fuel with which the vehicle/engine was originally certified.

(D) The test group/engine family converted to dual-fuel or mixed-fuel operation properly purges hydrocarbon vapor from the evaporative emission canister when the vehicle/engine is operating on the alternative fuel.

(E) The test group/engine family converted to an alternative fuel uses fueling systems, evaporative emission control systems, and engine powertrain components that are compatible with the alternative fuel and designed with the principles of good engineering judgment.

(iv) You must include any other information as the Administrator may deem appropriate, which may include test data, to establish the conversion system is for the purpose of conversion to a clean alternative fuel.

* * * * *

§ 85.524 [Removed]

■ 6. Remove § 85.524.

■ 7. Amend § 85.525 by revising paragraph (b)(3) introductory text to read as follows:

§ 85.525 Applicable standards.

* * * * *

(b) * * *

(3) Subject to the following exceptions and special provisions, compliance with greenhouse gas emission standards for medium-duty vehicles and heavy-duty vehicles subject to 40 CFR 86.1819–14 is demonstrated by complying with the N_2O and CH_4 standards and provisions set forth in 40 CFR 86.1819–14 and the in-use CO_2 exhaust emission standard set forth in 40 CFR 86.1819–14(b) as determined by the OEM for the subconfiguration that is identical to the fuel conversion emission data vehicle (EDV):

* * * * *

■ 8. Amend § 85.535 by revising paragraph (f) to read as follows:

§ 85.535 Liability, recordkeeping, and end of year reporting.

* * * * *

(f) Clean alternative fuel conversion manufacturers must submit an end of the year sales report to EPA describing the number of clean alternative fuel conversions by fuel type(s) and vehicle test group/engine family by January 31 of the following year. The number of conversions is the sum of the calendar year intermediate age conversions, outside useful life conversions, and the same conversion model year certified clean alternative fuel conversions. The number of conversions will be added to any other vehicle and engine sales accounted for using 40 CFR 86.1838–01 or 1036.150(d), as appropriate to determine small volume manufacturer or qualified small volume test group/engine family status.

* * * * *

■ 9. Amend § 85.1503 by revising paragraphs (a) and (c) to read as follows:

§ 85.1503 General requirements for importation of nonconforming vehicles and engines.

(a) A nonconforming vehicle or engine offered for importation into the United States must be imported by an ICI who is a current holder of a valid certificate of conformity unless an exemption or exclusion is granted by the Administrator under § 85.1511 or the vehicle is eligible for entry under § 85.1512.

* * * * *

(c) In any one certificate year (*e.g.,* the current model year), an ICI may finally admit no more than the following numbers of nonconforming vehicles into the United States under the provisions of §§ 85.1505 and 85.1509, except as allowed by paragraph (e) of this section:

(1) [Reserved]

(2) A total of 25 light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles. This limit applies for vehicles with engines, including plug-in hybrid electric vehicles. This limit does not apply for electric vehicles.

(3) 50 highway motorcycles.

* * * * *

■ 10. Amend § 85.1509 by:

■ a. Revising paragraph (a) introductory text.

■ b. Removing and reserving paragraphs (b) through (f).

■ c. Removing the paragraph headings from paragraphs (j), (k), and (l).

The revision reads as follows:

§ 85.1509 Final admission of modification and test vehicles.

(a) A motor vehicle or motor vehicle engine may be imported under this section by a certificate holder possessing a currently valid certificate of conformity only if—

* * * * *

■ 11. Amend § 85.1510 by revising paragraphs (d)(1) and (f) to read as follows:

§ 85.1510 Maintenance instructions, warranties, emission labeling and fuel economy requirements.

* * * * *

(d) * * *

(1) The certificate holder shall affix a fuel economy label that complies with the requirements of 40 CFR part 600, subpart D. The requirement for fuel economy labels does not apply for electric vehicles.

* * * * *

(f) *Corporate Average Fuel Economy (CAFE).* Certificate holders shall comply with any applicable CAFE requirements of the Energy Policy and Conservation Act, 15 U.S.C. 2001 *et seq.,* and 40 CFR part 600, for all vehicles imported under §§ 85.1505 and 85.1509.

■ 12. Revise and republish § 85.1515 to read as follows:

§ 85.1515 Emission standards and test procedures applicable to imported nonconforming motor vehicles and motor vehicle engines.

(a) Notwithstanding any other requirements of this subpart, any motor vehicle or motor vehicle engine conditionally imported pursuant to § 85.1505 or § 85.1509 and required to be emission tested shall be tested using the FCT at 40 CFR part 86 applicable to current model year motor vehicles and motor vehicle engines at the time of testing or reduced testing requirements as follows:

(1) ICIs are eligible for reduced testing under this paragraph (a) subject to the following conditions:

(i) The OEM must have a valid certificate of conformity covering the vehicle.

(ii) The vehicle must be in its original configuration as certified by the OEM. This applies for all emission-related components, including the electronic control module, engine calibrations, and all evaporative/refueling control hardware. It also applies for OBD software and hardware, including all sensors and actuators.

(iii) The vehicle modified as described in paragraph (a)(1)(ii) of this section must fully comply with all applicable emission standards and requirements.

(iv) Vehicles must have the proper OBD systems installed and operating. When faults are present, the ICI must test and verify the system's ability to find the faults (such as disconnected components), set codes, and illuminate the light, and set readiness codes as appropriate for each vehicle. When no fault is present, the ICI must verify that after sufficient prep driving (typically one FTP test cycle), all OBD readiness codes are set and the OBD system does not indicate a malfunction (*i.e.,* no codes set and no light illuminated).

(v) The ICI may not modify more than 300 vehicles in any given model year using reduced testing provisions in this paragraph (a).

(vi) The ICI must state in the application for certification that it will meet all the conditions in this paragraph (a)(1).

(2) The following provisions allow for ICIs to certify vehicles with reduced testing:

(i) In addition to the test waivers specified in 40 CFR 86.1829, you may provide a statement in the application for certification, supported by engineering analysis, that vehicles comply with any of the following standards that apply instead of submitting test data:

(A) Cold temperature CO, NMHC, NMOG+NO_X, and PM emission standards specified in 40 CFR 86.1811.

(B) SFTP emission standards specified in 40 CFR 86.1811 and 86.1816 for all pollutants, and separate emission standards that apply for US06 and SC03 duty cycles.

(C) For anything other than diesel-fueled vehicles, PM emission standards specified in 40 CFR 86.1811 and 86.1816.

(D) Any running loss, refueling, spitback, bleed emissions, and leak standards specified in 40 CFR part 86, subparts A and S.

(ii) You must perform testing and submit test data as follows to demonstrate compliance with emission standards:

(A) *Exhaust and fuel economy tests.* You must measure emissions over the FTP driving cycle and the highway fuel economy driving cycle as specified in 40 CFR 1066.801 to meet the fuel economy requirements in 40 CFR part 600 and demonstrate compliance with the exhaust emission standards in 40 CFR part 86 (other than PM). Measure exhaust emissions and fuel economy with the same test procedures used by the original manufacturer to test the vehicle for certification. However, you must use an electric dynamometer meeting the requirements of 40 CFR part 1066, subpart B, unless we approve a different dynamometer based on excessive compliance costs. If you certify based on testing with a different dynamometer, you must state in the application for certification that all vehicles in the emission family will comply with emission standards if tested on an electric dynamometer.

(B) *Evaporative emission test.* You may measure evaporative emissions as specified in this paragraph (a)(2)(ii)(B) to demonstrate compliance with the evaporative emission standards in 40 CFR part 86 instead of the otherwise specified procedures. Use measurement equipment for evaporative measurements specified in 40 CFR part 86, subpart B, except that the evaporative emission enclosure does not need to accommodate varying ambient temperatures. The evaporative measurement procedure is integral to the procedure for measuring exhaust emissions over the FTP driving cycle as described in paragraph (a)(ii)(2)(A) of this section. Perform canister preconditioning using the same procedure used by the original manufacturer to certify the vehicle; perform this canister loading before the initial preconditioning drive. Perform a diurnal emission test at the end of the stabilization period before the exhaust emission test by heating the fuel from 60 to 84 °F, either by exposing the vehicle to increasing ambient temperatures or by applying heat directly to the fuel tank. Measure hot soak emissions as described in 40 CFR 86.138–96(k). We may approve alternative measurement procedures that are equivalent to or more stringent than the specified procedures if the specified procedures are impractical for particular vehicle models or measurement facilities. The sum of the measured diurnal and hot soak values must meet the appropriate emission standard as specified in this section.

(b) [Reserved]

(c) Nonconforming motor vehicles conditionally imported pursuant to § 85.1505 or § 85.1509 must meet all the emission standards specified in 40 CFR part 86 for the OP year of the vehicle, with the following exceptions and clarifications:

(1) The useful life specified in 40 CFR part 86 for the OP year of the motor vehicle is applicable where useful life is not designated in this subpart.

(2)(i) Nonconforming light-duty vehicles and light light-duty trucks (LDV/LLDTs) originally manufactured in OP years 2004, 2005 or 2006 must meet the FTP exhaust emission standards of bin 9 in Tables S04–1 and S04–2 in 40 CFR 86.1811–04 and the evaporative emission standards for light-duty vehicles and light light-duty trucks specified in 40 CFR 86.1811–01(e)(5).

(ii) Nonconforming LDT3s and LDT4s (HLDTs) and medium-duty passenger vehicles (MDPVs) originally manufactured in OP years 2004 through 2006 must meet the FTP exhaust emission standards of bin 10 in Tables S04–1 and S04–2 in 40 CFR 86.1811–04 and the applicable evaporative emission standards specified in 40 CFR 86.1811–04(e)(5). For 2004 OP year HLDTs and MDPVs where modifications commence on the first vehicle of a test group before December 21, 2003, this requirement does not apply to the 2004 OP year. ICIs opting to bring all their 2004 OP year HLDTs and MDPVs into compliance with the exhaust emission standards of bin 10 in Tables S04–1 and S04–2 in 40 CFR 86.1811–04, may use the optional higher NMOG values for their 2004–2006 OP year LDT2s and 2004–2008 LDT4s.

(iii) Nonconforming LDT3s and LDT4s (HLDTs) and medium-duty passenger vehicles (MDPVs) originally manufactured in OP years 2007 and 2008 must meet the FTP exhaust emission standards of bin 8 in Tables S04–1 and S04–2 in 40 CFR 86.1811–04 and the applicable evaporative standards specified in 40 CFR 86.1811–04(e)(5).

(iv) Nonconforming LDV/LLDTs originally manufactured in OP years 2007 through 2021 and nonconforming HLDTs and MDPVs originally manufactured in OP year 2009 through 2021 must meet the FTP exhaust emission standards of bin 5 in Tables S04–1 and S04–2 in 40 CFR 86.1811–04, and the evaporative standards specified in 40 CFR 86.1811–04(e)(1) through (4).

(v) ICIs are exempt from the Tier 2 and the interim non-Tier 2 phase-in intermediate percentage requirements for exhaust, evaporative, and refueling emissions described in 40 CFR 86.1811–04.

(vi) In cases where multiple standards exist in a given model year in 40 CFR part 86 due to phase-in requirements of new standards, the applicable standards for motor vehicle engines required to be certified to engine-based standards are the least stringent standards applicable to the engine type for the OP year.

(vii) Nonconforming LDV/LLDTs originally manufactured in OP years 2009 through 2021 must meet the evaporative emission standards in Table S09–1 in 40 CFR 86.1811–09(e). However, LDV/LLDTs originally manufactured in OP years 2009 and 2010 and imported by ICIs who qualify as small-volume manufacturers as defined in 40 CFR 86.1838–01 are exempt from the LDV/LLDT evaporative emission standards in Table S09–1 in 40 CFR 86.1811–09(e), but must comply with the Tier 2 evaporative emission standards in Table S04–3 in 40 CFR 86.1811–04(e).

(viii) Nonconforming HLDTs and MDPVs originally manufactured in OP years 2010 through 2021 must meet the evaporative emission standards in Table S09–1 in 40 CFR 86.1811–09(e). However, HLDTs and MDPVs originally manufactured in OP years 2010 and 2011 and imported by ICIs, who qualify as small-volume manufacturers as defined in 40 CFR 86.1838–01, are exempt from the HLDTs and MDPVs evaporative emission standards in Table S09–1 in 40 CFR 86.1811–09(e), but must comply with the Tier 2 evaporative emission standards in Table S04–3 in 40 CFR 86.1811–04(e).

(ix) Nonconforming LDV/LLDTs originally manufactured in OP years 2013 through 2021 must meet the cold temperature NMHC emission standards in Table S10–1 in 40 CFR 86.1811–10(g). Nonconforming HLDTs and MDPVs originally manufactured in OP years 2015 through 2021 must meet the cold temperature NMHC emission standards in Table S10–1 in 40 CFR 86.1811–10(g).

(x) Nonconforming vehicles subject to the provisions of 40 CFR part 86, subpart S, originally manufactured in OP years 2022 through 2031 must meet the Tier 3 and related exhaust emission standards in 40 CFR 86.1811–17 and 86.1816–18, the Tier 3 evaporative emission standards in 40 CFR 86.1813–17, and the refueling emission standards in 40 CFR 86.1813–17(b) and have an OBD system meeting the requirements of 40 CFR 86.1806–17. In cases where the standard allows or requires demonstrating compliance using emission credits, each vehicle imported under this paragraph (c) is subject to the specified fleet average standard.

(xi) Nonconforming vehicles subject to the provisions of 40 CFR part 86, subpart S, originally manufactured in OP years 2032 and later must meet the Tier 4 exhaust emission standards in 40 CFR 86.1811–27, the Tier 3 evaporative emission standards in 86.1813–17, and the refueling emission standards in 40 CFR 86.1813–17(b) and have an OBD system meeting the requirements of 40 CFR 86.1806–27. In cases where the standard allows or requires demonstrating compliance using emission credits, each vehicle imported under this paragraph (c) is subject to the specified fleet average standard.

(3) The following provisions apply for demonstrating compliance with the Tier 2 fleet average NO_X standard in 40 CFR 86.1811–04:

(i) As an option to the requirements of paragraph (c)(2)(i) through (viii) of this section, independent commercial importers may elect to meet lower bins in Tables S04–1 and S04–2 of 40 CFR 86.1811–04 than specified in paragraph (c)(2) of this section and bank or sell NO_X credits as permitted in 40 CFR 86.1860–04 and 40 CFR 86.1861–04. An ICI may not meet higher bins in Tables S04–1 and S04–2 of 40 CFR 86.1811–04 than specified in paragraph (c)(2) of this section unless it demonstrates to the Administrator at the time of certification that it has obtained appropriate and sufficient NO_X credits from another manufacturer, or has generated them in a previous model year or in the current model year and not transferred them to another manufacturer or used them to address other vehicles as permitted in 40 CFR 86.1860–04 and 40 CFR 86.1861–04.

(ii) Where an ICI desires to obtain a certificate of conformity using a bin higher than specified in paragraph (c)(2) of this section, but does not have sufficient credits to cover vehicles produced under such certificate, the Administrator may issue such certificate if the ICI has also obtained a certificate of conformity for vehicles certified using a bin lower than that required under paragraph (c)(2) of this section. The ICI may then produce vehicles to the higher bin only to the extent that it has generated sufficient credits from vehicles certified to the lower bin during the same model year.

(iii) Except for the situation where an ICI desires to bank, sell or use NO_X credits as described in this paragraph (c)(3), the requirements of 40 CFR 86.1811–04 related to fleet average NO_X standards and requirements to comply with such standards do not apply to vehicles modified under this subpart.

(iv) ICIs using bins higher than those specified in paragraph (c)(2) of this section must monitor their production so that they do not produce more vehicles certified to the standards of such bins than their available credits can cover. ICIs must not have a credit deficit at the end of a model year and are not permitted to use the deficit carryforward provisions provided in 40 CFR 86.1860–04(e).

(v) The Administrator may condition the certificates of conformity issued to ICIs as necessary to ensure that vehicles subject to this paragraph (c) comply with the appropriate average NO_X standard for each model year.

(4) The following provisions apply for demonstrating compliance with the cold temperature NMHC fleet average standards in 40 CFR 86.1811–10 through 2021:

(i) As an alternative to the requirements of paragraphs (c)(2)(ix) of this section, ICIs may elect to meet a cold temperature NMHC family emission level below the cold temperature NMHC fleet average standards specified in Table S10–1 of 40 CFR 86.1811–10 and bank or sell credits as permitted in 40 CFR 86.1864–10. An ICI may not meet a higher cold temperature NMHC family emission level than the fleet average standards in Table S10–1 of 40 CFR 86.1811–10, unless it demonstrates to the Administrator at the time of certification that it has obtained appropriate and sufficient NMHC credits from another manufacturer, or has generated them in a previous model year or in the current model year and not traded them to another manufacturer or used them to address other vehicles as permitted in 40 CFR 86.1864–10.

(ii) Where an ICI desires to obtain a certificate of conformity using a higher cold temperature NMHC family emission level than specified in paragraph (c)(2)(ix) of this section, but does not have sufficient credits to cover vehicles imported under such certificate, the Administrator may issue such certificate if the ICI has also obtained a certificate of conformity for vehicles certified using a cold temperature NMHC family emission level lower than that required under paragraph (c)(2)(ix) of this section. The ICI may then import vehicles to the higher cold temperature NMHC family emission level only to the extent that it has generated sufficient credits from vehicles certified to a family emission level lower than the cold temperature NMHC fleet average standard during the same model year.

(iii) ICIs using cold temperature NMHC family emission levels higher than the cold temperature NMHC fleet average standards specified in paragraph (c)(2)(ix) of this section must monitor their imports so that they do not import more vehicles certified to such family emission levels than their available credits can cover. ICIs must not have a credit deficit at the end of a model year and are not permitted to use the deficit carryforward provisions provided in 40 CFR 86.1864–10.

(iv) The Administrator may condition the certificates of conformity issued to ICIs as necessary to ensure that vehicles subject to this paragraph (c)(8) comply with the applicable cold temperature NMHC fleet average standard for each model year.

(5) In cases where a vehicle is subject to a Tier 3 or Tier 4 credit-based standard as described in paragraphs (c)(2)(x) and (xi) of this section, an ICI may import a vehicle with emissions higher than the applicable standard if it first arranges to purchase appropriate and sufficient emission credits from a manufacturer that has generated the emission credits as specified in 40 CFR part 86, subpart S. A vehicle's emissions may not exceed the specified values for the highest available NMOG + NO_X bin or the evaporative emissions FEL cap. Vehicles subject to this paragraph (c)(5) may not generate emission credits.

(6) An ICI may comply with the cold temperature PM standard in 40 CFR 86.1811–27(c) based on an engineering evaluation.

(d) An ICI may not certify using nonconformance penalties and may not participate in the averaging, banking, and trading program for GHG emissions.

■ 13. Revise § 85.1702 to read as follows:

§ 85.1702 Definitions.

As used in this subpart, all terms not defined herein shall have the meaning given them in the Act:

Certificate holder has the meaning given in 40 CFR 1068.30.

Export exemption means an exemption granted by statute under 42 U.S.C. 7522(b)(3) for the purpose of exporting new motor vehicles or new motor vehicle engines.

National security exemption means an exemption which may be granted under 42 U.S.C. 7522(b)(1) of the Act for the purpose of national security.

Pre-certification vehicle means an uncertified vehicle that a certificate holder employs in fleets from year to year in the ordinary course of business for product development, production method assessment, and market promotion, but not involving lease or sale.

Pre-certification vehicle engine means an uncertified heavy-duty engine owned by a manufacturer and used in a manner not involving lease or sale in a vehicle employed from year to year in the ordinary course of business for product development, production method assessment and market promotion purposes.

Testing exemption means an exemption which may be granted under 42 U.S.C. 7522(b)(1) for the purpose of research investigations, studies, demonstrations or training, but not including national security.

■ 14. Amend § 85.1716 by revising the introductory text to read as follows:

§ 85.1716 Approval of an emergency vehicle field modification (EVFM).

This section describes how you may implement design changes for an emergency vehicle that has already been placed into service to ensure that the vehicle will perform properly in emergency situations. This applies for any light-duty vehicle, light-duty truck, or heavy-duty vehicle meeting the definition of emergency vehicle in 40 CFR 86.1803–01 or 1036.801. In this section, ''you'' refers to the certifying manufacturer and ''we'' refers to the EPA Administrator and any authorized representatives.

* * * * *

■ 15. Amend § 85.1803 by adding paragraph (e) to read as follows:

§ 85.1803 Remedial Plan.

* * * * *

(e) A remedial plan for an alternative remedy under 40 CFR 86.1865–12(j)(3) that does not involve vehicle repairs may omit items from this section that do not apply. For example, such a remedial plan will generally omit information related to proper maintenance, vehicle repairs, and vehicle labeling.

■ 16. Amend § 85.1805 by:

■ a. Revising paragraph (a) introductory text.

■ b. Redesignating paragraphs (b) and (c) as paragraphs (c) and (d), respectively.

■ c. Adding new paragraph (b).

The revision and addition read as follows:

§ 85.1805 Notification to vehicle or engine owners.

(a) Except as specified in paragraph (b) of this section, the notification of vehicle or engine owners shall contain the following:

* * * * *

(b) In the case of manufacturers submitting an alternative remedy under 40 CFR 86.1865–12(j)(3) that does not involve vehicle repairs, the proposed remedy must also include a proposal for notifying owners of the nonconformity. The notification must contain the following:

(1) The statement: ''The Administrator of the U.S. Environmental Protection Agency has determined that your vehicle or engine may be emitting pollutants in excess of the Federal emission standards as defined in 40 CFR part 86. These emission standards were established to protect the public health or welfare from the dangers of air pollution.''

(2) A clear description of the measures to be taken to correct the nonconformity.

* * * * *

■ 17. Revise § 85.2101 to read as follows:

§ 85.2101 General applicability.

(a) Sections 85.2101 through 85.2111 are applicable to all 1981 and later model year vehicles subject to standards under 40 CFR part 86, subpart S.

(b) References in this subpart to engine families and emission control systems shall be deemed to apply to durability groups and test groups as applicable.

■ 18. Amend § 85.2102 by revising paragraph (a) introductory text and paragraphs (a)(4), (10), and (11) to read as follows:

§ 85.2102 Definitions.

(a) As used in §§ 85.2101 through 85.2111 all terms not defined herein shall have the meaning given them in the Act. All terms additionally not defined in the Act shall have the meaning given in 40 CFR 86.1803–01, 1065.1001, or 1068.30:

* * * * *

(4) *Emission performance warranty* means that warranty described in § 85.2103(c) and 42 U.S.C. 7541(b).

* * * * *

(10) *Useful life* means that period established under 40 CFR 86.1805.

(11) *Vehicle* means any vehicle subject to standards under 40 CFR part 86, subpart S.

* * * * *

■ 19. Revise § 85.2103 to read as follows:

§ 85.2103 Emission warranty.

(a) The manufacturer of each vehicle to which this subpart applies must provide a written commitment to meet warranty requirements as described in this section.

(b) The warranty periods under this section apply based on the vehicle's age in years and on the vehicle's odometer reading. The warranty period expires based on the specified age or mileage, whichever comes first. The warranty period for a particular vehicle begins on the date the vehicle is delivered to its ultimate purchaser or, if the vehicle is first placed in service as a ''demonstrator'' or ''company'' car prior to delivery, on the date it is first placed in service.

(c) Under the emission performance warranty, in the case of a vehicle failing to conform at any time during its useful life to the applicable emission standards or family emission limits as determined by an EPA-approved emission test, the manufacturer must remedy that nonconformity at no cost to the owner if such nonconformity results or will result in the vehicle owner having to bear any penalty or other sanction (including the denial of the right to use the vehicle) under local, State, or Federal law. The following warranty periods apply:

(1) For light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles, the warranty period for the emission performance warranty is 24 months or 24,000 miles, except that the warranty period is 8 years or 80,000 miles for any nonconformity resulting from a failed specified major emission control component identified in paragraph (d) and (e) of this section.

(2) For medium-duty vehicles, the warranty period for the emission performance warranty is 5 years or 50,000 miles, except that the warranty period is 8 years or 80,000 miles for any

nonconformity resulting from a failed specified major emission control component identified in paragraph (d) and (e) of this section.

(d) An emission defect warranty applies as follows:

(1) An emission defect warranty applies for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles for a warranty period of two years or 24,000 miles, except that the following specified major emission control components have a warranty period of eight years or 80,000 miles:

(i) Catalytic converters and SCR catalysts, and related components.

(ii) Particulate filters and particulate traps, used with both spark-ignition and compression-ignition engines.

(iii) Components related to exhaust gas recirculation with compression-ignition engines.

(iv) Emission control module.

(v) Batteries serving as a Renewable Energy Storage System for electric vehicles and plug-in hybrid electric vehicles, along with all components needed to charge the system, store energy, and transmit power to move the vehicle. This paragraph (d)(1)(v) is optional for vehicles not yet subject to battery monitoring requirements under 40 CFR 86.1815–27.

(2) An emission defect warranty applies for medium-duty vehicles for a warranty period of five years or 50,000 miles, except that the specific major emission control components identified in paragraph (d)(1) of this section have a warranty period of eight years or 80,000 miles.

(3) An electric vehicle or plug-in hybrid electric vehicle fails to meet the manufacturer-defined value for percentage usable battery energy for the specified period as determined by the State of Certified Energy monitor required under 40 CFR 86.1815–27, subject to the warranty claim procedures in § 85.2106.

■ 20. Amend § 85.2104 by revising paragraphs (d) through (g) to read as follows:

§ 85.2104 Owners' compliance with instructions for proper maintenance and use.

* * * * *

(d) The time/mileage interval for scheduled maintenance services shall be the service interval specified for the part in the written instructions for proper maintenance and use. However, in the case of certified parts having a maintenance or replacement interval different from that specified in the written instructions for proper maintenance and use, the time/mileage interval shall be the service interval for which the part was certified.

(e) The owner may perform maintenance or have maintenance performed more frequently than required in the maintenance instructions.

(f) Written instruction for proper use of battery electric vehicles and plug-in hybrid electric vehicles may identify certain behaviors or vehicle operating modes expected to unreasonably or artificially shorten battery durability. For example, exceeding a vehicle's towing capacity might be considered improper use. However, the manufacturer should not consider actions to be improper use if the vehicle can be designed to prevent the targeted behaviors or operating modes. Evidence of compliance with the requirement to properly use vehicles under this paragraph (f) is generally limited to onboard data logging, though manufacturers may also request vehicle owners to make a statement regarding specific behaviors or vehicle operating modes.

(g) Except as provided in paragraph (h) of this section, a manufacturer may deny an emission warranty claim on the basis of noncompliance with the written instructions for proper maintenance and use if and only if:

(1) An owner is not able to comply with a request by a manufacturer for evidence pursuant to paragraph (c) or (f) of this section; or

(2) Notwithstanding the evidence presented pursuant to paragraph (c) of this section, the manufacturer can prove that the vehicle failed because of any of the following conditions:

(i) The vehicle was abused.

(ii) An instruction for the proper maintenance and use was performed in a manner resulting in a component's being improperly installed or a component or related parameter's being adjusted substantially outside of the manufacturer's specifications.

(iii) Unscheduled maintenance was performed on a vehicle which resulted in the removing or rendering inoperative of any component affecting the vehicle's emissions.

* * * * *

■ 21. Amend § 85.2105 by revising paragraph (b)(3) to read as follows:

§ 85.2105 Aftermarket parts.

* * * * *

(b) * * *

(3) List all objective evidence as defined in § 85.2102 that was used in the determination to deny warranty. This evidence must be made available to the vehicle owner or EPA upon request.

* * * * *

■ 22. Amend § 85.2109 by revising paragraph (a) to read as follows:

§ 85.2109 Inclusion of warranty provisions in owners' manuals and warranty booklets.

(a) A manufacturer shall furnish with each new motor vehicle, a full explanation of the emission warranties required by 42 U.S.C. 7541(a) and (b), including at a minimum the following information:

(1) A basic statement of the coverage of the emissions performance warranty as set out in § 85.2103. This shall be separated from any other warranty given by the manufacturer and shall be prefaced by the title ''Emissions Performance Warranty'' set in bold face type.

(2) A list of all items which are covered by the emission performance warranty for the full useful life of the vehicle. This list shall contain all specified major emission control components. All items listed pursuant to this subsection shall be described in the same manner as they are likely to be described on a service facility work receipt for that vehicle.

(3) A list or a reference to the location of the instructions for proper maintenance and use, together with the time and/or mileage interval at which such instructions are to be performed.

(4) An explanation of the effect that the use of certified parts will have on the emission performance warranty. This explanation shall comport with the provisions of § 85.2105 (b) and (c), including a statement in boldface type that maintenance, replacement, or repair of the emission control devices and systems may be performed by any automotive repair establishment or individual using any certified part.

(5) Complete instructions as to when and how an owner may bring a claim under the emissions performance warranty, as governed by §§ 85.2104 and 85.2106. These instructions shall include all the following:

(i) An explanation of the point in time at which a claim may be raised.

(ii) Complete procedures as to the manner in which a claim may be raised.

(iii) The provisions for manufacturer liability contained in § 85.2106(f) if the manufacturer fails to respond within the time period set in accordance with § 85.2106(d).

(iv) For battery electric vehicles and plug-in hybrid electric vehicles, the manufacturer-defined value for percentage usable battery energy specified in § 85.2103(d)(3).

(6) An explanation that an owner may obtain further information concerning the emission warranties or that an owner may report violations of the

terms of the emission warranties provided under 42 U.S.C. 7541(a) and (b) by contacting the Director, Compliance Division, Environmental Protection Agency, 2000 Traverwood Dr., Ann Arbor, MI 48105 (Attention: Warranty) or email to: *complianceinfo@epa.gov*.

* * * * *

■ 23. Revise § 85.2110 to read as follows:

§ 85.2110 Submission of owners' manuals and warranty statements to EPA.

(a) The manufacturer of each vehicle to which this subpart applies must send to EPA an owner's manual and warranty booklet (if applicable) in electronic format for each model vehicle that completely and accurately represent the warranty terms for that vehicle.

(1) The owner's manuals and warranty booklets should be received by EPA 60 days prior to the introduction of the vehicle for sale.

(2) If the manuals and warranty booklets are not in their final format 60 days prior to the introduction of the vehicle for sale, a manufacturer may submit the most recent draft at that time, provided that the manufacturer promptly submits final versions when they are complete.

(b) All materials described in paragraph (a) of this section shall be sent to the Designated Compliance Officer as specified at 40 CFR 1068.30 (Attention: Warranty Booklet).

PART 86—CONTROL OF EMISSIONS FROM NEW AND IN–USE HIGHWAY VEHICLES AND ENGINES

■ 24. The authority citation for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 25. Revise and republish § 86.1 to read as follows:

§ 86.1 Incorporation by reference.

Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, EPA must publish a document in the **Federal Register** and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at EPA and at the National Archives and Records Administration (NARA). Contact EPA at: U.S. EPA, Air and Radiation Docket Center, WJC West Building, Room 3334, 1301 Constitution Ave. NW, Washington, DC 20004; *www.epa.gov/dockets*; (202) 202–1744. For information on inspecting this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations.html* or email *fr.inspection@nara.gov*. The material may be obtained from the following sources:

(a) *ASTM International (ASTM).* ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428–2959; (610) 832–9585; *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 (''ASTM C1549''); IBR approved for § 86.1869–12(b).

(2) ASTM D86–12, Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure, approved December 1, 2012 (''ASTM D86''); IBR approved for §§ 86.113–04(a); 86.113–94(b); 86.213(a); 86.513(a).

(3) ASTM D93–13, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester, approved July 15, 2013 (''ASTM D93''); IBR approved for § 86.113–94(b).

(4) ASTM D445–12, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity), approved April 15, 2012 (''ASTM D445''); IBR approved for § 86.113–94(b).

(5) ASTM D613–13, Standard Test Method for Cetane Number of Diesel Fuel Oil, approved December 1, 2013 (''ASTM D613''); IBR approved for § 86.113–94(b).

(6) ASTM D975–13a, Standard Specification for Diesel Fuel Oils, approved December 1, 2013 (''ASTM D975''); IBR approved for § 86.1910(c).

(7) ASTM D976–06 (Reapproved 2011), Standard Test Method for Calculated Cetane Index of Distillate Fuels, approved October 1, 2011 (''ASTM D976''); IBR approved for § 86.113–94(b).

(8) ASTM D1319–13, Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption, approved May 1, 2013 (''ASTM D1319''); IBR approved for §§ 86.113–04(a); 86.213(a); 86.513(a).

(9) ASTM D1945–03 (reapproved 2010), Standard Test Method for Analysis of Natural Gas by Gas Chromatography, approved January 1, 2010 (''ASTM D1945''); IBR approved for §§ 86.113–94(e); 86.513(d).

(10) ASTM D2163–07, Standard Test Method for Determination of Hydrocarbons in Liquefied Petroleum (LP) Gases and Propane/Propene Mixtures by Gas Chromatography, approved December 1, 2007 (''ASTM D2163''); IBR approved for §§ 86.113–94(f).

(11) ASTM D2622–10, Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry, approved February 15, 2010 (''ASTM D2622''); IBR approved for §§ 86.113–04(a); 86.113–94(b); 86.213(a); 86.513(a).

(12) ASTM D2699–13b, Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel, approved October 1, 2013 (''ASTM D2699''); IBR approved for §§ 86.113–04(a); 86.213(a).

(13) ASTM D2700–13b, Standard Test Method for Motor Octane Number of Spark-Ignition Engine Fuel, approved October 1, 2013 (''ASTM D2700''); IBR approved for §§ 86.113–04(a); 86.213(a).

(14) ASTM D3231–13, Standard Test Method for Phosphorus in Gasoline, approved June 15, 2013 (''ASTM D3231''); IBR approved for §§ 86.113–04(a); 86.213(a); 86.513(a).

(15) ASTM D3237–12, Standard Test Method for Lead in Gasoline by Atomic Absorption Spectroscopy, approved June 1, 2012 (''ASTM D3237''); IBR approved for §§ 86.113–04(a); 86.213(a); 86.513(a).

(16) ASTM D4052–11, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter, approved October 15, 2011 (''ASTM D4052''); IBR approved for § 86.113–94(b).

(17) ASTM D5186–03 (Reapproved 2009), Standard Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels and Aviation Turbine Fuels by Supercritical Fluid Chromatography, approved April 15, 2009 (''ASTM D5186''); IBR approved for § 86.113–94(b).

(18) ASTM D5191–13, Standard Test Method for Vapor Pressure of Petroleum Products (Mini Method), approved December 1, 2013 (''ASTM D5191''); IBR approved for §§ 86.113–04(a); 86.213(a); 86.513(a).

(19) ASTM D5769–20, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry, approved June 1, 2020 (''ASTM5769''); IBR approved for §§ 86.113–04(a); 86.213(a); 86.513(a).

(20) ASTM D6550–20, Standard Test Method for Determination of Olefin Content of Gasolines by Supercritical-Fluid Chromatography, approved July 1, 2020 (''ASTM D6550''); IBR approved for §§ 86.113–04(a); 86.213(a); 86.513(a).

(21) ASTM E29–93a, Standard Practice for Using Significant Digits in

Test Data to Determine Conformance with Specifications, approved March 15, 1993 (''ASTM E29''); IBR approved for §§ 86.004–15(c); 86.007–11(a); 86.007–15(m); 86.1803–01; 86.1823–01(a); 86.1824–01(c); 86.1825–01(c).

(22) ASTM E903–96, Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres, approved April 10, 1996 (''ASTM E903''); IBR approved for § 86.1869–12(b).

(23) ASTM E1918–06, Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field, approved August 15, 2006 (''ASTM E1918''); IBR approved for § 86.1869–12(b).

(b) *American National Standards Institute (ANSI).* American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036; (212) 642–4900; *www.ansi.org.*

(1) ANSI NGV1–2006, Standard for Compressed Natural Gas Vehicle (NGV) Fueling Connection Devices, 2nd edition, reaffirmed and consolidated March 2, 2006; IBR approved for § 86.1813–17(f).

(2) CSA IR–1–15, Compressed Natural Gas Vehicle (NGV) High Flow Fueling Connection Devices—Supplement to NGV 1–2006, ANSI approved August 26, 2015; IBR approved for § 86.1813–17(f).

(c) *California Air Resources Board (California ARB).* California Air Resources Board, 1001 I Street, Sacramento, CA 95812; (916) 322–2884; *www.arb.ca.gov.*

(1) California Requirements Applicable to the LEV III Program, including the following documents:

(i) LEV III exhaust emission standards are in Title 13 Motor Vehicles, Division 3 Air Resources Board, Chapter 1 Motor Vehicle Pollution Control Devices, Article 2 Approval of Motor Vehicle Pollution Control Devices (New Vehicles), § 1961.2 Exhaust Emission Standards and Test Procedures—2015 and Subsequent Model Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles, effective as of December 31, 2012; IBR approved for § 86.1803–01.

(ii) LEV III evaporative emission standards for model year 2015 and later vehicles are in Title 13 Motor Vehicles, Division 3 Air Resources Board, Chapter 1 Motor Vehicle Pollution Control Devices, Article 2 Approval of Motor Vehicle Pollution Control Devices (New Vehicles) § 1976 Standards and Test Procedures for Motor Vehicle Fuel Evaporative Emissions, effective as of December 31, 2012; IBR approved for § 86.1803–01.

(2) 13 CCR 1962.5, Title 13, Motor Vehicles, Division 3, Air Resources Board, Chapter 1, Motor Vehicle Pollution Control Devices, Article 2, Approval of Motor Vehicle Pollution Control Devices (New Vehicles), § 1962.5 Data Standardization Requirements for 2026 and Subsequent Model Year Light-Duty Zero Emission Vehicles and Plug-in Hybrid Electric Vehicles; Operative November 30, 2022; IBR approved for § 86.1815–27(h).

(3) 13 CCR 1962.7, Title 13, Motor Vehicles, Division 3, Air Resources Board, Chapter 1, Motor Vehicle Pollution Control Devices, Article 2, Approval of Motor Vehicle Pollution Control Devices (New Vehicles), § 1962.7 In-Use Compliance, Corrective Action and Recall Protocols for 2026 and Subsequent Model Year Zero-Emission and Plug-in Hybrid Electric Passenger Cars and Light-Duty Trucks; Operative November 30, 2022; IBR approved for § 86.1815–27(h).

(4) 13 CCR 1968.2 (known as Onboard Diagnostics II (OBD–II)), Title 13, Motor Vehicles, Division 3, Air Resources Board, Chapter 1, Motor Vehicle Pollution Control Devices, Article 2, Approval of Motor Vehicle Pollution Control Devices (New Vehicles), § 1968.2 Malfunction and Diagnostic System Requirements—2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines, effective as of July 31, 2013; IBR approved for § 86.1806–17(a).

(5) 13 CCR 1968.2 (known as Onboard Diagnostics II (OBD–II)), Title 13, Motor Vehicles, Division 3, Air Resources Board, Chapter 1, Motor Vehicle Pollution Control Devices, Article 2, Approval of Motor Vehicle Pollution Control Devices (New Vehicles), § 1968.2 Malfunction and Diagnostic System Requirements—2004 and Subsequent Model-Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines; Operative November 30, 2022; IBR approved for § 86.1806–27(a).

(d) *International Organization for Standardization (ISO).* International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland; 41–22–749–01–11; *www.iso.org.*

(1) 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).

(2) 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 § 86.010–18(k).

(e) *National Institute of Standards and Technology (NIST).* National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899; *reflib@nist.gov; www.nist.gov.*

(1) NIST Special Publication 811, 2008 Edition, Guide for the Use of the International System of Units (SI), March 2008; IBR approved for § 86.1901(d).

(2) [Reserved]

(f) *SAE International (SAE).* SAE International, 400 Commonwealth Dr., Warrendale, PA 15096–0001; (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada); *www.sae.org.*

(1) SAE J1151, Methane Measurement Using Gas Chromatography, stabilized September 2011; IBR approved for § 86.111–94(b).

(2) SAE J1349, Engine Power Test Code—Spark Ignition and Compression Ignition—As Installed Net Power Rating, revised September 2011; IBR approved for § 86.1803–01.

(3) SAE J1711 FEB2023, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles; Revised February 2023; IBR approved for § 86.1866–12(b).

(4) SAE J1877, Recommended Practice for Bar-Coded Vehicle Identification Number Label, July 1994; IBR approved for § 86.1807–01(f).

(5) SAE J1930, Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms, Revised May 1998; IBR approved for §§ 86.1808–01(f); 86.1808–07(f).

(6) 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 § 86.010–18(k).

(7) SAE J1939, Recommended Practice for a Serial Control and Communications Vehicle Network, Revised October 2007; IBR approved for § 86.010–18(k).

(8) SAE J1939–13, Off-Board Diagnostic Connector, Revised March 2004; IBR approved for § 86.010–18(k).

(9) SAE J1939–71, Vehicle Application Layer (Through February 2007), Revised January 2008; IBR approved for § 86.010–38(j).

(10) SAE J1939–73, Application Layer—Diagnostics, Revised September 2006; IBR approved for §§ 86.010–18(k); 86.010–38(j).

(11) SAE J1939–81, Network Management, Revised May 2003; IBR approved for § 86.010–38(j).

(12) SAE J1962, Diagnostic Connector Equivalent to ISO/DIS 15031–3, December 14, 2001, Revised April 2002; IBR approved for § 86.010–18(k).

(13) SAE J1978, OBD II Scan Tool—Equivalent to ISO/DIS 15031–4, December 14, 2001, Revised April 2002; IBR approved for § 86.010–18(k).

(14) SAE J1979, E/E Diagnostic Test Modes, Revised September 1997; IBR approved for §§ 86.1808–01(f) and 86.1808–07(f).

(15) SAE J1979, (R) E/E Diagnostic Test Modes, Revised May 2007; IBR approved for § 86.010–18(k).

(16) SAE J2012, (R) Diagnostic Trouble Code Definitions Equivalent to ISO/DIS 15031–6, April 30, 2002, Revised April 2002; IBR approved for § 86.010–18(k).

(17) SAE J2064 FEB2011, R134a Refrigerant Automotive Air-Conditioned Hose, Revised February 2011; IBR approved for § 86.1867–12(a).

(18) SAE J2284–3, High Speed CAN (HSC) for Vehicle Applications at 500 KBPS, May 2001; IBR approved for §§ 86.1808–01(f); 86.1808–07(f).

(19) SAE J2403, Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature—Truck and Bus; Revised August 2007; IBR approved for §§ 86.010–18(k); 86.010–38(j).

(20) SAE J2534, Recommended Practice for Pass-Thru Vehicle Programming, February 2002; IBR approved for §§ 86.1808–01(f); 86.1808–07(f).

(21) 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).

(22) SAE J2727 SEP2023, Mobile Air Conditioning System Refrigerant Emissions Estimate for Mobile Air Conditioning Refrigerants, Revised September 2023; IBR approved for §§ 86.1819–14(h); 86.1867–12(a); 86.1867–31(a).

(23) 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).

(24) SAE J2807 FEB2020, Performance Requirements for Determining Tow-Vehicle Gross Combination Weight Rating and Trailer Weight Rating, Revised February 2020; IBR approved for § 86.1845–04(h).

(g) *Truck and Maintenance Council (TMC).* Truck and Maintenance Council, 950 North Glebe Road, Suite 210, Arlington, VA 22203–4181; (703) 838–1754; *tmc@trucking.org; tmc.trucking.org.*

(1) TMC RP 1210B, Revised June 2007, WINDOWSTMCOMMUNICATION API; IBR approved for § 86.010–38(j).

(2) [Reserved]

(h) *UN Economic Commission for Europe (UNECE).* UN Economic Commission for Europe, Information Service, Palais des Nations, CH–1211 Geneva 10, Switzerland; *unece_info@un.org; www.unece.org.*

(1) ECE/TRANS/180/Add.22, Addendum 22: United Nations Global Technical Regulation, No. 22, United Nations Global Technical Regulation on In-vehicle Battery Durability for Electrified Vehicles; Adopted April 14, 2022, (''GTR No. 22''); IBR approved for § 86.1815–27.

(2) [Reserved]

§ 86.113–04 [Amended]

■ 26. Amend § 86.113–04 by removing and reserving paragraph (a)(2)(i).

■ 27. Amend § 86.113–15 by:

■ a. Removing the introductory text.

■ b. Adding paragraphs (b) and (c).

■ c. Removing paragraphs (d) through (g).

The revisions read as follows:

§ 86.113–15 Fuel specifications.

* * * * *

(b) Diesel fuel. For diesel-fueled engines, use the ultra low-sulfur diesel fuel specified in 40 CFR 1065.703.

(c) Other fuels. For fuels other than gasoline or diesel fuel, use the appropriate test fuel as specified in 40 CFR part 1065, subpart H.

■ 28. Add § 86.113–27 to read as follows:

§ 86.113–27 Fuel specifications.

Use the fuels specified in 40 CFR part 1065 to perform valid tests, as follows:

(a) For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use vehicles will use.

(b) For diesel-fueled engines, use the ultra low-sulfur diesel fuel specified in 40 CFR part 1065.703 for emission testing.

(c) The following fuel requirements apply for gasoline-fueled engines:

(1) Use the appropriate E10 fuel specified in 40 CFR part 1065.710(b) to demonstrate compliance with all exhaust, evaporative, and refueling emission standards under subpart S of this part.

(2) For vehicles certified for 50-state sale, you may instead use California Phase 3 gasoline (E10) as adopted in California's LEV III program as follows:

(i) You may use California Phase 3 gasoline (E10) as adopted in California's LEV III program for exhaust emission testing.

(ii) If you certify vehicles to LEV III evaporative emission standards with California Phase 3 gasoline (E10), you may use that collection of data to certify to evaporative emission standards. For evaporative emission testing with California test fuels, perform tests based on the test temperatures specified by the California Air Resources Board. Note that this paragraph (c)(2)(ii) does not apply for refueling, spitback, high-altitude, or leak testing.

(iii) If you certify using fuel meeting California's specifications, we may perform testing with E10 test fuel meeting either California or EPA specifications.

(d) Interim test fuel specifications apply for model years 2027 through 2029 as described in 40 CFR 600.117.

(e) Additional test fuel specifications apply as specified in subpart S of this part.

■ 29. Amend § 86.132–96 by revising paragraphs (a), (b), (f), (g), (h) introductory text, and (j) introductory text to read as follows:

§ 86.132–96 Vehicle preconditioning.

(a) Prepare the vehicle for testing as described in this section. Store the vehicle before testing in a way that prevents fuel contamination and preserves the integrity of the fuel system. The vehicle shall be moved into the test area and the following operations performed.

(b)(1) *Gasoline- and Methanol-Fueled Vehicles.* Drain the fuel tank(s) and fill with test fuel, as specified in § 86.113, to the ''tank fuel volume'' defined in § 86.082–2. Install the fuel cap(s) within one minute after refueling.

(2) *Gaseous-Fueled Vehicles.* Fill fuel tanks with fuel that meets the specifications in § 86.113. Fill the fuel tanks to a minimum of 75 percent of service pressure for natural gas-fueled vehicles or a minimum of 75 percent of available fill volume for liquefied petroleum gas-fueled vehicles. However, if you omit the refueling event in paragraph (f) of this section, refuel the vehicles to 85 percent instead of 75 percent. Draining the fuel tanks at the start of the test is not required if the fuel in the tanks already meets the specifications in § 86.113.

* * * * *

(f) Drain and then fill the vehicle's fuel tank(s) with test fuel, as specified in § 86.113, to the ''tank fuel volume'' defined in § 86.082–2. Refuel the vehicle within 1 hour after completing the preconditioning drive. Install fuel cap(s) within 1 minute after refueling.

Park the vehicle within five minutes after refueling. However, for the following vehicles you may omit this refueling event and instead drive the vehicle off the dynamometer and park it within five minutes after the preconditioning drive:

(1) Diesel-fueled vehicles.

(2) Gaseous-fueled vehicles.

(3) Fuel economy data vehicles.

(4) In-use vehicles subject to testing under § 86.1845.

(g) The vehicle shall be soaked for not less than 12 hours nor more than 36 hours before the cold start exhaust emission test. The soak period starts at the end of the refueling event, or at the end of the previous drive if there is no refueling.

(h) During the soak period for the three-diurnal test sequence described in § 86.130–96, precondition any evaporative canisters as described in this paragraph (h); however, canister preconditioning is not required for fuel economy data vehicles. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister must be preconditioned separately. If production evaporative canisters are equipped with a functional service port designed for vapor load or purge steps, the service port shall be used during testing to precondition the canister. In addition, for model year 1998 and later vehicles equipped with refueling canisters, these canisters shall be preconditioned for the three-diurnal test sequence according to the procedure in paragraph (j)(1) of this section. If a vehicle is designed to actively control evaporative or refueling emissions without a canister, the manufacturer shall devise an appropriate preconditioning procedure, subject to the approval of the Administrator.

* * * * *

(j) During the soak period for the supplemental two-diurnal test sequence described in § 86.130–96, precondition any evaporative canisters using one of the methods described in this paragraph (j); however, canister preconditioning is not required for fuel economy data vehicles. For vehicles with multiple canisters in a series configuration, the set of canisters must be preconditioned as a unit. For vehicles with multiple canisters in a parallel configuration, each canister must be preconditioned separately. In addition, for model year 1998 and later vehicles equipped with refueling canisters, these canisters shall be preconditioned for the supplemental two-diurnal test sequence according to the procedure in paragraph (j)(1) of this section. Canister emissions are measured to determine breakthrough. Breakthrough is here defined as the point at which the cumulative quantity of hydrocarbons emitted is equal to 2 grams.

* * * * *

■ 30. Amend § 86.134–96 by revising paragraph (g)(1)(xvi) to read as follows:

§ 86.134–96 Running loss test.

* * * * *

(g) * * *

(1) * * *

(xvi) Fuel tank pressure may exceed 10 inches of water during the running loss test only if the manufacturer demonstrates that vapor would not be vented to the atmosphere upon fuel cap removal. Note that this allows for temporary pressure exceedances for vehicles whose tank pressure otherwise remains below 10 inches of water.

* * * * *

§ 86.165–12 [Removed]

■ 31. Remove § 86.165–12.

§ 86.213 [Amended]

■ 32. Amend § 86.213 by removing and reserving paragraph (b).

§ 86.1801–01 [Removed]

■ 33. Remove § 86.1801–01.

■ 34. Revise and republish § 86.1801–12 to read as follows:

§ 86.1801–12 Applicability.

(a) *Applicability.* The provisions of this subpart apply to certain types of new vehicles as described in this paragraph (a). Where the provisions apply for a type of vehicle, they apply for vehicles powered by any fuel, unless otherwise specified. In cases where a provision applies only to a certain vehicle group based on its model year, vehicle class, motor fuel, engine type, or other distinguishing characteristics, the limited applicability is cited in the appropriate section. Testing references in this subpart generally apply to Tier 2 and older vehicles, while testing references to 40 CFR part 1066 generally apply to Tier 3 and newer vehicles; see § 86.101 for detailed provisions related to this transition. The provisions of this subpart apply to certain vehicles as follows:

(1) The provisions of this subpart apply for light-duty vehicles and light-duty trucks.

(2) The provisions of this subpart apply for medium-duty passenger vehicles. The provisions of this subpart also apply for medium-duty vehicles at or below 14,000 pounds GVWR, except as follows:

(i) The provisions of this subpart are optional for diesel-cycle vehicles through model year 2017; however, if you are using the provisions of § 86.1811–17(b)(9) or § 86.1816–18(b)(8) to transition to the Tier 3 exhaust emission standards, the provisions of this subpart are optional for those diesel-cycle vehicles until the start of the Tier 3 phase-in for those vehicles.

(ii) The exhaust emission standards of this part are optional for vehicles above 22,000 pounds GCWR and for all incomplete medium-duty vehicles. Certain requirements in this subpart apply for such vehicles even if they are not certified to the exhaust emission standards of this subpart as follows:

(A) Such vehicles remain subject to the evaporative and refueling emission standards of this subpart.

(B) Such vehicles may remain subject to the greenhouse gas standards in § 86.1819–14 as specified in 40 CFR 1036.635.

(C) Such vehicles may remain subject to onboard diagnostic requirements a specified in 40 CFR 1036.110.

(iii) The provisions of this subpart are optional for diesel-fueled Class 3 heavy-duty vehicles in a given model year if those vehicles are equipped with engines certified to the appropriate standards in § 86.007–11 or 40 CFR 1036.104 for which less than half of the engine family's sales for the model year in the United States are for complete Class 3 heavy-duty vehicles. This includes engines sold to all vehicle manufacturers. If you are the original manufacturer of the engine and the vehicle, base this showing on your sales information. If you manufacture the vehicle but are not the original manufacturer of the engine, you must use your best estimate of the original manufacturer's sales information.

(3) The provisions of this subpart do not apply to heavy-duty vehicles above 14,000 pounds GVWR (see § 86.016–1 and 40 CFR parts 1036 and 1037), except as follows:

(i) Heavy-duty vehicles above 14,000 pounds GVWR may be optionally certified to the exhaust emission standards in this subpart, including the greenhouse gas emission standards, if they are properly included in a test group with similar vehicles at or below 14,000 pounds GVWR. Emission standards apply to these vehicles as if they were Class 3 medium-duty vehicles. The work factor for these vehicles may not be greater than the largest work factor that applies for vehicles in the test group that are at or below 14,000 pounds GVWR (see § 86.1819–14).

(ii) The greenhouse gas standards apply for certain vehicles above 14,000 pounds GVWR as specified in § 86.1819–14.

(iii) Evaporative and refueling emission standards apply for heavy-duty vehicles above 14,000 pounds GVWR as specified in 40 CFR 1037.103.

(4) If you optionally certify vehicles to standards under this subpart, those vehicles are subject to all the regulatory requirements as if the standards were mandatory.

(b) *Relationship to 40 CFR parts 1036 and 1037.* If any heavy-duty vehicle is not subject to standards and certification requirements under this subpart, the vehicle and its installed engine are instead subject to standards and certification requirements under 40 CFR parts 1036 and 1037, as applicable. If you optionally certify engines or vehicles to standards under 40 CFR part 1036 or 40 CFR part 1037, respectively, those engines or vehicles are subject to all the regulatory requirements in 40 CFR parts 1036 and 1037 as if they were mandatory. Note that heavy-duty engines subject to greenhouse gas standards under 40 CFR part 1036 before model year 2027 are also subject to standards and certification requirements under subpart A of this part 86.

(c) *Clean alternative fuel conversions.* The provisions of this subpart also apply to clean alternative fuel conversions as defined in 40 CFR 85.502 of all vehicles described in paragraph (a) of this section.

(d) *Small-volume manufacturers.* Special certification procedures are available for small-volume manufacturers as described in § 86.1838.

(e) *You.* The term ''you'' in this subpart refers to manufacturers subject to the emission standards and other requirements of this subpart.

(f) *Vehicle.* The term ''vehicle'', when used generically, does not exclude any type of vehicle for which the regulations apply (such as light-duty trucks).

(g) *Complete and incomplete vehicles.* Several provisions in this subpart, including the applicability provisions described in this section, are different for complete and incomplete vehicles. We differentiate these vehicle types as described in 40 CFR 1037.801.

(h) *Applicability of provisions of this subpart to light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, and heavy-duty vehicles.* Numerous sections in this subpart provide requirements or procedures applicable to a ''vehicle'' or ''vehicles.'' Unless otherwise specified or otherwise determined by the Administrator, the term ''vehicle'' or ''vehicles'' in those provisions apply equally to light-duty vehicles (LDVs), light-duty trucks (LDTs), medium-duty passenger vehicles (MDPVs), and heavy-duty vehicles (HDVs), as those terms are defined in § 86.1803–01. Note that this subpart also identifies heavy-duty vehicles at or below 14,000 pounds GVWR that are not medium-duty passenger vehicles as medium-duty vehicles.

(i) *Types of pollutants.* Emission standards and related requirements apply for different types of pollutants as follows:

(1) *Criteria pollutants.* Criteria pollutant standards apply for NO_X, NMOG, HC, formaldehyde, PM, and CO, including exhaust, evaporative, and refueling emission standards. These pollutants are sometimes described collectively as ''criteria pollutants'' because they are either criteria pollutants under the Clean Air Act or precursors to the criteria pollutants ozone and PM.

(2) *Greenhouse gas emissions.* This subpart contains standards and other regulations applicable to the emission of the air pollutant defined as the aggregate group of six greenhouse gases: carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

(3) *Nomenclature.* Numerous sections in this subpart refer to requirements relating to ''exhaust emissions.'' Unless otherwise specified or otherwise determined by the Administrator, the term ''exhaust emissions'' refers at a minimum to emissions of all pollutants described by emission standards in this subpart, including carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4).

(j) *Exemption from greenhouse gas emission standards for small businesses.* Manufacturers that qualify as a small business under the Small Business Administration regulations in 13 CFR part 121 are exempt from certain standards and associated provisions as specified in §§ 86.1815, 86.1818, and 86.1819 and in 40 CFR part 600. 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:

(1) Vehicle manufacturers (NAICS code 336111).

(2) Independent commercial importers (NAICS codes 811111, 811112, 811198, 423110, 424990, and 441120).

(3) Alternate fuel vehicle converters (NAICS codes 335312, 336312, 336322, 336399, 454312, 485310, and 811198).

(k) *Conditional exemption from greenhouse gas emission standards.* Manufacturers 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 for model years 2012 through 2016. 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 § 86.1838–01(d), eligibility shall be based on that manufacturer's vehicle production.

(1) [Reserved]

(2) Maintaining eligibility for exemption from greenhouse gas emission standards. To remain eligible for exemption under this paragraph (k) the manufacturer's average sales for the three most recent consecutive model years must remain below 5,000. If a manufacturer's average sales for the three most recent consecutive model years exceeds 4999, the manufacturer will no longer be eligible for exemption and must meet applicable emission standards according to the provisions in this paragraph (k)(2).

(i) If a manufacturer's average sales for three consecutive model years exceeds 4999, and if the increase in sales is the result of corporate acquisitions, mergers, or purchase by another manufacturer, the manufacturer shall comply with the emission standards described in § 86.1818–12(c) through (e), as applicable, beginning with the first model year after the last year of the three consecutive model years.

(ii) If a manufacturer's average sales for three consecutive model years exceeds 4999 and is less than 50,000, and if the increase in sales is solely the result of the manufacturer's expansion in vehicle production, the manufacturer shall comply with the emission standards described in § 86.1818–12(c) through (e), as applicable, beginning with the second model year after the last year of the three consecutive model years.

(iii) If a manufacturer's average sales for three consecutive model years exceeds 49,999, the manufacturer shall comply with the emission standards described in § 86.1818–12(c) through (e), as applicable, beginning with the first model year after the last year of the three consecutive model years.

■ 35. Amend § 86.1803–01 by:

■ a. Revising the definitions for ''Banking'' and ''Defeat device''.

■ b. Removing the definition for ''Durability useful life''.

■ c. Revising the definition for "Electric vehicle".

■ d. Removing the definitions for "Fleet average cold temperature NMHC standard" and "Fleet average NO_X standard".

■ e. Adding definitions for "Incomplete vehicle" and "Light-duty program vehicle" in alphabetical order.

■ f. Revising the definitions for "Light-duty truck" and "Medium-duty passenger vehicle (MDPV)".

■ g. Adding definitions for "Medium-duty vehicle", "Rechargeable Energy Storage System (RESS)", and "Revoke" in alphabetical order.

■ h. Revising the definition for "Supplemental FTP (SFTP)".

■ i. Adding definitions for "Suspend", "Tier 4", and "United States" in alphabetical order.

■ j. Removing the definition for "Useful life".

■ k. Adding a definition for "Void" in alphabetical order.

The revisions and additions read as follows:

§ 86.1803–01 Definitions.

* * * * *

Banking means the retention of emission credits by the manufacturer generating the emission credits, for use in future model year certification programs as permitted by regulation.

* * * * *

Defeat device means an auxiliary emission control device (AECD) that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, unless:

(1) Such conditions are substantially included in driving cycles specified in this subpart, the fuel economy test procedures in 40 CFR part 600, and the air conditioning efficiency test in 40 CFR 1066.845;

(2) The need for the AECD is justified in terms of protecting the vehicle against damage or accident;

(3) The AECD does not go beyond the requirements of engine starting; or

(4) The AECD applies only for emergency vehicles and the need is justified in terms of preventing the vehicle from losing speed, torque, or power due to abnormal conditions of the emission control system, or in terms of preventing such abnormal conditions from occurring, during operation related to emergency response. Examples of such abnormal conditions may include excessive exhaust backpressure from an overloaded particulate trap, and running out of diesel exhaust fluid for engines that rely on urea-based selective catalytic reduction.

* * * * *

Electric vehicle means a motor vehicle that is powered solely by an electric motor drawing current from a rechargeable energy storage system, such as from storage batteries or other portable electrical energy storage devices, including hydrogen fuel cells, provided that:

(1) The vehicle is capable of drawing recharge energy from a source off the vehicle, such as residential electric service; and

(2) The vehicle must be certified to Bin 0 emission standards.

(3) The vehicle does not have an onboard combustion engine/generator system as a means of providing electrical energy.

* * * * *

Incomplete vehicle has the meaning given in 40 CFR 1037.801.

* * * * *

Light-duty program vehicle means any medium-duty passenger vehicle and any vehicle subject to standards under this subpart that is not a heavy-duty vehicle. This definition generally applies for model year 2027 and later vehicles.

Light-duty truck has one of the following meanings:

(1) Except as specified in paragraph (2) of this definition, light-duty truck means any motor vehicle that is not a heavy-duty vehicle, but is:

(i) Designed primarily for purposes of transportation of property or is a derivation of such a vehicle; or

(ii) Designed primarily for transportation of persons and has a capacity of more than 12 persons; or

(iii) Available with special features enabling off-street or off-highway operation and use.

(2) Starting in model year 2027, light-duty truck has the meaning given for "Light truck" in 40 CFR 600.002. Vehicles that qualify as emergency vehicles for any reason under § 86.1803–01 are light-duty trucks if they are derived from light-duty trucks.

* * * * *

Medium-duty passenger vehicle (MDPV) has one of the following meanings:

(1) Except as specified in paragraph (2) of this definition, Medium-duty passenger vehicle means any heavy-duty vehicle (as defined in this subpart) with a gross vehicle weight rating (GVWR) of less than 10,000 pounds that is designed primarily for the transportation of persons. The MDPV definition does not include any vehicle which:

(i) Is an "incomplete vehicle" as defined in this subpart; or

(ii) Has a seating capacity of more than 12 persons; or

(iii) Is designed for more than 9 persons in seating rearward of the driver's seat; or

(iv) 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.

(2) Starting with model year 2027, or earlier at the manufacturer's discretion, Medium-duty passenger vehicle means any heavy-duty vehicle subject to standards under this subpart that is designed primarily for the transportation of persons, with seating rearward of the driver, except that the MDPV definition does not include any vehicle that has any of the following characteristics:

(i) Is an "incomplete vehicle" as defined in this subpart.

(ii) Has a seating capacity of more than 12 persons.

(iii) Is designed for more than 9 persons in seating rearward of the driver's seat.

(iv) Is equipped with an open cargo area (for example, a pick-up truck box or bed) with an interior length of 72.0 inches or more for vehicles above 9,500 pounds GVWR with a work factor above 4,500 pounds. A covered box not readily accessible from the passenger compartment will be considered an open cargo area for purposes of this definition. For purposes of this definition, measure the cargo area's interior length from front to back at floor level with all gates and doors closed.

(v) Is equipped with an open cargo area with an interior length of 94.0 inches or more for vehicles at or below 9,500 pounds GVWR and for all vehicles with a work factor at or below 4,500 pounds.

(vi) Is a van in a configuration with greater cargo-carrying volume than passenger-carrying volume at the point of first retail sale. Determine cargo-carrying volume accounting for any installed second-row seating, even if the manufacturer has not described that as an available feature.

Medium-duty vehicle means any heavy-duty vehicle subject to standards under this subpart, excluding medium-duty passenger vehicles. This definition generally applies for model year 2027 and later vehicles.

* * * * *

Rechargeable Energy Storage System (RESS) has the meaning given in 40 CFR 1065.1001. For electric vehicles and hybrid electric vehicles, this may also be referred to as a Rechargeable Electrical Energy Storage System.

* * * * *

Revoke has the meaning given in 40 CFR 1068.30.

* * * * *

Supplemental FTP (SFTP) means the test procedures designed to measure emissions during aggressive and microtransient driving over the US06 cycle and during driving while the vehicle's air conditioning system is operating over the SC03 cycle as described in § 86.1811–17.

Suspend has the meaning given in 40 CFR 1068.30.

* * * * *

Tier 4 means relating to the Tier 4 emission standards described in § 86.1811–27. Note that a Tier 4 vehicle continues to be subject to Tier 3 evaporative emission standards.

* * * * *

United States has the meaning given in 40 CFR 1068.30.

* * * * *

Void has the meaning given in 40 CFR 1068.30.

* * * * *

■ 36. Amend § 86.1805–17 by revising paragraphs (c) and (d) and removing paragraph (f).

The revisions read as follows:

§ 86.1805–17 Useful life.

* * * * *

(c) *Cold temperature emission standards.* The cold temperature NMHC emission standards in § 86.1811–17 apply for a useful life of 10 years or 120,000 miles for LDV and LLDT, and 11 years or 120,000 miles for HLDT and HDV. The cold temperature CO emission standards in § 86.1811–17 apply for a useful life of 5 years or 50,000 miles.

(d) *Criteria pollutants.* The useful life provisions of this paragraph (d) apply for all emission standards not covered by paragraph (b) or (c) of this section. This paragraph (d) applies for the cold temperature emission standards in § 86.1811–27(c). Except as specified in paragraph (f) of this section and in §§ 86.1811, 86.1813, and 86.1816, the useful life for LDT2, HLDT, MDPV, and HDV is 15 years or 150,000 miles. The useful life for LDV and LDT1 is 10 years or 120,000 miles. Manufacturers may optionally certify LDV and LDT1 to a useful life of 15 years or 150,000 miles, in which case the longer useful life would apply for all the standards and requirements covered by this paragraph (d).

* * * * *

§ 86.1806–05 [Removed]

■ 37. Remove § 86.1806–05.

■ 38. Amend § 86.1806–17 by revising and republishing paragraph (b)(4) and revising paragraph (e) to read as follows:

§ 86.1806–17 Onboard diagnostics.

* * * * *

(b) * * *

(4) For vehicles with installed compression-ignition engines that are subject to standards and related requirements under 40 CFR 1036.104 and 1036.111, you must comply with the following additional requirements:

(i) Make parameters related to engine derating and other inducements available for reading with a generic scan tool as specified in 40 CFR 1036.110(b)(9)(vi).

(ii) Design your vehicles to display information related to engine derating and other inducements in the cab as specified in 40 CFR 1036.110(c)(1) and 1036.601(c).

* * * * *

(e) Onboard diagnostic requirements apply for alternative-fuel conversions as described in 40 CFR part 85, subpart F.

* * * * *

■ 39. Add § 86.1806–27 to read as follows:

§ 86.1806–27 Onboard diagnostics.

Model year 2027 and later vehicles must have onboard diagnostic (OBD) systems as described in this section. OBD systems must generally detect malfunctions in the emission control system, store trouble codes corresponding to detected malfunctions, and alert operators appropriately. Vehicles may optionally comply with the requirements of this section instead of the requirements of § 86.1806–17 before model year 2027.

(a) Vehicles must comply with the 2022 OBD requirements adopted for California as described in this paragraph (a). California's 2022 OBD–II requirements are part of Title 13, section 1968.2 of the California Code of Regulations, operative November 30, 2022 (incorporated by reference, see § 86.1). We may approve your request to certify an OBD system meeting a later version of California's OBD requirements if you demonstrate that it complies with the intent of this section. The following clarifications and exceptions apply for vehicles certified under this subpart:

(1) For vehicles not certified in California, references to vehicles meeting certain California Air Resources Board emission standards are understood to refer to the corresponding EPA emission standards for a given family, where applicable. Use good engineering judgment to correlate the specified standards with the bin standards that apply under this subpart.

(2) Vehicles must comply with OBD requirements throughout the useful life as specified in § 86.1805. If the specified useful life is different for evaporative and exhaust emissions, the useful life specified for evaporative emissions applies for monitoring related to fuel-system leaks and the useful life specified for exhaust emissions applies for all other parameters.

(3) The purpose and applicability statements in 13 CCR 1968.2(a) and (b) do not apply.

(4) The anti-tampering provisions in 13 CCR 1968.2(d)(1.4) do not apply.

(5) The requirement to verify proper alignment between the camshaft and crankshaft described in 13 CCR 1968.2(e)(15.2.1)(C) applies only for vehicles equipped with variable valve timing.

(6) The deficiency provisions described in paragraph (c) of this section apply instead of 13 CCR 1968.2(k).

(7) Apply thresholds for exhaust emission malfunctions from Tier 4 vehicles based on the thresholds calculated for the corresponding bin standards in the California LEV III program as prescribed for the latest model year in 13 CCR 1968.2(d). For example, for Tier 4 Bin 10 standards, apply the threshold that applies for the LEV standards. For cases involving Tier 4 standards that have no corresponding bin standards from the California LEV III program, use the monitor threshold for the next highest LEV III bin. For example, for Tier 4 Bin 5 and Bin 10 standards, apply a threshold of 50 mg/mile (15 mg/mile $\times$ 3.33). You may apply thresholds that are more stringent than we require under this paragraph (a)(7).

(8) Apply thresholds and testing requirements as specified in 40 CFR 1036.110(b)(5), (6) and (11) for engines certified to emission standards under 40 CFR part 1036.

(b) For vehicles with installed compression-ignition engines that are subject to standards and related requirements under 40 CFR 1036.104 and 1036.111, you must comply with the following additional requirements:

(1) Make parameters related to engine derating and other inducements available for reading with a generic scan tool as specified in 40 CFR 1036.110(b)(9)(vi).

(2) Design your vehicles to display information related to engine derating and other inducements in the cab as

specified in 40 CFR 1036.110(c)(1) and 1036.601(c).

(c) You may ask us to accept as compliant a vehicle that does not fully meet specific requirements under this section. Such deficiencies are intended to allow for minor deviations from OBD standards under limited conditions. We expect vehicles to have functioning OBD systems that meet the objectives stated in this section. The following provisions apply regarding OBD system deficiencies:

(1) Except as specified in paragraph (d) of this section, we will not approve a deficiency that involves the complete lack of a major diagnostic monitor, such as monitors related to exhaust aftertreatment devices, oxygen sensors, air-fuel ratio sensors, NO_X sensors, engine misfire, evaporative leaks, and diesel EGR (if applicable).

(2) We will approve a deficiency only if you show us that full compliance is infeasible or unreasonable considering any relevant factors, such as the technical feasibility of a given monitor, or the lead time and production cycles of vehicle designs and programmed computing upgrades.

(3) Our approval for a given deficiency applies only for a single model year, though you may continue to ask us to extend a deficiency approval in renewable one-year increments. We may approve an extension if you demonstrate an acceptable level of effort toward compliance and show that the necessary hardware or software modifications would pose an unreasonable burden.

(d) For alternative-fuel vehicles, manufacturers may request a waiver from specific requirements for which monitoring may not be reliable for operation with the alternative fuel. However, we will not waive requirements that we judge to be feasible for a particular manufacturer or vehicle model.

(e) OBD-related requirements for alternative-fuel conversions apply as described in 40 CFR part 85, subpart F.

(f) You may ask us to waive certain requirements in this section for emergency vehicles. We will approve your request for an appropriate duration if we determine that the OBD requirement in question could harm system performance in a way that would impair a vehicle's ability to perform its emergency functions.

(g) The following interim provisions describe an alternate implementation schedule for the requirements of this section in certain circumstances:

(1) Manufacturers may delay complying with all the requirements of this section, and instead meet all the requirements that apply under § 86.1806–17 for any vehicles above 6,000 pounds GVWR that are not yet subject to all the Tier 4 standards in § 86.1811.

(2) Except as specified in this paragraph (g)(2), small-volume manufacturers may delay complying with all the requirements of this section until model year 2030, and instead meet all the requirements that apply under § 86.1806–17 during those years.

■ 40. Amend § 86.1807–01 by adding paragraph (a)(3)(iv) and revising paragraph (d) to read as follows:

§ 86.1807–01 Vehicle labeling.

(a) * * *

(3) * * *

(iv) Monitor family and battery durability family as specified in § 86.1815–27, if applicable;

* * * * *

(d) The following provisions apply for incomplete vehicles certified under this subpart:

(1) Incomplete light-duty trucks must have the following prominent statement printed on the label required by paragraph (a)(3)(v) of this section: ''This vehicle conforms to U.S. EPA regulations applicable to 20xx Model year Light-Duty Trucks when it does not exceed XXX pounds in curb weight, XXX pounds in gross vehicle weight rating, and XXX square feet in frontal area.''

(2) Incomplete heavy-duty vehicles must have the following prominent statement printed on the label required by paragraph (a)(3)(v) of this section: ''This vehicle conforms to U.S. EPA regulations applicable to 20xx Model year Heavy-Duty Vehicles when it does not exceed XXX pounds in curb weight, XXX pounds in gross vehicle weight rating, and XXX square feet in frontal area.''

* * * * *

§ 86.1808–01 [Amended]

■ 41. Amend § 86.1808–01 by removing and reserving paragraph (e).

§§ 86.1809–01 and 86.1809–10 [Removed]

■ 42. Remove §§ 86.1809–01 and 86.1809–10.

■ 43. Revise § 86.1809–12 to read as follows:

§ 86.1809–12 Prohibition of defeat devices.

(a) No new vehicle shall be equipped with a defeat device.

(b) EPA may test or require testing on any vehicle at a designated location, using driving cycles and conditions that may reasonably be expected to be encountered in normal operation and use, for the purposes of investigating a potential defeat device.

(c) For cold temperature CO, NMHC, and $NMOG+NO_X$ emission control, EPA will use a guideline to determine the appropriateness of the CO emission control and the NMHC or $NMOG+NO_X$ emission control at ambient temperatures between 25 °F (the upper bound of the range for cold temperature testing) and 68 °F (the lower bound of the FTP test temperature range). The guideline for CO and $NMOG+NO_X$ emission congruity across the intermediate temperature range is the linear interpolation between the CO or $NMOG+NO_X$ standard applicable at 25 °F and the corresponding standard applicable at 68 °F. The guideline for NMHC emission congruity across the intermediate temperature range is the linear interpolation between the NMHC FEL pass limit (*e.g.,* 0.3499 g/mi for a 0.3 g/mi FEL) applicable at 20 °F and the Tier 2 NMOG standard or the Tier 3 or Tier 4 $NMOG+NO_X$ bin standard to which the vehicle was certified at 68 °F, where the intermediate temperature NMHC level is rounded to the nearest 0.01 g/mile for comparison to the interpolated line. The following provisions apply for vehicles that exceed the specified emission guideline during intermediate temperature testing:

(1) If the CO emission level is greater than the 20 °F emission standard, the vehicle will automatically be considered to be equipped with a defeat device without further investigation. If the intermediate temperature NMHC or $NMOG+NO_X$ emission level, rounded to the nearest 0.01 g/mile or the nearest 10 mg/mile, is greater than the 20 °F FEL pass limit, the vehicle will be presumed to have a defeat device unless the manufacturer provides evidence to EPA's satisfaction that the cause of the test result in question is not due to a defeat device.

(2) If the conditions in paragraph (c)(1) of this section do not apply, EPA may investigate the vehicle design for the presence of a defeat device under paragraph (d) of this section.

(d) The following provisions apply for vehicle designs EPA designates for investigation as possible defeat devices:

(1) The manufacturer must show to EPA's satisfaction that the vehicle design does not incorporate strategies that unnecessarily reduce emission control effectiveness exhibited over the driving cycles specified in this subpart, the fuel economy test procedures in 40 CFR part 600, or the air conditioning efficiency test in 40 CFR 1066.845, when the vehicle is operated under conditions that may reasonably be

expected to be encountered in normal operation and use.

(2) [Reserved]

(3) The following information requirements apply:

(i) Upon request by EPA, the manufacturer must provide an explanation containing detailed information regarding test programs, engineering evaluations, design specifications, calibrations, on-board computer algorithms, and design strategies incorporated for operation both during and outside of the Federal emission test procedures.

(ii) For purposes of investigation of possible cold temperature CO, NMHC, or $NMOG+NO_X$ defeat devices under this paragraph (d), the manufacturer must provide an explanation to show to EPA's satisfaction that CO emissions and NMHC or $NMOG+NO_X$ emissions are reasonably controlled in reference to the linear guideline across the intermediate temperature range.

(e) For each test group the manufacturer must submit an engineering evaluation with the Part II certification application demonstrating to EPA's satisfaction that a discontinuity in emissions of non-methane organic gases, particulate matter, carbon monoxide, carbon dioxide, oxides of nitrogen, nitrous oxide, methane, and formaldehyde measured on the Federal Test Procedure (40 CFR 1066.801(c)(1)) and on the Highway Fuel Economy Test Procedure (40 CFR 1066.801(c)(5)) does not occur in the temperature range of 20 to 86 °F.

■ 44. Amend § 86.1810–17 by revising paragraph (g) and revising and republishing paragraph (h) to read as follows:

§ 86.1810–17 General requirements.

* * * * *

(g) The cold temperature standards in this subpart refer to test procedures set forth in subpart C of this part and 40 CFR part 1066, subpart H. All other emission standards in this subpart rely on test procedures set forth in subpart B of this part and 40 CFR part 1066, subpart H. These procedures rely on the test specifications in 40 CFR parts 1065 and 1066 as described in subparts B and C of this part.

(h) Multi-fueled vehicles (including dual-fueled and flexible-fueled vehicles) must comply with all the requirements established for each consumed fuel (and blend of fuels for flexible-fueled vehicles). The following specific provisions apply for flexible-fueled vehicles that operate on ethanol and gasoline:

(1) For criteria exhaust emissions, we may identify the worst-case fuel blend for testing in addition to what is required for gasoline-fueled vehicles. The worst-case fuel blend may be the fuel specified in 40 CFR 1065.725, or it may consist of a combination of the fuels specified in 40 CFR 1065.710(b) and 1065.725. We may waive testing with the worst-case blended fuel for US06 and/or SC03 duty cycles; if we waive only SC03 testing for Tier 3 vehicles, substitute the SC03 emission result using the standard test fuel for gasoline-fueled vehicles to calculate composite SFTP emissions.

(2) For evaporative and refueling emissions, test using the fuel specified in 40 CFR 1065.710(b).

(3) No additional spitback or evaporative emission testing is required beyond the emission measurements with the gasoline test fuel specified in 40 CFR 1065.710.

* * * * *

■ 45. Amend § 86.1811–17 by revising paragraphs (b)(8)(iii)(B), (d) introductory text, and (g)(2)(ii) to read as follows:

§ 86.1811–17 Exhaust emission standards for light-duty vehicles, light-duty trucks and medium-duty passenger vehicles.

* * * * *

(b) * * *

(8) * * *

(iii) * * *

(B) You may continue to use the E0 test fuel specified in § 86.113 as described in 40 CFR 600.117.

* * * * *

(d) *Special provisions for Otto-cycle engines.* The following special provisions apply for vehicles with Otto-cycle engines:

* * * * *

(g) * * *

(2) * * *

(ii) The manufacturer must calculate its fleet average cold temperature NMHC emission level(s) as described in § 86.1864–10(b).

* * * * *

■ 46. Add § 86.1811–27 to read as follows:

§ 86.1811–27 Criteria exhaust emission standards.

(a) *Applicability and general provisions.* The criteria exhaust emission standards of this section apply for both light-duty program vehicles and medium-duty vehicles, starting with model year 2027.

(1) A vehicle meeting all the requirements of this section is considered a Tier 4 vehicle meeting the Tier 4 standards. Vehicles meeting some but not all requirements are considered interim Tier 4 vehicles as described in paragraph (b)(6)(iv) of this section.

(2) The Tier 4 standards include testing over a range of driving schedules and ambient temperatures. The standards for 25 °C or 35 °C testing in paragraph (b) of this section apply separate from the −7 °C testing in paragraph (c) of this section. We may identify these standards based on nominal ambient test temperatures. Note that −7 °C testing is also identified as cold temperature testing elsewhere in this subpart.

(3) See § 86.1813 for evaporative and refueling emission standards.

(4) See § 86.1818 for greenhouse gas emission standards.

(b) *Exhaust emission standards for 25 and 35 °C testing.* Exhaust emissions may not exceed standards over several driving cycles as follows:

(1) Measure emissions using the chassis dynamometer procedures of 40 CFR part 1066, as follows:

(i) Establish appropriate load settings based on loaded vehicle weight for light-duty program vehicles and adjusted loaded vehicle weight for medium-duty vehicles (see § 86.1803).

(ii) Emission standards under this paragraph (b) apply for all the following driving cycles unless otherwise specified:

The driving cycle . . .	is identified in . . .
(A) FTP	40 CFR 1066.801(c)(1).
(B) US06	40 CFR 1066.801(c)(2).
(C) SC03	40 CFR 1066.801(c)(3).
(D) HFET	40 CFR 1066.801(c)(5).
(E) ACC II—Mid-temperature intermediate soak	40 CFR 1066.801(c)(8).
(F) ACC II—Early driveaway	40 CFR 1066.801(c)(9).
(G) ACC II High-load PHEV engine starts	40 CFR 1066.801(c)(10).

(iii) Testing occurs at (20–30) °C ambient temperatures, except that a nominal ambient temperature of 35.0 °C applies for testing over the SC03 driving cycle. See paragraph (c) of this section for emission standards and measurement procedures that apply for cold temperature testing.

(iv) Hydrocarbon emission standards are expressed as NMOG; however, for certain vehicles you may measure exhaust emissions based on nonmethane hydrocarbon instead of NMOG as described in 40 CFR 1066.635.

(v) Measure emissions from hybrid electric vehicles (including plug-in hybrid electric vehicles) as described in 40 CFR part 1066, subpart F, except that these procedures do not apply for plug-in hybrid electric vehicles during charge-depleting operation.

(2) Fully phased-in standards apply as specified in the following table:

TABLE 1—TO PARAGRAPH (b)(2)—FULLY PHASED-IN TIER 4 CRITERIA EXHAUST EMISSION STANDARDS [a]

	$NMOG+NO_X$ (mg/mile) [b]	PM (mg/mile) [c]	CO (g/mile) [d]	Formaldehyde (mg/mile) [e]
Light-duty program vehicles	15	0.5	1.7	4
Medium-duty vehicles	75	0.5	3.2	6

[a] Paragraphs (b)(6) and (f) of this section describe how these standards phase in for model year 2027 and later vehicles.
[b] The $NMOG+NO_X$ standards apply on a fleet-average basis using discrete bin standards as described in paragraphs (b)(4) and (6) of this section.
[c] PM standards do not apply for the SC03, HFET, and ACC II driving cycles specified in paragraphs (b)(1)(ii)(C) through (G) of this section.
[d] Alternative CO standards of 9.6 and 25 g/mile apply for the US06 driving cycle for light-duty program vehicles and medium-duty vehicles, respectively. CO standards do not apply for the ACC II driving cycles specified in paragraph (b)(1)(ii)(E) through (G) of this section.
[e] Formaldehyde standards apply only for the FTP driving cycle.

(3) The FTP standards specified in this paragraph (b) apply equally for testing at low-altitude conditions and high-altitude conditions. The US06, SC03, and HFET standards apply only for testing at low-altitude conditions.

(4) The $NMOG+NO_X$ emission standard is based on a fleet average for a given model year.

(i) You must specify a family emission limit (FEL) for each test group based on the FTP emission standard corresponding to each named bin. The FEL serves as the emission standard for the test group with respect to all specified driving cycles. Calculate your fleet average emission level as described in § 86.1860 to show that you meet the specified fleet average standard. For multi-fueled vehicles, calculate fleet average emission levels based only on emission levels for testing with gasoline or diesel fuel. You may generate emission credits for banking and trading, and you may use banked or traded credits as described in § 86.1861 for demonstrating compliance with the fleet average $NMOG+NO_X$ emission standard. You comply with the fleet average emission standard for a given model year if you have enough credits to show that your fleet average emission level is at or below the applicable standard.

(ii) Select one of the identified values from table 2 of this section for demonstrating that your fleet average emission level for light-duty program vehicles complies with the fleet average $NMOG+NO_X$ emission standard. These FEL values define emission bins that also determine corresponding emission standards for $NMOG+NO_X$ emission standards for ACC II driving cycles, as follows:

TABLE 2 TO PARAGRAPH (b)(4)(ii)—TIER 4 $NMOG+NO_X$ BIN STANDARDS FOR LIGHT-DUTY PROGRAM VEHICLES

[mg/mile]

FEL name	FTP, US06, SC03, HFET	ACC II—Mid-temperature intermediate soak (3–12 hours)	ACC II—Mid-temperature intermediate soak (40 minutes) [a]	ACC II—Mid-temperature intermediate soak (10 minutes)	ACC II—Early driveaway [b]	ACC II—High-power PHEV engine starts [b c]
Bin 70	70	70	54	35	82	200
Bin 65	65	65	50	33	77	188
Bin 60	60	60	46	30	72	175
Bin 55	55	55	42	28	67	163
Bin 50	50	50	38	25	62	150
Bin 45	45	45	35	23	57	138
Bin 40	40	40	31	20	52	125
Bin 35	35	35	27	18	47	113
Bin 30	30	30	23	15	42	100
Bin 25	25	25	19	13	37	84
Bin 20	20	20	15	10	32	67
Bin 15	15	15	12	8	27	51
Bin 10	10	10	8	5	22	34
Bin 5	5	5	4	3	17	17
Bin 0	0					

[a] Calculate the bin standard for a soak time between 10 and 40 minutes based on a linear interpolation between the corresponding bin values for a 10-minute soak and a 40-minute soak. Similarly, calculate the bin standard for a soak time between 40 minutes and 3 hours based on a linear interpolation between the corresponding bin values for a 40-minute soak and a 3-hour soak.
[b] Qualifying vehicles are exempt from standards for early driveaway and high-power PHEV engine starts as described in paragraph (b)(5) of this section.
[c] Alternative standards apply for high-power PHEV engine starts for model years 2027 through 2029 as described in paragraph (b)(6)(v) of this section.

(iii) You may select one of the identified values from table 2 to paragraph (b)(4)(ii) of this section for demonstrating that your fleet average emission level for medium-duty vehicles complies with the fleet average $NMOG+NO_X$ emission standard. The following additional $NMOG+NO_X$ bin standards are also available for medium-duty vehicles: 75, 85, 100, 125, 150, and 170 mg/mile. Medium-duty vehicles are not subject to standards based on the ACC II driving cycles specified in paragraphs (b)(1)(ii)(E) through (G) of this section.

(5) Qualifying vehicles are exempt from certain ACC II bin standards as follows:

(i) Vehicles are exempt from the ACC II bin standards for early driveaway if the vehicle prevents engine starting during the first 20 seconds of a cold-start FTP test interval and the vehicle does not use an electrically heated catalyst or other technology to precondition the engine or emission controls such that $NMOG+NO_X$ emissions would be higher during the first 505 seconds of the early driveaway driving cycle compared to the first 505 seconds of the conventional FTP driving cycle.

(ii) Vehicles are exempt from the ACC II bin standards for high-power PHEV engine starts if their all-electric range on the cold-start US06 driving cycles is at or above 10 miles for model years 2027 through 2029, and at or above 40 miles for model year 2030 and later.

(6) The Tier 4 standards phase in over several years, as follows:

(i) *Light-duty program vehicles.* Include all light-duty program vehicles at or below 6,000 pounds GVWR in the calculation to comply with the Tier 4 fleet average $NMOG+NO_X$ standard for 25 °C testing in paragraph (b)(2) of this section. You must meet all the other Tier 4 requirements with 20, 40, 60, and 100 percent of your projected nationwide production volumes in model years 2027 through 2030, respectively. A vehicle counts toward meeting the phase-in percentage only if it meets all the requirements of this section. Fleet average $NMOG+NO_X$ standards apply as follows for model year 2027 through 2032 light-duty program vehicles:

TABLE 3 TO PARAGRAPH (b)(6)(i)—DECLINING FLEET AVERAGE $NMOG+NO_X$ STANDARDS FOR LIGHT-DUTY PROGRAM VEHICLES

Model year	Fleet average $NMOG+NO_X$ standard (mg/mile)
2027	25
2028	23
2029	21
2030	19
2031	17
2032	15

(ii) *Default phase-in for vehicles above 6,000 pounds GVWR.* The default approach for phasing in the Tier 4 standards for vehicle above 6,000 pounds GVWR is for all those vehicles to meet the fully phased in Tier 4 standards of this section starting in model year 2030 for light-duty program vehicles and in model year 2031 for medium-duty vehicles. Manufacturers using this default phase-in for medium-duty vehicles may not use credits generated from earlier model years for demonstrating compliance with the Tier 4 $NMOG+NO_X$ standards under this paragraph (b).

(iii) *Alternative early phase-in for vehicles above 6,000 pounds GVWR.* Manufacturers may use the following alternative early phase-in provisions to transition to the Tier 4 exhaust emission standards on an earlier schedule for vehicles above 6,000 pounds GVWR.

(A) If you select the alternative early phase-in for light-duty program vehicles above 6,000 pounds GVWR, you must demonstrate that you meet the phase-in requirements in paragraph (b)(6)(i) of this section based on all your light-duty program vehicles.

(B) If you select the alternative early phase-in for medium-duty vehicles, include all medium-duty vehicles in the calculation to comply with the Tier 4 fleet average $NMOG+NO_X$ standard starting in model year 2027. You must meet all the other Tier 4 requirements with 20, 40, 60, 80, and 100 percent of a manufacturer's projected nationwide production volumes in model years 2027 through 2031, respectively. A vehicle counts toward meeting the phase-in percentage only if it meets all the requirements of this section. Medium-duty vehicles complying with the alternative early phase-in are subject to the following fleet average $NMOG+NO_X$ standards for model years 2027 through 2033:

TABLE 4 TO PARAGRAPH (b)(6)(iii)(B)—DECLINING FLEET AVERAGE $NMOG+NO_X$ STANDARDS FOR MEDIUM-DUTY VEHICLES

Model year	Fleet average $NMOG+NO_X$ standard (mg/mile)
2027	175
2028	160
2029	140
2030	120
2031	100
2032	80
2033	75

(C) If you select the alternative early phase-in but are unable to meet all the requirements that apply in any model year before model year 2030 for light-duty program vehicles and model year 2031 for medium-duty vehicles, you may switch to the default phase-in. Switching to the default phase-in does not affect certification or compliance obligations for model years before you switch to the default phase-in.

(iv) *Interim Tier 4 vehicles.* Vehicles not meeting all the requirements of this section during the phase-in are considered ''interim Tier 4 vehicles''. Interim Tier 4 vehicles are subject to all the requirements of this subpart that apply for Tier 3 vehicles except for the fleet average $NMOG+NO_X$ standards in §§ 86.1811–17 and 86.1816–18. Interim Tier 4 vehicles may certify to the 25 °C fleet average $NMOG+NO_X$ standard under this section using all available Tier 3 bins under §§ 86.1811–17 and 86.1816–18. Interim Tier 4 vehicles are subject to the whole collection of Tier 3 bin standards, and they are not subject to any of the Tier 4 bin standards specified in this section. Note that manufacturers complying with the default phase-in specified in paragraph (b)(6)(ii) of this section for Interim Tier 4 light-duty program vehicles above 6,000 pounds GVWR will need to meet a Tier 3 fleet average $NMOG+NO_X$ standard in model years 2027 through 2029 in addition to the Tier 4 fleet average $NMOG+NO_X$ standard for vehicles at or below 6,000 pounds GVWR in those same years. Note that emission credits from those Tier 3 and Tier 4 light-duty program vehicles remain in the same averaging set.

(v) *Phase-in for high-power PHEV engine starts.* The following bin standards apply for high-power PHEV engine starts in model years 2027 through 2029 instead of the analogous standards specified in paragraph (b)(4)(ii) of this section:

TABLE 5 TO PARAGRAPH (b)(6)(v)—MODEL YEAR 2027 THROUGH 2029 BIN STANDARDS FOR HIGH-POWER PHEV ENGINE STARTS

FEL name	ACC II—High-power PHEV engine starts (mg/mile)
Bin 70	320
Bin 65	300
Bin 60	280
Bin 55	260
Bin 50	240
Bin 45	220
Bin 40	200
Bin 35	175
Bin 30	150
Bin 25	125
Bin 20	100
Bin 15	75
Bin 10	50
Bin 5	25

(vi) *MDPV.* Any vehicle that becomes an MDPV as a result of the revised definition in § 86.1803–01 starting in model 2027 remains subject to the heavy-duty Tier 3 standards in § 86.1816–18 under the default phase-in specified in paragraph (b)(6)(ii) of this section for model years 2027 through 2030.

(vii) Keep records as needed to show that you meet the requirements specified in this paragraph (b) for phasing in standards and for complying with declining fleet average average standards.

(c) *Exhaust emission standards for −7 °C testing.* Exhaust emissions may not exceed standards for −7 °C testing, as follows:

(1) Measure emissions as described in 40 CFR 1066.801(c)(1) and (6).

(2) The standards apply to gasoline-fueled and diesel-fueled vehicles, except as specified. Multi-fuel, bi-fuel or dual-fuel vehicles must comply with requirements using only gasoline and diesel fuel, as applicable. Testing with other fuels such as electricity or a high-level ethanol-gasoline blend is not required.

(3) The following standards apply equally for light-duty program vehicles and medium-duty vehicles:

(i) Gasoline-fueled vehicles must meet a fleet average NMOG+NO_X standard of 300 mg/mile. Calculate fleet average emission levels as described in § 86.1864. There is no NMOG+NO_X standard for diesel-fueled vehicles, but manufacturers must measure and report emissions as described in § 86.1829–15(g).

(ii) The PM standard is 0.5 mg/mile.

(iii) The CO standard is 10.0 g/mile.

(4) The CO standard applies at both low-altitude and high-altitude conditions. The NMOG+NO_X and PM standards apply only at low-altitude conditions. However, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitudes. Any deviation from low altitude emission control practices must be included in the auxiliary emission control device (AECD) descriptions submitted at certification. Any AECD specific to high altitude must require engineering emission data for EPA evaluation to quantify any emission impact and validity of the AECD.

(5) Phase-in requirements for standards under this paragraph (c) apply as described in paragraphs (b)(6) and (f) of this section.

(d) *Special provisions for spark-ignition engines.* The following A/C-on specific calibration provisions apply for vehicles with spark-ignition engines:

(1) A/C-on specific calibrations (*e.g.,* air-fuel ratio, spark timing, and exhaust gas recirculation) that differ from A/C-off calibrations may be used for a given set of engine operating conditions (*e.g.,* engine speed, manifold pressure, coolant temperature, air charge temperature, and any other parameters). Such calibrations must not unnecessarily reduce emission control effectiveness during A/C-on operation when the vehicle is operated under conditions that may reasonably be expected during normal operation and use. If emission control effectiveness decreases as a result of such calibrations, the manufacturer must describe in the Application for Certification the circumstances under which this occurs and the reason for using these calibrations.

(2) For AECDs involving commanded enrichment, these AECDs must not operate differently for A/C-on operation than for A/C-off operation. This includes both the sensor inputs for triggering enrichment and the degree of enrichment employed.

(e) *Off-cycle emission standards for high-GCWR vehicles.* Model year 2031 and later medium-duty vehicles above 22,000 pounds GCWR must meet off-cycle emission standards as follows:

(1) The engine-based off-cycle emission standards in 40 CFR 1036.104(a)(3) apply for vehicles with compression-ignition engines based on measurement procedures with 2-bin moving average windows. Manufacturers may instead meet the following alternative standards for measurement procedures with 3-bin moving average windows:

TABLE 6 TO PARAGRAPH (e)(1)—ALTERNATIVE OFF-CYCLE STANDARDS FOR HIGH-GCWR VEHICLES WITH COMPRESSION-IGNITION ENGINES [a]

Off-cycle bin	NO_X [b]	HC mg/hp·hr	PM mg/hp·hr	CO g/hp·hr
Bin 1	7.5 g/hr			
Bin 2a	75 mg/hp·hr	210	7.5	23.25
Bin 2b	30 mg/hp·hr	210	7.5	23.25

[a] Listed standards include a conformity factor of 1.5. Accuracy margins apply as described in § 86.1845–04(h).
[b] There is no temperature-based adjustment to the off-cycle NO_X standard for testing with three-bin moving average windows.

(2) The following emission standards apply for spark-ignition engines:

TABLE 7 TO PARAGRAPH (e)(2)—OFF-CYCLE EMISSION STANDARDS FOR HIGH-GCWR VEHICLES WITH SPARK-IGNITION ENGINES [a]

Pollutant	Off-cycle emission standard
NO_X [b]	30 mg/hp·hr.
HC	210 mg/hp·hr.
PM	7.5 mg/hp·hr.

TABLE 7 TO PARAGRAPH (e)(2)—OFF-CYCLE EMISSION STANDARDS FOR HIGH-GCWR VEHICLES WITH SPARK-IGNITION ENGINES [a]—Continued

Pollutant	Off-cycle emission standard
CO	21.6 g/hp·hr.

[a] Listed standards include a conformity factor of 1.5.
[b] There is no temperature-based adjustment to the off-cycle NO_X standard for vehicles with spark-ignition engines.

(3) In-use testing requirements and measurement procedures apply as described in § 86.1845–04(h).

(f) *Small-volume manufacturers.* Small-volume manufacturers may use the following phase-in provisions for light-duty program vehicles:

(1) Instead of the 25 °C fleet average $NMOG+NO_X$ standards specified in this section, small-volume manufacturers may meet alternate fleet average standards of 51 mg/mile for model year 2027 and 30 mg/mile for model years 2028 through 2031. The 15 mg/mile standard applies starting in model year 2032.

(2) Instead of the phase-in specified in paragraph (b)(6)(i) of this section, small-volume manufacturers may comply with all the requirements of this section other than the $NMOG+NO_X$ standards starting in model year 2032.

■ 47. Amend § 86.1813–17 by:
■ a. Revising paragraph (a)(2)(i) introductory text;
■ b. Adding paragraphs (a)(2)(iv) and (v); and
■ c. Revising paragraphs (b)(1) and (g)(2)(ii)(B).

The revisions and additions read as follows:

§ 86.1813–17 Evaporative and refueling emission standards.

* * * * *

(a) * * *

(2) * * *

(i) The emission standard for the sum of diurnal and hot soak measurements from the two-diurnal test sequence and the three-diurnal test sequence is based on a fleet average in a given model year. You must specify a family emission limit (FEL) for each evaporative family. The FEL serves as the emission standard for the evaporative family with respect to all required diurnal and hot soak testing. Calculate your fleet average emission level as described in § 86.1860 based on the FEL that applies for low-altitude testing to show that you meet the specified standard. For multi-fueled vehicles, calculate fleet average emission levels based only on emission levels for testing with gasoline. You may generate emission credits for banking and trading, and you may use banked or traded credits for demonstrating compliance with the diurnal plus hot soak emission standard for vehicles required to meet the Tier 3 standards, other than gaseous-fueled or electric vehicles, as described in § 86.1861 starting in model year 2017. You comply with the emission standard for a given model year if you have enough credits to show that your fleet average emission level is at or below the applicable standard. You may exchange credits between or among evaporative families within an averaging set as described in § 86.1861. Separate diurnal plus hot soak emission standards apply for each evaporative/refueling emission family as shown for high-altitude conditions. The sum of diurnal and hot soak measurements may not exceed the following Tier 3 standards:

* * * * *

(iv) Vehicles that become light-duty vehicles based on the change in the definition for ''light-duty truck'' for Tier 4 vehicles may continue to meet the same evaporative emission standards under this paragraph (a) through model year 2031 as long as they qualify for carryover certification as described in § 86.1839.

(v) Vehicles that are no longer medium-duty vehicles based on the change in the definition for ''medium-duty passenger vehicles'' for Tier 4 vehicles may continue to meet the same evaporative emission standards under this paragraph (a) through model year 2031 as long as they qualify for carryover certification as described in § 86.1839.

* * * * *

(b) * * *

(1) The following implementation dates apply for incomplete heavy-duty vehicles:

(i) Refueling standards apply starting with model year 2027 for incomplete heavy-duty vehicles certified under 40 CFR part 1037 and in model year 2030 for incomplete heavy-duty vehicles certified under this subpart, unless the manufacturer complies with the alternate phase-in specified in paragraph (b)(1)(iii) of this section. If you do not meet the alternative phase-in requirement for model year 2026, you must certify all your incomplete heavy-duty vehicles above 14,000 pounds GVWR to the refueling standard in model year 2027.

(ii) Refueling standards are optional for incomplete heavy-duty vehicles at or below 14,000 pounds GVWR through model year 2029, unless the manufacturer uses the alternate phase-in specified in paragraph (b)(1)(iii) of this section to meet standards together for heavy-duty vehicles above and below 14,000 pounds GVWR.

(iii) Manufacturers may comply with an alternate phase-in of the refueling standard for incomplete heavy-duty vehicles as described in this paragraph (b)(1)(iii). Manufacturers must meet the refueling standard during the phase-in based on their projected nationwide production volume of all incomplete heavy-duty vehicles subject to standards under this subpart and under 40 CFR part 1037 as described in Table 4 of this section. Keep records as needed to show that you meet phase-in requirements.

TABLE 4 OF § 86.1813–17—ALTERNATIVE PHASE-IN SCHEDULE FOR REFUELING EMISSION STANDARDS FOR INCOMPLETE HEAVY-DUTY VEHICLES

Model year	Minimum percentage of heavy-duty vehicles subject to the refueling standard
2026	40
2027	40
2028	80
2029	80
2030	100

* * * * *

(g) * * *

(2) * * *

(ii) * * *

(B) All the vehicles meeting the leak standard must also meet the Tier 3 evaporative emission standards. Through model year 2026, all vehicles meeting the leak standard must also meet the OBD requirements in § 86.1806–17(b)(1).

* * * * *

■ 48. Add § 86.1815–27 to read as follows:

§ 86.1815–27 Battery-related requirements for battery electric vehicles and plug-in hybrid electric vehicles.

Except as specified in paragraph (h) of this section, battery electric vehicles and plug-in hybrid electric vehicles must meet requirements related to batteries serving as a Rechargeable Energy Storage System from GTR No. 22 (incorporated by reference, see § 86.1). The requirements of this section apply starting in model year 2027 for vehicles at or below 6,000 pounds GVWR. The requirements of this section start to apply for vehicles above 6,000 pounds GVWR when they are first certified to Tier 4 NMOG+NO_X bin standards under § 86.1811–27(b), not later than model year 2031. The following clarifications and adjustments to GTR No. 22 apply for vehicles subject to this section:

(a) Manufacturers must install an operator-accessible display that monitors, estimates, and communicates the vehicle's State of Certified Energy (SOCE) and include information in the application for certification as described in § 86.1844. Display SOCE as a percentage expressed at least to the nearest whole number. Manufacturers that qualify as small businesses under § 86.1801–12(j)(1) must meet the requirements of this paragraph (a) but are not subject to the requirements in paragraphs (c) through (g) of this section; however, small businesses may trade credits they generate from battery electric vehicles and plug-in hybrid electric vehicles for a given model year only if they meet requirements in paragraphs (c) through (g) of this section.

(b) Requirements in GTR No. 22 related to State of Certified Range do not apply.

(c) Evaluate SOCE based on measured Usable Battery Energy (UBE) values. Use the Multi-Cycle Range and Energy Consumption Test described in 40 CFR 600.116–12(a) for battery electric vehicles and either the UDDS Full Charge Test (FCT) or the HFET FCT as described in 40 CFR 600.116–12(c)(11) for plug-in hybrid electric vehicles. For medium-duty vehicles, perform testing with test weight set to Adjusted Loaded Vehicle Weight.

(d) In-use vehicles must display SOCE values that are accurate within 5 percent of measured values as calculated in GTR No. 22.

(e) Batteries installed in light-duty program vehicles must meet a Minimum Performance Requirement such that measured usable battery energy is at least 80 percent of the vehicle's certified usable battery energy after 5 years or 62,000 miles, and at least 70 percent of certified usable battery energy at 8 years or 100,000 miles.

(f) Manufacturers must divide test groups into families and perform testing and submit reports as follows:

(1) Identify battery durability families and monitor families as specified in Section 6.1 of GTR No. 22. Include vehicles in the same battery durability family only if there are no chemistry differences that would be expected to influence durability, such as proportional metal composition of the cathode, composition of the anode, or differences in particle size or morphology of cathode or anode active materials.

(2) Perform Part A testing to verify that SOCE monitors meet accuracy requirements as described in § 86.1845–04. Test the number of vehicles and determine a pass or fail result as specified in Section 6.3 of GTR No. 22.

(3) For light-duty program vehicles, perform Part B verification for each battery durability family included in a monitor family subject to Part A testing to verify that batteries have SOCE meeting the Minimum Performance Requirement. Determine performance by reading SOCE monitors with a physical inspection, remote inspection using wireless technology, or any other appropriate means.

(i) Randomly select test vehicles from at least 10 different U.S. states or territories, with no more than 50 percent of selected vehicles coming from any one state or territory. Select vehicles to represent a wide range of climate conditions and operating characteristics.

(ii) Select at least 500 test vehicles per year from each from each battery durability family, except that we may approve your request to select fewer vehicles for a given battery durability family based on limited production volumes. If you test fewer than 500 vehicles, you may exclude up to 5 percent of the tested vehicles to account for the limited sample size. Test vehicles may be included from year to year, or test vehicles may change over the course of testing for the battery durability family.

(iii) A battery durability family passes if 90 percent or more of sampled vehicles have reported values at or above the Minimum Performance Requirement.

(iv) Continue testing for eight years after the end of production for vehicles included in the battery durability family. Note that testing will typically require separate testing from multiple model years in a given calendar year.

(4) You may request our approval to group monitors and batteries differently, or to adjust testing specifications. Submit your request with your proposed alternative specifications, along with technical justification. In the case of broadening the scope of a monitor family, include data demonstrating that differences within the proposed monitor family do not cause error in estimating SOCE.

(5) Submit electronic reports to document the results of testing as described in § 86.1847.

(g) If vehicles do not comply with monitor accuracy requirements under this section, the recall provisions in 40 CFR part 85, subpart S, apply for each affected monitor family. If battery electric and plug-in hybrid electric vehicles do not comply with battery durability requirements under this section, the manufacturer must account for the nonconformity by forfeiting GHG credits calculated for all the vehicles within the battery durability group (see § 86.1865–12(j)(3)). Manufacturers must similarly adjust NMOG+NO_X credits for battery electric vehicles (see § 86.1861–17(f)).

(h) Manufacturers may meet the requirements of this section for battery electric vehicles by instead complying with monitor accuracy and battery durability requirements based on the procedures specified in 13 CCR 1962.7 (incorporated by reference, see § 86.1), subject to the following exceptions and clarifications:

(1) References to the California ARB Executive Officer are deemed to mean the EPA Administrator. References to California are deemed to mean the United States. Test vehicles may be registered in any U.S. state or territory.

(2) Model year 2027 through 2029 vehicles must be designed to maintain 70 percent or more of the certification range value for at least 70 percent of the vehicles in a test group. Model year 2030 and later vehicles must be designed to maintain 80 percent or more of the certification range value as an average value for all vehicles in a test group. These requirements apply for a useful life of 10 years or 150,000 miles, whichever occurs first. If vehicles do not comply with these battery durability requirements, the manufacturer must adjust all credit balances to account for the nonconformity by forfeiting GHG credits calculated for all the vehicles within the test group (see § 86.1865–12(j)(3)). Manufacturers must similarly adjust NMOG+NO_X credits (see § 86.1861–17(f)).

(3) EPA may perform compliance and enforcement testing to support a finding of nonconformity as described in 13 CCR 1962.7(e).

(4) A minimum nationwide sampling rate of 500 in-use vehicles applies under

13 CCR 1962.7(d)(1). Select vehicles as described in paragraph (f)(3)(i) of this section.

(5) Manufacturers must meet the data standardization requirements in 13 CCR 1962.5 (incorporated by reference, see § 86.1).

(6) Vehicles continue to be subject to warranty requirements as specified in 40 CFR part 85, subpart V.

(7) Meeting requirements under this paragraph (h) does not depend on creating battery durability families and monitor families. The Part A testing requirements for monitor accuracy also do not apply.

(8) Include the following information in the application for certification for each test group instead of the information specified in § 86.1844–01(d)(19):

(i) The worst-case certified range value to represent the test group, instead of certified usable battery energy.

(ii) A statement attesting that the SOCE monitor meets the accuracy requirement appropriate for the model year.

(iii) A statement that each test group meets the design targets in paragraph (h)(2) of this section.

■ 49. Amend § 86.1816–18 by revising paragraph (a) introductory text and adding paragraph (b)(14) to read as follows:

§ 86.1816–18 Emission standards for heavy-duty vehicles.

(a) *Applicability and general provisions.* This section describes Tier 3 exhaust emission standards for complete heavy-duty vehicles. These standards are optional for incomplete heavy-duty vehicles and for heavy-duty vehicles above 14,000 pounds GVWR as described in § 86.1801. Greenhouse gas emission standards are specified in § 86.1818 for MDPV and in § 86.1819 for other HDV. See § 86.1813 for evaporative and refueling emission standards. This section starts to apply in model year 2018, except that the provisions may apply to vehicles before model year 2018 as specified in paragraph (b)(11) of this section. This section applies for model year 2027 and later vehicles only as specified in § 86.1811–27. Separate requirements apply for MDPV as specified in § 86.1811. See subpart A of this part for requirements that apply for incomplete heavy-duty vehicles and for heavy-duty engines certified independent of the chassis. The following general provisions apply:

* * * * *

(b) * * *

(14) Starting in model year 2027, you may certify vehicles using the following transitional Tier 4 bins as part of the compliance demonstration for meeting the Tier 4 declining fleet average NMOG+NO_X standard in § 86.1811–27(b)(6):

TABLE 8 OF § 86.1816–18—TRANSITIONAL TIER 4 BIN STANDARDS—CLASS 2b

[g/mile]

FEL name	NMOG+NO_X		CO	
	FTP (FEL)	HD–SFTP	FTP	HD–SFTP
Bin 125	0.125	0.125	3.2	12.0
Bin 100	0.100	0.100	3.2	12.0
Bin 85	0.085	0.085	3.2	12.0
Bin 75	0.075	0.075	3.2	12.0

TABLE 9 OF § 86.1816–18—TRANSITIONAL TIER 4 BIN STANDARDS—CLASS 3

[g/mile]

FEL name	NMOG+NO_X		CO	
	FTP (FEL)	HD–SFTP	FTP	HD–SFTP
Bin 170	0.170	0.170	3.7	4.0
Bin 150	0.150	0.150	3.7	4.0
Bin 125	0.125	0.125	3.7	4.0
Bin 100	0.100	0.100	3.7	4.0
Bin 85	0.085	0.085	3.7	4.0
Bin 75	0.075	0.075	3.7	4.0

* * * * *

§§ 86.1817–05 and 86.1817–08 [Removed]

■ 50. Remove §§ 86.1817–05 and 86.1817–08.

■ 51. Amend § 86.1818–12 by:

■ a. Revising and republishing paragraph (a),;

■ b. Revising paragraphs (b) introductory text and (c);

■ c. Removing and reserving paragraph (e);

■ d. Revising paragraph (f) introductory text;

■ e. Revising and republishing paragraph (g); and

■ f. Revising paragraph (h).

The revisions read as follows:

§ 86.1818–12 Greenhouse gas emission standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

(a) *Applicability.* (1) The greenhouse gas standards and related requirements in this section apply to 2012 and later model year LDV, LDT, and MDPV, including multi-fuel vehicles, vehicles fueled with alternative fuels, hybrid electric vehicles, plug-in hybrid electric vehicles, electric vehicles, and fuel cell vehicles. Unless otherwise specified, multi-fuel vehicles must comply with all requirements established for each consumed fuel.

(2) The standards specified in this section apply for testing at both low-altitude conditions and high-altitude conditions. However, manufacturers must submit an engineering evaluation indicating that common calibration approaches are utilized at high altitude instead of performing testing for certification, consistent with § 86.1829. 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 requires engineering emission data for EPA evaluation to quantify any emission impact and determine the validity of the AECD.

(3) A manufacturer that qualifies as a small business according to § 86.1801–12(j) is exempt from the emission standards in this section and the associated provisions in 40 CFR part 600; however, manufacturers may trade emission credits generated in a given model year only by certifying to emission standards that apply for that model year. Starting in model year 2027, manufacturers may produce no more than 500 exempt vehicles in any model year under this paragraph (a)(3). This limit applies for vehicles with engines, including plug-in hybrid electric vehicles; this limit does not apply for electric vehicles. Vehicles that are not exempt under this paragraph (a)(3) must meet emission standards as specified in this section.

(b) *Definitions.* The following definitions apply for this section:

* * * * *

(c) *Fleet average* CO_2 *standards.* Fleet average CO_2 standards apply as follows for passenger automobiles and light trucks:

(1) Each manufacturer must comply with separate fleet average CO_2 standards for passenger automobiles and light trucks. To calculate the fleet average CO_2 standards for passenger automobiles for a given model year, multiply each CO_2 target value by the production volume of passenger automobiles for the corresponding model type-footprint combination, then sum those products and divide the sum by the total production volume of passenger automobiles in that model year. Repeat this calculation using production volumes of light trucks to determine the separate fleet average CO_2 standards for light trucks. Round the resulting fleet average CO_2 emission standards to the nearest whole gram per mile. Averaging calculations and other compliance provisions apply as described in § 86.1865.

(2) A CO_2 target value applies for each unique combination of model type and footprint. The CO_2 target serves as the emission standard that applies throughout the useful life for each vehicle. Determine the CO_2 target values from the following table for model year 2032 and later, or from paragraph (h) of this section for model year 2031 and earlier:

TABLE 1 TO PARAGRAPH (c)(2)—FOOTPRINT-BASED CO_2 TARGET VALUES

Vehicle type	Footprint cutpoints (ft^2)		CO_2 target value (g/mile)		
	Low	High	Below low cutpoint	Between cutpoints [a]	Above high cutpoint
Passenger automobile	45	56	71.8	$0.35 \times f + 56.2$	75.6
Light truck	45	70.0	75.7	$1.38 \times f + 13.8$	110.1

[a] Calculate the CO_2 target value for vehicles between the footprint cutpoints as shown, using vehicle footprint, *f*, and rounding the result to the nearest 0.1 g/mile.

* * * * *

(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.

* * * * *

(g) *Alternative fleet average standards for manufacturers with limited sales.* Manufacturers meeting the criteria in this paragraph (g) may request alternative fleet average CO_2 standards for model year 2031 and earlier vehicles.

(1) *Eligibility for alternative standards.* Eligibility as determined in this paragraph (g) shall be based on the total nationwide sales of combined passenger automobiles and light trucks. The terms ''sales'' and ''sold'' as used in this paragraph (g) shall mean vehicles produced for sale in the states and territories of the United States. For the purpose of determining eligibility the sales of related companies shall be aggregated according to the provisions of § 86.1838–01(b)(3), or, if a manufacturer has been granted operational independence status under § 86.1838–01(d), eligibility shall be based on that manufacturer's vehicle sales. 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 greenhouse gas emission standards in this section. 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 sales 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.* Alternative standards apply as follows:

(i) Where EPA has exercised its regulatory authority to administratively specify alternative standards, those alternative standards approved for model year 2021 continue to apply through model year 2026. Starting in model year 2027, manufacturers must certify to the standards in paragraph (h) of this section on a delayed schedule, as follows:

In model year . . .	Manufacturers must certify to the standards that would otherwise apply in . . .
(A) 2027	2025
(B) 2028	2025
(C) 2029	2027
(D) 2030	2028
(E) 2031	2030

(ii) EPA may approve a request from other manufacturers for alternative fleet average CO_2 standards under this paragraph (g). The alternative standards for those manufacturers will apply by model year as specified in paragraph (g)(5)(i) of this section.

(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. Manufacturers may generate credits in a given model year for trading to another manufacturer by certifying to the standards in paragraph (h) of this section for the current model year across the manufacturer's full product line. A manufacturer certifying to the standards in paragraph (h) of this section will no longer be eligible to certify to the alternative standards under this paragraph (g) in later model years.

(7) Starting in model year 2032, all manufacturers must certify to the standards in paragraph (c) of this section.

(h) *Historical and interim standards.* The following CO_2 target values apply for model year 2031 and earlier vehicles:

(1) CO_2 target values apply as follows for passenger automobiles:

TABLE 2 TO PARAGRAPH (h)(1)—HISTORICAL AND INTERIM CO_2 TARGET VALUES FOR PASSENGER AUTOMOBILES

Model year	Footprint cutpoints (ft²)		CO_2 target value (g/mile)		
	Low	High	Below low cutpoint	Between cutpoints [a]	Above high cutpoint
2012	41	56	244.0	4.72 × *f* + 50.5	315.0
2013	41	56	237.0	4.72 × *f* + 43.3	307.0
2014	41	56	228.0	4.72 × *f* + 34.8	299.0
2015	41	56	217.0	4.72 × *f* + 23.4	288.0
2016	41	56	206.0	4.72 × *f* + 12.7	277.0
2017	41	56	195.0	4.53 × *f* + 8.9	263.0
2018	41	56	185.0	4.35 × *f* + 6.5	250.0
2019	41	56	175.0	4.17 × *f* + 4.2	238.0
2020	41	56	166.0	4.01 × *f* + 1.9	226.0
2021	41	56	161.8	3.94 × *f* + 0.2	220.9
2022	41	56	159.0	3.88 × *f*—0.1	217.3
2023	41	56	145.6	3.56 × *f*—0.4	199.1
2024	41	56	138.6	3.39 × *f*—0.4	189.5
2025	41	56	130.5	3.26 × *f*—3.2	179.4
2026	41	56	114.3	3.11 × *f*—13.1	160.9
2027	42	56	135.9	0.66 × *f* + 108.0	145.2
2028	43	56	123.8	0.60 × *f* + 97.9	131.6
2029	44	56	110.6	0.54 × *f* + 87.0	117.0
2030	45	56	98.2	0.47 × *f* + 76.9	103.4
2031	45	56	85.3	0.41 × *f* + 66.8	89.8

[a] Calculate the CO_2 target value for vehicles between the footprint cutpoints as shown, using vehicle footprint, *f,* and rounding the result to the nearest 0.1 g/mile.

(2) CO_2 target values apply as follows for light trucks:

TABLE 3 TO PARAGRAPH (h)(2)—HISTORICAL AND INTERIM CO_2 TARGET VALUES FOR LIGHT TRUCKS

Model year	Footprint cutpoints (ft²)		CO_2 target value (g/mile)		
	Low	High	Below low cutpoint	Between cutpoints [a]	Above high cutpoint
2012	41	66.0	294.0	4.04 × *f* + 128.6	395.0
2013	41	66.0	284.0	4.04 × *f* + 118.7	385.0
2014	41	66.0	275.0	4.04 × *f* + 109.4	376.0
2015	41	66.0	261.0	4.04 × *f* + 95.1	362.0
2016	41	66.0	247.0	4.04 × *f* + 81.1	348.0
2017	41	50.7	238.0	4.87 × *f* + 38.3	—
2017	50.8	66.0	—	4.04 × *f* + 80.5	347.0
2018	41	60.2	227.0	4.76 × *f* + 31.6	—
2018	60.3	66.0		4.04 × *f* + 75.0	342.0
2019	41	66.4	220.0	4.68 × *f* + 27.7	339.0
2020	41	68.3	212.0	4.57 × *f* + 24.6	337.0
2021	41	68.3	206.5	4.51 × *f* + 21.5	329.4
2022	41	68.3	203.0	4.44 × *f* + 20.6	324.1

TABLE 3 TO PARAGRAPH (h)(2)—HISTORICAL AND INTERIM CO_2 TARGET VALUES FOR LIGHT TRUCKS—Continued

Model year	Footprint cutpoints (ft^2)		CO_2 target value (g/mile)		
	Low	High	Below low cutpoint	Between cutpoints [a]	Above high cutpoint
2023	41	74.0	181.1	$3.97 \times f + 18.4$	312.1
2024	41	74.0	172.1	$3.77 \times f + 17.4$	296.5
2025	41	74.0	159.3	$3.58 \times f + 12.5$	277.4
2026	41	74.0	141.8	$3.41 \times f + 1.9$	254.4
2027	42	73.0	150.3	$2.89 \times f + 28.9$	239.9
2028	43	72.0	136.8	$2.58 \times f + 25.8$	211.7
2029	44	71.0	122.7	$2.27 \times f + 22.7$	184.0
2030	45	70.0	108.8	$1.98 \times f + 19.8$	158.3
2031	45	70.0	91.8	$1.67 \times f + 16.7$	133.5

[a] Calculate the CO_2 target value for vehicles between the footprint cutpoints as shown, using vehicle footprint, *f*, and rounding the result to the nearest 0.1 g/mile.

■ 52. Amend § 86.1819–14 by:
■ a. Revising the section heading, the introductory text, and paragraphs (a)(2), (d)(10), (d)(13), (d)(15), (d)(17), and (h).
■ b. Revising and republishing paragraphs (j) and (k).

The revisions and republications read as follows:

§ 86.1819–14 Greenhouse gas emission standards for medium-duty and heavy-duty vehicles.

This section describes exhaust emission standards for CO_2, CH_4, and N_2O for medium-duty vehicles. The standards of this section apply for model year 2014 and later vehicles that are chassis-certified with respect to criteria pollutants under this subpart S. Additional medium-duty and heavy-duty vehicles may be subject to the standards of this section as specified in paragraph (j) of this section. Any medium-duty or heavy-duty vehicles not subject to standards under this section are instead subject to greenhouse gas standards under 40 CFR part 1037, and engines installed in these vehicles are subject to standards under 40 CFR part 1036. If you are not the engine manufacturer, you must notify the engine manufacturer that its engines are subject to 40 CFR part 1036 if you intend to use their engines in vehicles that are not subject to standards under this section. Vehicles produced by small businesses may be exempted from the standards of this section as described in paragraph (k)(5) of this section.

(a) * * *

(2) CO_2 target values apply as described in this paragraph (a)(2) for model year 2032 and later. See paragraph (k)(4) of this section for model year 2031 and earlier:

(i) For vehicles with work factor at or below 5,500 pounds, use the appropriate work factor in the following equation to calculate a target value for each vehicle subconfiguration (or group of subconfigurations as allowed under paragraph (a)(4) of this section), rounding to the nearest whole g/mile:

$CO_2\ Target = 0.0221 \times WF + 170$

(ii) For vehicles with work factor above 5,500 pounds, the CO_2 target value is 292 g/mile.

* * * * *

(d) * * *

(10) For dual-fuel, multi-fuel, and flexible-fuel vehicles, perform exhaust testing on each fuel type (for example, gasoline and E85).

(i) Use either the conventional-fueled CO_2 emission rate or a weighted average of your emission results as specified in 40 CFR 600.510–12(k) for light-duty trucks.

(ii) If you certify to an alternate standard for N_2O or CH_4 emissions, you may not exceed the alternate standard when tested on either fuel.

* * * * *

(13) This paragraph (d)(13) applies for CO_2 reductions resulting from technologies that were not in common use before 2010 that are not reflected in the specified test procedures. While you are not required to prove that such technologies were not in common use with heavy-duty vehicles before model year 2010, we will not approve your request if we determine they do not qualify. These may be described as off-cycle or innovative technologies. We may allow you to generate emission credits consistent with the provisions of § 86.1869–12(c) and (d), but only through model year 2026. The 5-cycle methodology is not presumed to be preferred over alternative methodologies described in § 86.1869–12(d).

* * * * *

(15) You must submit a final report within 90 days after the end of the model year. Unless we specify otherwise, include applicable information identified in § 86.1865–12(l), 40 CFR 600.512, and 49 CFR 535.8(e). The final report must include at least the following information:

(i) Model year.

(ii) Applicable fleet average CO_2 standard.

(iii) Calculated fleet average CO_2 value and all the values required to calculate the CO_2 value.

(iv) Number of credits or debits incurred and all values required to calculate those values.

(v) Resulting balance of credits or debits.

(vi) N_2O emissions.

(vii) CH_4 emissions.

(viii) Total and percent leakage rates under paragraph (h) of this section (through model year 2026 only).

* * * * *

(17) You may calculate emission rates for weight increments less than the 500-pound increment specified for test weight. This does not change the applicable test weights.

(i) Use the ADC equation in paragraph (g) of this section to adjust your emission rates for vehicles in increments of 50, 100, or 250 pounds instead of the 500 pound test-weight increments. Adjust emissions to the midpoint of each increment. This is the equivalent emission weight. For example, vehicles with a test weight basis of 11,751 to 12,250 pounds (which have an equivalent test weight of 12,000 pounds) could be regrouped into 100-pound increments as follows:

TABLE 1 TO PARAGRAPH (d)(17)(I)—EXAMPLE OF TEST-WEIGHT GROUPINGS

Test weight basis	Equivalent emission weight	Equivalent test weight
11,751–11,850	11,800	12,000
11,851–11,950	11,900	12,000
11,951–12,050	12,000	12,000
12,051–12,150	12,100	12,000
12,151–12,250	12,200	12,000

(ii) You must use the same increment for all equivalent test weight classes across your whole product line in a given model year. You must also specify curb weight for calculating the work factor in a way that is consistent with your approach for determining test weight for calculating ADCs under this paragraph (d)(17).

* * * * *

(h) *Air conditioning leakage.* Loss of refrigerant from your air conditioning systems may not exceed a total leakage rate of 11.0 grams per year or a percent leakage rate of 1.50 percent per year, whichever is greater. This applies for all refrigerants. Calculate the annual rate of refrigerant leakage according to the procedures specified in SAE J2727 SEP2023 (incorporated by reference, see § 86.1) or as specified in § 86.1867–12(a). Calculate the percent leakage rate as: [total leakage rate (g/yr)] ÷ [total refrigerant capacity (g)] × 100. Round your percent leakage rate to the nearest one-hundredth of a percent. For purpose of this requirement, ''refrigerant capacity'' is the total mass of refrigerant recommended by the vehicle manufacturer as representing a full charge. Where full charge is specified as a pressure, use good engineering judgment to convert the pressure and system volume to a mass.

* * * * *

(j) *GHG certification of additional vehicles under this subpart.* You may certify certain complete or cab-complete vehicles to the GHG standards of this section. Certain high-GCWR vehicles may also be subject to the GHG standards of this section. All vehicles optionally certified under this paragraph (j) are deemed to be subject to the GHG standards of this section. Note that for vehicles above 14,000 pounds GVWR and at or below 26,000 pounds GVWR, GHG certification under this paragraph (j) does not affect how you may or may not certify with respect to criteria pollutants.

(1) For GHG compliance, you may certify any complete or cab-complete spark-ignition vehicles above 14,000 pounds GVWR and at or below 26,000 pounds GVWR to the GHG standards of this section even though this section otherwise specifies that you may certify vehicles to the GHG standards of this section only if they are chassis-certified for criteria pollutants. This paragraph (j)(1) also applies for vehicles at or below 14,000 pounds GVWR with GCWR above 22,000 pounds with installed engines that have been certified under 40 CFR part 1036 as described in 40 CFR 1036.635.

(2) You may apply the provisions of this section to cab-complete vehicles based on a complete sister vehicle. In unusual circumstances, you may ask us to apply these provisions to Class 2b or Class 3 incomplete vehicles that do not meet the definition of cab-complete.

(i) Except as specified in paragraph (j)(3) of this section, for purposes of this section, a complete sister vehicle is a complete vehicle of the same vehicle configuration as the cab-complete vehicle. You may not apply the provisions of this paragraph (j) to any vehicle configuration that has a four-wheel rear axle if the complete sister vehicle has a two-wheel rear axle.

(ii) Calculate the target value for fleet average CO_2 emissions under paragraph (a) or (k)(4) of this section based on the work factor value that applies for the complete sister vehicle.

(iii) Test these cab-complete vehicles using the same equivalent test weight and other dynamometer settings that apply for the complete vehicle from which you used the work factor value (the complete sister vehicle). For GHG certification, you may submit the test data from that complete sister vehicle instead of performing the test on the cab-complete vehicle.

(iv) You are not required to produce the complete sister vehicle for sale to use the provisions of this paragraph (j)(2). This means the complete sister vehicle may be a carryover vehicle from a prior model year or a vehicle created solely for the purpose of testing.

(3) For GHG purposes, if a cab-complete vehicle is not of the same vehicle configuration as a complete sister vehicle due only to certain factors unrelated to coastdown performance, you may use the road-load coefficients from the complete sister vehicle for certification testing of the cab-complete vehicle, but you may not use emission data from the complete sister vehicle for certifying the cab-complete vehicle.

(4) The GHG standards of this section and related provisions apply for vehicles above 22,000 pounds GCWR as described in 40 CFR 1036.635.

(k) *Interim provisions.* The following provisions apply instead of other provisions in this subpart:

(1) *Incentives for early introduction.* Manufacturers may voluntarily certify in model year 2013 (or earlier model years for electric vehicles) to the greenhouse gas standards that apply starting in model year 2014 as specified in 40 CFR 1037.150(a).

(2) *Early credits.* To generate early credits under this paragraph (k)(2) for any vehicles other than electric vehicles, you must certify your entire U.S.-directed fleet to these standards. If you calculate a separate fleet average for advanced-technology vehicles under paragraph (k)(7) of this section, you must certify your entire U.S.-directed production volume of both advanced and conventional vehicles within the fleet. If some test groups are certified after the start of the model year, you may generate credits only for production that occurs after all test groups are certified. For example, if you produce three test groups in an averaging set and you receive your certificates for those test groups on January 4, 2013, March 15, 2013, and April 24, 2013, you may not generate credits for model year 2013 for vehicles from any of the test groups produced before April 24, 2013. Calculate credits relative to the standard that would apply in model year 2014 using the applicable equations in this subpart and your model year 2013 U.S.-directed production volumes. These credits may be used to show compliance with the standards of this subpart for 2014 and later model years. We recommend that you notify us of your intent to use this provision before submitting your applications.

(3) *Compliance date.* Compliance with the standards of this section was optional before January 1, 2014 as specified in 40 CFR 1037.150(g).

(4) *Historical and interim standards.* The following CO_2 target values apply for model year 2031 and earlier vehicles:

(i) CO_2 target values apply as follows for model years 2014 through 2027, except as specified in paragraph (k)(4)(ii) of this section:

TABLE 2 TO PARAGRAPH (k)(4)(i)—CO_2 TARGET VALUES FOR MODEL YEARS 2014 THROUGH 2027

Model year	CO_2 target (g/mile) [a]	
	Spark-ignition	Compression-ignition
2014	0.0482 × *WF* + 371	0.0478 × *WF* + 368.
2015	0.0479 × *WF* + 369	0.0474 × *WF* + 366.
2016	0.0469 × *WF* + 362	0.0460 × *WF* + 354.
2017	0.0460 × *WF* + 354	0.0445 × *WF* + 343.
2018–2020	0.0440 × *WF* + 339	0.0416 × *WF* + 320.
2021	0.0429 × *WF* + 331	0.0406 × *WF* + 312.
2022	0.0418 × *WF* + 322	0.0395 × *WF* + 304.
2023	0.0408 × *WF* + 314	0.0386 × *WF* + 297.
2024	0.0398 × *WF* + 306	0.0376 × *WF* + 289.
2025	0.0388 × *WF* + 299	0.0367 × *WF* + 282.
2026	0.0378 × *WF* + 291	0.0357 × *WF* + 275.
2027	0.0348 × *WF* + 268	0.0348 × *WF* + 268.

[a] Electric vehicles are subject to the compression-ignition CO_2 target values.

(ii) The following optional alternative CO_2 target values apply for model years 2014 through 2020:

TABLE 3 TO PARAGRAPH (k)(4)(ii)—ALTERNATIVE CO_2 TARGET VALUES FOR MODEL YEARS 2014 THROUGH 2020

Model year	CO_2 target (g/mile)	
	Spark-ignition	Compression-ignition.
2014	0.0482 × *WF* + 371	0.0478 × *WF* + 368.
2015	0.0479 × *WF* + 369	0.0474 × *WF* + 366.
2016–2018	0.0456 × *WF* + 352	0.0440 × *WF* + 339.
2019–2020	0.0440 × *WF* + 339	0.0416 × *WF* + 320.

(iii) CO_2 target values apply as follows for all engine types for model years 2028 through 2031:

TABLE 4 TO PARAGRAPH (k)(4)(iii)—CO_2 TARGET VALUES FOR MODEL YEARS 2028 THROUGH 2031

Model year	Work factor cutpoint (pounds)	CO_2 target value (g/mile)	
		Below cutpoint	Above cutpoint
2028	8,000	0.0339 × *WF* + 270	541
2029	6,800	0.0310 × *WF* + 246	457
2030	5,500	0.0280 × *WF* + 220	374
2031	5,500	0.0251 × *WF* + 195	333

(5) *Provisions for small manufacturers.* Standards apply on a delayed schedule for manufacturers meeting the small business criteria specified in 13 CFR 121.201 (NAICS code 336111); the employee and revenue limits apply to the total number employees and total revenue together for affiliated companies. Qualifying small manufacturers are not subject to the greenhouse gas standards of this section for vehicles with a date of manufacture before January 1, 2022, as specified in 40 CFR 1037.150(c). In addition, small manufacturers producing vehicles that run on any fuel other than gasoline, E85, or diesel fuel may delay complying with every later standard under this part by one model year through model year 2026. The following provisions apply starting with model year 2027:

(i) Qualifying small manufacturers remain subject to the model year 2026 greenhouse gas standards; however, small manufacturers may trade emission credits generated in a given model year only by certifying to standards that apply for that model year.

(ii) Small manufacturers may produce no more than 500 exempt vehicles in any model year under paragraph (k)(5)(i) of this section. This limit applies for vehicles with engines, including plug-in hybrid electric vehicles; this limit does not apply for electric vehicles. Vehicles that are not exempt under this paragraph (k)(5) must meet emission standards as specified in this section.

(6) *Alternate N_2O standards.* Manufacturers may show compliance with the N_2O standards using an engineering analysis. This allowance also applies for model year 2015 and later test groups carried over from model 2014 consistent with the provisions of § 86.1839. You may not certify to an N_2O FEL different than the standard without measuring N_2O emissions.

(7) *Advanced-technology credits.* Provisions for advanced-technology credits apply as described in 40 CFR 1037.615. If you generate credits from Phase 1 vehicles certified with advanced technology (in model years 2014 through 2020), you may multiply these credits by 1.50. If you generate credits from model year 2021 through 2026 vehicles certified with advanced technology, you may multiply these credits by 3.5 for plug-in hybrid electric vehicles, 4.5 for battery electric vehicles, and 5.5 for fuel cell vehicles. Advanced-technology credits from Phase 1 vehicles may be used to show compliance with any standards of this part or 40 CFR part 1036 or part 1037, subject to the restrictions in 40 CFR 1037.740. Similarly, you may use up to 60,000 Mg per year of advanced-technology credits generated under 40 CFR 1036.615 or 1037.615 (from Phase 1 vehicles) to demonstrate compliance with the CO_2 standards in this section. Include vehicles generating credits in separate fleet average calculations (and exclude them from your conventional fleet average calculation). You must first apply these advanced-technology vehicle credits to any deficits for other vehicles in the averaging set before applying them to other averaging sets. The provisions of this paragraph (k)(7) do not apply for credits generated from model year 2027 and later vehicles.

(8) *Loose engine sales.* This paragraph (k)(8) applies for model year 2023 and earlier spark-ignition engines with identical hardware compared with engines used in vehicles certified to the standards of this section, where you sell such engines as loose engines or as engines installed in incomplete vehicles that are not cab-complete vehicles. You may include such engines in a test group certified to the standards of this section, subject to the following provisions:

(i) Engines certified under this paragraph (k)(8) are deemed to be certified to the standards of 40 CFR 1036.108 as specified in 40 CFR 1036.150(j).

(ii) For 2020 and earlier model years, the maximum allowable U.S.-directed production volume of engines you sell under this paragraph (k)(8) in any given model year is ten percent of the total U.S-directed production volume of engines of that design that you produce for heavy-duty applications for that model year, including engines you produce for complete vehicles, cab-complete vehicles, and other incomplete vehicles. The total number of engines you may certify under this paragraph (k)(8), of all engine designs, may not exceed 15,000 in any model year. Engines produced in excess of either of these limits are not covered by your certificate. For example, if you produce 80,000 complete model year 2017 Class 2b pickup trucks with a certain engine and 10,000 incomplete model year 2017 Class 3 vehicles with that same engine, and you do not apply the provisions of this paragraph (k)(8) to any other engine designs, you may produce up to 10,000 engines of that design for sale as loose engines under this paragraph (k)(8). If you produced 11,000 engines of that design for sale as loose engines, the last 1,000 of them that you produced in that model year 2017 would be considered uncertified.

(iii) For model years 2021 through 2023, the U.S.-directed production volume of engines you sell under this paragraph (k)(8) in any given model year may not exceed 10,000 units.

(iv) This paragraph (k)(8) does not apply for engines certified to the standards of 40 CFR 1036.108.

(v) Label the engines as specified in 40 CFR 1036.135 including the following compliance statement: ''THIS ENGINE WAS CERTIFIED TO THE ALTERNATE GREENHOUSE GAS EMISSION STANDARDS OF 40 CFR 1036.150(j).'' List the test group name instead of an engine family name.

(vi) Vehicles using engines certified under this paragraph (k)(8) are subject to the emission standards of 40 CFR 1037.105.

(vii) For certification purposes, your engines are deemed to have a CO_2 target value and test result equal to the CO_2 target value and test result for the complete vehicle in the applicable test group with the highest equivalent test weight, except as specified in paragraph (k)(8)(vii)(B) of this section. Use these values to calculate your target value, fleet average emission rate, and in-use emission standard. Where there are multiple complete vehicles with the same highest equivalent test weight, select the CO_2 target value and test result as follows:

(A) If one or more of the CO_2 test results exceed the applicable target value, use the CO_2 target value and test result of the vehicle that exceeds its target value by the greatest amount.

(B) If none of the CO_2 test results exceed the applicable target value, select the highest target value and set the test result equal to it. This means that you may not generate emission credits from vehicles certified under this paragraph (k)(8).

(viii) Production and in-use CO_2 standards apply as described in paragraph (b) of this section.

(ix) N_2O and CH_4 standards apply as described in paragraph (c) of this section.

(x) State in your applications for certification that your test group and engine family will include engines certified under this paragraph (k)(8). This applies for your greenhouse gas vehicle test group and your criteria pollutant engine family. List in each application the name of the corresponding test group/engine family.

(9) *Credit adjustment for useful life.* For credits that you calculate based on a useful life of 120,000 miles, multiply any banked credits that you carry forward for use in model year 2021 and later by 1.25.

(10) *CO_2 rounding.* For model year 2014 and earlier vehicles, you may round measured and calculated CO_2 emission levels to the nearest 0.1 g/mile, instead of the nearest whole g/mile as specified in paragraphs (a), (b), and (g) of this section.

■ 53. Amend § 86.1820–01 by revising paragraphs (b) introductory text and (b)(7) and adding paragraph (b)(8) to read as follows:

§ 86.1820–01 Durability group determination.

* * * * *

(b) To be included in the same durability group, vehicles must be identical in all the respects listed in paragraphs (b)(1) through (7) of this section and meet one of the criteria specified in paragraph (b)(8) of this section:

* * * * *

(7) Type of particulate filter (none, catalyzed, noncatalyzed).

(8) The manufacturer must choose one of the following two criteria:

(i) Grouping statistic:

(A) Vehicles are grouped based upon the value of the grouping statistic determined using the following equation:

$$GS = \frac{Cat\ Vol}{Disp} \cdot Loading\ Rate$$

Where:

GS = Grouping Statistic used to evaluate the range of precious metal loading rates and relative sizing of the catalysts compared to the engine displacement that are allowable within a durability group. The grouping statistic shall be rounded to a tenth of a gram/liter.

Cat Vol = Total volume of the catalyst(s) in liters. Include the volume of any catalyzed particulate filters.

Disp = Displacement of the engine in liters.

Loading rate = The mass of total precious metal(s) in the catalyst (or the total mass of all precious metal(s) of all the catalysts if the vehicle is equipped with multiple catalysts) in grams divided by the total volume of the catalyst(s) in liters. Include the mass of precious metals in any catalyzed particulate filters.

(B) Engine-emission control system combinations which have a grouping statistic which is either less than 25 percent of the largest grouping statistic value, or less than 0.2 g/liter (whichever allows the greater coverage of the durability group) shall be grouped into the same durability group.

(ii) The manufacturer may elect to use another procedure which results in at least as many durability groups as required using criteria in paragraph (b)(8)(i) of this section providing that only vehicles with similar emission deterioration or durability are combined into a single durability group.

* * * * *

■ 54. Amend § 86.1821–01 by revising paragraph (b)(10) to read as follows:

§ 86.1821–01 Evaporative/refueling family determination.

* * * * *

(b) * * *

(10) Evaporative emission standard or family emission limit (FEL) for testing at low-altitude conditions.

* * * * *

§ 86.1823–01 [Removed]

■ 55. Remove § 86.1823–01.

■ 56. Amend § 86.1823–08 by revising and republishing paragraph (f) and revising paragraph (n) to read as follows:

§ 86.1823–08 Durability demonstration procedures for exhaust emissions.

* * * * *

(f) *Use of deterioration program to determine compliance with the standard.* A manufacturer may select from two methods for using the results of the deterioration program to determine compliance with the applicable emission standards. Either a deterioration factor (DF) is calculated and applied to the emission data vehicle (EDV) emission results or aged components are installed on the EDV prior to emission testing.

(1) *Deterioration factors.* (i) Deterioration factors are calculated using all FTP emission test data generated during the durability testing program except as noted:

(A) Multiple tests at a given mileage point are averaged together unless the same number of tests are conducted at each mileage point.

(B) Before and after maintenance test results are averaged together.

(C) Zero-mile test results are excluded from the calculation.

(D) Total hydrocarbon (THC) test points beyond the 50,000-mile (useful life) test point are excluded from the intermediate useful life deterioration factor calculation.

(E) A procedure may be employed to identify and remove from the DF calculation those test results determined to be statistical outliers providing that the outlier procedure is consistently applied to all vehicles and data points and is approved in advance by the Administrator.

(ii) The deterioration factor must be based on a linear regression, or another regression technique approved in advance by the Administrator. The deterioration must be a multiplicative or additive factor. Separate factors will be calculated for each regulated emission constituent and for the full and intermediate useful life periods as applicable. Separate DF's are calculated for each durability group except as provided in § 86.1839.

(A) A multiplicative DF will be calculated by taking the ratio of the full or intermediate useful life mileage level, as appropriate (rounded to four decimal places), divided by the stabilized mileage (reference § 86.1831–01(c), *e.g.,* 4000-mile) level (rounded to four decimal places) from the regression analysis. The result must be rounded to three-decimal places of accuracy. The rounding required in this paragraph must be conducted in accordance with § 86.1837. Calculated DF values of less than one must be changed to one for the purposes of this paragraph.

(B) An additive DF will be calculated to be the difference between the full or intermediate useful life mileage level (as appropriate) minus the stabilized mileage (reference § 86.1831–01(c), *e.g.,* 4000-mile) level from the regression analysis. The full useful life regressed emission value, the stabilized mileage regressed emission value, and the DF result must be rounded to the same precision and using the same procedures as the raw emission results according to the provisions of § 86.1837–01. Calculated DF values of less than zero must be changed to zero for the purposes of this paragraph.

(iii) For Tier 3 vehicles, the DF calculated by these procedures will be used for determining full and intermediate useful life compliance with FTP exhaust emission standards, SFTP exhaust emission standards, and cold CO emission standards. At the manufacturer's option and using procedures approved by the Administrator, a separate DF may be calculated exclusively using cold CO test data to determine compliance with cold CO emission standards. Also, at the manufacturer's option and using procedures approved by the Administrator, a separate DF may be calculated exclusively using US06 and/or air conditioning (SC03) test data to determine compliance with the SFTP emission standards.

(iv) For Tier 4 vehicles, the DF calculated by these procedures may be used for determining compliance with all the standards identified in § 86.1811–27. At the manufacturer's option and using procedures approved by the Administrator, manufacturers may calculate a separate DF for the following standards and driving schedules:

(A) Testing to determine compliance with cold temperature emission standards.

(B) US06 testing.

(C) SC03 testing.

(D) HFET.

(E) Mid-temperature intermediate soak testing.

(F) Early driveaway testing.

(G) High-power PHEV engine starts.

(2) *Installation of aged components on emission data vehicles.* For full and intermediate useful life compliance determination, the manufacturer may elect to install aged components on an EDV prior to emission testing rather than applying a deterioration factor. Different sets of components may be aged for full and intermediate useful life periods. Components must be aged using an approved durability procedure that complies with paragraph (b) of this section. The list of components to be aged and subsequently installed on the EDV must selected using good engineering judgment.

* * * * *

(n) *Emission component durability.* The manufacturer shall use good engineering judgment to determine that all emission-related components are designed to operate properly for the full useful life of the vehicles in actual use.

§§ 86.1824–01 and 86.1824–07 [Removed]

■ 57. Remove §§ 86.1824–01 and 86.1824–07.

■ 58. Amend § 86.1824–08 by revising paragraphs (c)(1) and (k) to read as follows:

§ 86.1824–08 Durability demonstration procedures for evaporative emissions.

* * * * *

(c) * * *

(1) Mileage accumulation must be conducted using the SRC or any road cycle approved under the provisions of § 86.1823–08(e)(1).

* * * * *

(k) *Emission component durability.* The manufacturer shall use good engineering judgment to determine that all emission-related components are designed to operate properly for the full useful life of the vehicles in actual use.

§ 86.1825–01 [Removed]

■ 59. Remove § 86.1825–01.

■ 60. Amend § 86.1825–08 by revising the introductory text and paragraphs (c)(1) and (h) to read as follows:

§ 86.1825–08 Durability demonstration procedures for refueling emissions.

The durability-related requirements of this section apply for vehicles subject to refueling standards under this subpart. Refer to the provisions of §§ 86.1801 and 86.1813 to determine applicability of the refueling standards to different classes of vehicles. Diesel-fueled vehicles may be exempt from the requirements of this section under § 86.1829.

* * * * *

(c) * * *

(1) Mileage accumulation must be conducted using the SRC or a road cycle approved under the provisions of § 86.1823–08(e)(1).

* * * * *

(h) *Emission component durability.* The manufacturer shall use good engineering judgment to determine that all emission-related components are designed to operate properly for the full useful life of the vehicles in actual use.

* * * * *

■ 61. Amend § 86.1827–01 by revising paragraph (a)(5) to read as follows:

§ 86.1827–01 Test group determination.

* * * * *

(a) * * *

(5) Subject to the same emission standards (except for CO_2), or FEL in the case of cold temperature NMHC or $NMOG+NO_X$ standards, except that a manufacturer may request to group vehicles into the same test group as vehicles subject to more stringent standards, so long as all the vehicles within the test group are certified to the most stringent standards applicable to any vehicle within that test group. For example, manufacturers may include medium-duty vehicles at or below 22,000 pounds GCWR in the same test group with medium-duty vehicles above 22,000 pounds GCWR, but all vehicles included in the test group are then subject to the off-cycle emission standards and testing requirements described in § 86.1811–27(e). Light-duty trucks and light-duty vehicles may be included in the same test group if all vehicles in the test group are subject to the same criteria exhaust emission standards.

* * * * *

■ 62. Revise and republish § 86.1828–01 to read as follows:

§ 86.1828–01 Emission data vehicle selection.

(a) *Criteria exhaust testing.* Within each test group, the vehicle configuration shall be selected which is expected to be worst-case for exhaust emission compliance on candidate in-use vehicles, considering all criteria exhaust emission constituents, all exhaust test procedures, and the potential impact of air conditioning on test results. For vehicles meeting Tier 4 standards, include consideration of cold temperature testing. See paragraph (c) of this section for cold temperature testing with vehicles not yet subject to Tier 4 standards. The selected vehicle will include an air conditioning engine code unless the worst-case vehicle configuration selected is not available with air conditioning. This vehicle configuration will be used as the EDV calibration.

(b) *Evaporative/Refueling testing.* Vehicles of each evaporative/refueling family will be divided into evaporative/refueling emission control systems.

(1) The vehicle configuration expected to exhibit the highest evaporative and/or refueling emission on candidate in-use vehicles shall be selected for each evaporative/refueling family and evaporative refueling emission system combination from among the corresponding vehicles selected for testing under paragraph (a) of this section. Separate vehicles may be selected to be tested for evaporative and refueling testing.

(2) Each test group must be represented by both evaporative and refueling testing (provided that the refueling standards are applicable) before it may be certified. That required testing may have been conducted on a vehicle in another test group provided the tested vehicle is a member of the same evaporative/refueling family and evaporative/refueling emission system combination and it was selected for testing in accordance with the provisions of paragraph (b)(1) of this section.

(3) For evaporative/refueling emission testing, the vehicle(s) selected shall be equipped with the worst-case evaporative/refueling emission hardware available on that vehicle considering such items as canister size and material, fuel tank size and material, purge strategy and flow rates, refueling characteristics, and amount of vapor generation.

(c) *Cold temperature testing—Tier 3.* For vehicles subject to Tier 3 standards, select test vehicles for cold temperature testing as follows:

(1) For cold temperature CO exhaust emission compliance for each durability group, the vehicle expected to emit the highest CO emissions at 20 degrees F on candidate in-use vehicles shall be selected from the test vehicles selected in accordance with paragraph (a) of this section.

(2) For cold temperature NMHC exhaust emission compliance for each durability group, the manufacturer must select the vehicle expected to emit the highest NMHC emissions at 20 °F on candidate in-use vehicles from the test vehicles specified in paragraph (a) of this section. When the expected worst-case cold temperature NMHC vehicle is also the expected worst-case cold temperature CO vehicle as selected in paragraph (c)(1) of this section, then cold temperature testing is required only for that vehicle; otherwise, testing is required for both the worst-case cold temperature CO vehicle and the worst-case cold temperature NMHC vehicle.

(d) [Reserved]

(e) *Alternative configurations.* The manufacturer may use good engineering judgment to select an equivalent or worst-case configuration in lieu of testing the vehicle selected in paragraphs (a) through (c) of this section. Carryover data satisfying the provisions of § 86.1839 may also be used in lieu of testing the configuration selected in paragraphs (a) through (c) of this section.

(f) *Good engineering judgment.* The manufacturer shall use good engineering judgment in making selections of vehicles under this section.

§ 86.1829–01 [Removed]

■ 63. Remove § 86.1829–01.

■ 64. Amend § 86.1829–15 by revising paragraphs (a), (b), (d), and (f) and adding paragraph (g) to read as follows:

§ 86.1829–15 Durability and emission testing requirements; waivers.

* * * * *

(a) Durability requirements apply as follows:

(1) One durability demonstration is required for each durability group. The

configuration of the DDV is determined according to § 86.1822. The DDV shall be tested and accumulate service mileage according to the provisions of §§ 86.1823, 86.1824, 86.1825, and 86.1831. Small-volume manufacturers and small-volume test groups may optionally use the alternative durability provisions of § 86.1838.

(2) Manufacturers may provide a statement in the application for certification that vehicles comply with the monitor accuracy and battery durability requirements of § 86.1815–27 instead of submitting test data for certification. The following durability testing requirements apply for battery electric vehicles and plug-in hybrid electric vehicles after certification:

(i) Manufacturers must perform monitor accuracy testing on in-use vehicles as described in § 86.1845–04(g) for each monitor family. Carryover provisions apply as described in § 86.1839–01(c).

(ii) Manufacturers must perform battery durability testing as described in § 86.1815–27(f)(2).

(b) The manufacturer must test EDVs as follows to demonstrate compliance with emission standards:

(1) Except as specified in this section, test one EDV in each test group using the test procedures specified in this subpart to demonstrate compliance with other exhaust emission standards.

(2) Test one EDV in each test group using the test procedures in 40 CFR part 1066 to demonstrate compliance with cold temperature exhaust emission standards.

(3) Test one EDV in each test group to each of the three discrete mid-temperature intermediate soak standards identified in § 86.1811–27.

(4) Test one EDV in each evaporative/refueling family and evaporative/refueling emission control system combination using the test procedures in subpart B of this part to demonstrate compliance with evaporative and refueling emission standards.

* * * * *

(d) Manufacturers may omit exhaust testing for certification in certain circumstances as follows:

(1) For vehicles subject to the Tier 3 PM standards in § 86.1811–17 (not the Tier 4 PM standards in § 86.1811–27), a manufacturer may provide a statement in the application for certification that vehicles comply with applicable PM standards instead of submitting PM test data for a certain number of vehicles. However, each manufacturer must test vehicles from a minimum number of durability groups as follows:

(i) Manufacturers with a single durability group subject to the Tier 3 PM standards in § 86.1811 must submit PM test data for that group.

(ii) Manufacturers with two to eight durability groups subject to the Tier 3 PM standards in § 86.1811 must submit PM test data for at least two durability groups each model year. EPA will work with the manufacturer to select durability groups for testing, with the general expectation that testing will rotate to cover a manufacturer's whole product line over time. If a durability group has been certified in an earlier model year based on submitted PM data, and that durability group is eligible for certification using carryover test data, that carryover data may count toward meeting the requirements of this paragraph (d)(1), subject to the selection of durability groups.

(iii) Manufacturers with nine or more durability groups subject to the Tier 3 PM standards in § 86.1811 must submit PM test data for at least 25 percent of those durability groups each model year. We will work with the manufacturer to select durability groups for testing as described in paragraph (d)(1)(ii) of this section.

(2) Small-volume manufacturers may provide a statement in the application for certification that vehicles comply with the applicable Tier 3 PM standard instead of submitting test data. Small-volume manufacturers must submit PM test data for vehicles that are subject to Tier 4 PM standards.

(3) Manufacturers may omit PM measurements for fuel economy and GHG testing conducted in addition to the testing needed to demonstrate compliance with the PM emission standards.

(4) Manufacturers may provide a statement in the application for certification that vehicles comply with the applicable formaldehyde standard instead of submitting test data.

(5) When conducting Selective Enforcement Audit testing, a manufacturer may petition the Administrator to waive the requirement to measure PM emissions and formaldehyde emissions.

(6) For model years 2012 through 2016, a manufacturer may provide a statement in its application for certification that vehicles comply with the applicable standards instead of measuring N_2O emissions. Such a statement may also be used for model year 2017 and 2018 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 model year 2019 and later vehicles may be waived from testing for N_2O emissions. Vehicles certified to N_2O standards using a compliance statement instead of submitting test data are not required to collect and submit N_2O emission data under the in-use testing requirements of § 86.1845.

(7) Manufacturers may provide a statement in the application for certification that vehicles comply with the mid-temperature intermediate soak standards for soak times not covered by testing.

(8) Manufacturers may provide a statement in the application for certification that medium-duty vehicles above 22,000 pounds GCWR comply with the off-cycle emission standards in § 86.1811–27(e) for all normal operation and use when tested as specified. Describe in the application for certification under § 86.1844–01(d)(8) any relevant testing, engineering analysis, or other information in sufficient detail to support the statement. We may direct you to include emission measurements representing typical engine in-use operation at a range of ambient conditions. For example, we may specify certain transient and steady-state engine operation that is typical for your vehicles. Also describe the procedure you used to determine a reference CO_2 emission rate, $e_{CO2FTPFCL}$, under § 86.1845–04(h)(6).

(9) For model year 2027 and 2028 vehicles subject to the Tier 4 PM standards in § 86.1811–27, a manufacturer may provide a statement in the application for certification that vehicles comply with the PM standard for −7 °C temperature testing instead of submitting PM test data.

* * * * *

(f) For electric vehicles and fuel cell vehicles, manufacturers may provide a statement in the application for certification that vehicles comply with all the emission standards and related requirements of this subpart instead of submitting test data. Tailpipe emissions of regulated pollutants from vehicles powered solely by electricity are deemed to be zero.

(g) Manufacturers must measure NMOG+NO_X emissions from −7 °C testing with Tier 4 diesel-fueled emission data vehicles and report values corresponding to submitted CO and PM test results in the application for certification. Note that it is not necessary to repeat NMOG+NO_X measurements for fuel economy, confirmatory, or in-use testing.

■ 65. Amend § 86.1834–01 by revising paragraph (h) to read as follows:

§ 86.1834–01 Allowable maintenance.

* * * * *

(h) When air conditioning exhaust emission tests are required, the manufacturer must document that the vehicle's air conditioning system is operating properly and in a representative condition. Required air conditioning system maintenance is performed as unscheduled maintenance and does not require the Administrator's approval.

■ 66. Amend § 86.1835–01 by revising paragraphs (a)(1)(i), (a)(4), (b)(1), and (d) introductory text to read as follows:

§ 86.1835–01 Confirmatory certification testing.

(a) * * *

(1) * * *

(i) The Administrator may adjust or cause to be adjusted any adjustable parameter of an emission-data vehicle which the Administrator has determined to be subject to adjustment for certification testing in accordance with § 86.1833–01(a)(1), to any setting within the physically adjustable range of that parameter, as determined by the Administrator in accordance with § 86.1833–01(a)(3), prior to the performance of any tests to determine whether such vehicle or engine conforms to applicable emission standards, including tests performed by the manufacturer. However, if the idle speed parameter is one which the Administrator has determined to be subject to adjustment, the Administrator shall not adjust it to a setting which causes a higher engine idle speed than would have been possible within the physically adjustable range of the idle speed parameter on the engine before it accumulated any dynamometer service, all other parameters being identically adjusted for the purpose of the comparison. The Administrator, in making or specifying such adjustments, will consider the effect of the deviation from the manufacturer's recommended setting on emissions performance characteristics as well as the likelihood that similar settings will occur on in-use light-duty vehicles, light-duty trucks, or complete heavy-duty vehicles. In determining likelihood, the Administrator will consider factors such as, but not limited to, the effect of the adjustment on vehicle performance characteristics and surveillance information from similar in-use vehicles.

* * * * *

(4) Retesting for fuel economy reasons or for compliance with greenhouse gas exhaust emission standards in § 86.1818–12 may be conducted under the provisions of 40 CFR 600.008–08.

(b) * * *

(1) If the Administrator determines not to conduct a confirmatory test under the provisions of paragraph (a) of this section, manufacturers will conduct a confirmatory test at their facility after submitting the original test data to the Administrator under either of the following circumstances:

(i) The vehicle configuration has previously failed an emission standard.

(ii) The test exhibits high emission levels determined by exceeding a percentage of the standards specified by the Administrator for that model year.

* * * * *

(d) *Conditional certification.* Upon request of the manufacturer, the Administrator may issue a conditional certificate of conformity for a test group which has not completed the Administrator testing required under paragraph (a) of this section. Such a certificate will be issued based upon the conditions that the confirmatory testing be completed in an expedited manner and that the results of the testing are in compliance with all standards and procedures.

* * * * *

■ 67. Amend § 86.1838–01 by revising and republishing paragraph (b) to read as follows:

§ 86.1838–01 Small-volume manufacturer certification procedures.

* * * * *

(b) *Eligibility requirements*—(1) *Small-volume manufacturers.* (i) Optional small-volume manufacturer certification procedures apply for vehicles produced by manufacturers with the following number of combined sales of vehicles subject to standards under this subpart in all states and territories of the United States in the model year for which certification is sought, including all vehicles and engines imported under the provisions of 40 CFR 85.1505 and 85.1509:

(A) At or below 5,000 units for the Tier 3 standards described in §§ 86.1811–17, 86.1813–17, and 86.1816–18 and the Tier 4 standards described in § 86.1811–27. This volume threshold applies for phasing in the Tier 3 and Tier 4 standards and for determining the corresponding deterioration factors.

(B) No small-volume sales threshold applies for the heavy-duty greenhouse gas standards; alternative small-volume criteria apply as described in § 86.1819–14(k)(5).

(C) At or below 15,000 units for all other requirements. See § 86.1845 for separate provisions that apply for in-use testing.

(ii) If a manufacturer's aggregated sales in the United States, as determined in paragraph (b)(3) of this section are fewer than the number of units specified in paragraph (b)(1)(i) of this section, the manufacturer (or each manufacturer in the case of manufacturers in an aggregated relationship) may certify under the provisions of paragraph (c) of this section.

(iii) A manufacturer that qualifies as a small business under the Small Business Administration regulations in 13 CFR part 121 is eligible for all the provisions that apply for small-volume manufacturers under this subpart. See § 86.1801–12(j) to determine whether companies qualify as small businesses.

(iv) The sales volumes specified in this section are based on actual sales, unless otherwise specified.

(v) Except for delayed implementation of new emission standards, an eligible manufacturer must transition out of the special provisions that apply for small-volume manufacturers as described in § 86.1801–12(k)(2)(i) through (iii) if sales volumes increase above the applicable threshold.

(2) *Small-volume test groups and small-volume monitor families.* (i) If the aggregated sales in all states and territories of the United States, as determined in paragraph (b)(3) of this section are equal to or greater than 15,000 units, then the manufacturer (or each manufacturer in the case of manufacturers in an aggregated relationship) will be allowed to certify a number of units under the small-volume test group certification procedures in accordance with the criteria identified in paragraphs (b)(2)(ii) through (iv) of this section. Similarly, the manufacturer will be exempt from Part A testing for monitor accuracy as described in § 86.1845–04(g) in accordance with the criteria identified in paragraphs (b)(2)(ii) through (iv) of this section for individual monitor families with aggregated sales up to 5,000 units in the current model year.

(ii) If there are no additional manufacturers in an aggregated relationship meeting the provisions of paragraph (b)(3) of this section, then the manufacturer may certify whole test groups whose total aggregated sales (including heavy-duty engines) are less than 15,000 units using the small-volume provisions of paragraph (c) of this section.

(iii) If there is an aggregated relationship with another manufacturer which satisfies the provisions of paragraph (b)(3) of this section, then the following provisions shall apply:

(A) If none of the manufacturers own 50 percent or more of another manufacturer in the aggregated relationship, then each manufacturer may certify whole test groups whose total aggregated sales (including heavy-duty engines) are less than 15,000 units using the small-volume provisions of paragraph (c) of this section.

(B) If any of the manufacturers own 50 percent or more of another manufacturer in the aggregated relationship, then the limit of 14,999 units must be shared among the manufacturers in such a relationship. In total for all the manufacturers involved in such a relationship, aggregated sales (including heavy-duty engines) of up to 14,999 units may be certified using the small-volume provisions of paragraph (c) of this section. Only whole test groups shall be eligible for small-volume status under paragraph (c) of this section.

(iv) In the case of a joint venture arrangement (50/50 ownership) between two manufacturers, each manufacturer retains its eligibility for 14,999 units under the small-volume test group certification procedures, but the joint venture must draw its maximum 14,999 units from the units allocated to its parent manufacturers. Only whole test groups shall be eligible for small-volume status under paragraph (c) of this section.

(3) *Sales aggregation for related manufacturers.* The projected or actual sales from different firms shall be aggregated in the following situations:

(i) Vehicles and/or engines produced by two or more firms, one of which is 10 percent or greater part owned by another.

(ii) Vehicles and/or engines produced by any two or more firms if a third party has equity ownership of 10 percent or more in each of the firms.

(iii) Vehicles and/or engines produced by two or more firms having a common corporate officer(s) who is (are) responsible for the overall direction of the companies.

(iv) Vehicles and/or engines imported or distributed by all firms where the vehicles and/or engines are manufactured by the same entity and the importer or distributor is an authorized agent of the entity.

* * * * *

■ 68. Revise and republish § 86.1839–01 to read as follows:

§ 86.1839–01 Carryover of certification and battery monitoring data.

(a) In lieu of testing an emission-data or durability vehicle selected under § 86.1822, § 86.1828, or § 86.1829, and submitting data therefrom, a manufacturer may submit exhaust emission data, evaporative emission data and/or refueling emission data, as applicable, on a similar vehicle for which certification has been obtained or for which all applicable data required under § 86.1845 has previously been submitted. To be eligible for this provision, the manufacturer must use good engineering judgment and meet the following criteria:

(1) In the case of durability data, the manufacturer must determine that the previously generated durability data represent a worst case or equivalent rate of deterioration for all applicable emission constituents compared to the configuration selected for durability demonstration. Prior to certification, the Administrator may require the manufacturer to provide data showing that the distribution of catalyst temperatures of the selected durability configuration is effectively equivalent or lower than the distribution of catalyst temperatures of the vehicle configuration which is the source of the previously generated data.

(2) In the case of emission data, the manufacturer must determine that the previously generated emissions data represent a worst case or equivalent level of emissions for all applicable emission constituents compared to the configuration selected for emission compliance demonstration.

(b) In lieu of using newly aged hardware on an EDV as allowed under the provisions of § 86.1823–08(f)(2), a manufacturer may use similar hardware aged for an EDV previously submitted, provided that the manufacturer determines that the previously aged hardware represents a worst case or equivalent rate of deterioration for all applicable emission constituents for durability demonstration.

(c) In lieu of testing battery electric vehicles or plug-in hybrid electric vehicles for monitor accuracy under § 86.1822–01(a) and submitting the test data, a manufacturer may rely on previously conducted testing on a similar vehicle for which such test data have previously been submitted to demonstrate compliance with monitor accuracy requirements. For vehicles to be eligible for this provision, they must have designs for battery monitoring that are identical in all material respects to the vehicles tested under § 86.1845–04(g). If a monitor family fails to meet accuracy requirements, repeat the testing under § 86.1845–04(g) as soon as practicable.

■ 69. Revise § 86.1840–01 to read as follows:

§ 86.1840–01 Special test procedures.

Provisions for special test procedures apply as described in 40 CFR 1065.10 and 1066.10. For example, manufacturers must propose a procedure for EPA's review and advance approval for testing and certifying vehicles equipped with periodically regenerating aftertreatment devices, including sufficient documentation and data for EPA to fully evaluate the request.

■ 70. Amend § 86.1841–01 by revising and republishing paragraph (a) and revising paragraph (e) to read as follows:

§ 86.1841–01 Compliance with emission standards for the purpose of certification.

(a) Certification levels of a test vehicle will be calculated for each emission constituent applicable to the test group for both full and intermediate useful life as appropriate.

(1) If the durability demonstration procedure used by the manufacturer under the provisions of § 86.1823, § 86.1824, or § 86.1825 requires a DF to be calculated, the DF shall be applied to the official test results determined in § 86.1835–01(c) for each regulated emission constituent and for full and intermediate useful life, as appropriate, using the following procedures:

(i) For additive DF's, the DF will be added to the emission result. The sum will be rounded to the same level of precision as the standard for the constituent at full and/or intermediate useful life, as appropriate. This rounded sum is the certification level for that emission constituent and for that useful life mileage.

(ii) For multiplicative DFs, the DF will be multiplied by the emission result for each regulated constituent. The product will be rounded to the same level of precision as the standard for the constituent at full and intermediate useful life, as appropriate. This rounded product is the certification level for that emission constituent and for that useful life mileage.

(iii) For a composite standard of $NMHC+NO_X$, the measured results of NMHC and NO_X must each be adjusted by their corresponding deterioration factors before the composite $NMHC+NO_X$ certification level is calculated. Where the applicable FTP exhaust hydrocarbon emission standard is an NMOG standard, the applicable NMOG deterioration factor must be used in place of the NMHC deterioration factor, unless otherwise approved by the Administrator.

(2) If the durability demonstration procedure used by the manufacturer under the provisions of § 86.1823, § 86.1824, or § 86.1825, as applicable, requires testing of the EDV with aged emission components, the official results of that testing determined under

the provisions of § 86.1835–01(c) shall be rounded to the same level of precision as the standard for each regulated constituent at full and intermediate useful life, as appropriate. This rounded emission value is the certification level for that emission constituent at that useful life mileage.

(3) Compliance with full useful life CO_2 exhaust emission standards shall be demonstrated at certification by the certification levels on the duty cycles specified for carbon-related exhaust emissions according to § 600.113 of this chapter.

(4) The rounding required in paragraph (a) of this section shall be conducted in accordance with the provisions of § 86.1837–01.

* * * * *

(e) Unless otherwise approved by the Administrator, manufacturers must not use Reactivity Adjustment Factors (RAFs) in their calculation of the certification level of any pollutant for any vehicle.

■ 71. Amend § 86.1844–01 by:

■ a. Revising and republishing paragraphs (d) and (e);

■ b. Revising paragraphs (g)(11) and (h); and

■ c. Removing paragraph (i).

The revisions and republication read as follows:

§ 86.1844–01 Information requirements: Application for certification and submittal of information upon request.

* * * * *

(d) *Part 1 Application.* Part 1 must contain the following items:

(1) Correspondence and communication information, such as names, mailing addresses, phone and fax numbers, and email addresses of all manufacturer representatives authorized to be in contact with EPA compliance staff. The address where official documents, such as certificates of conformity, are to be mailed must be clearly identified. At least one U.S. contact must be provided.

(2) A description of the durability group in accordance with the criteria listed in § 86.1820–01, or as otherwise used to group a product line.

(3) A description of applicable evaporative/refueling families and leak families in accordance with the criteria listed in § 86.1821–01, or as otherwise used to group a product line.

(4) Include the following durability information:

(i) A description of the durability method used to establish useful life durability, including exhaust and evaporative/refueling emission deterioration factors as required in §§ 86.1823, 86.1824 and 86.1825 when applicable.

(ii) The equivalency factor required to be calculated in § 86.1823–08(e)(1)(iii)(B), when applicable.

(5) A description of each test group in accordance with the criteria listed in § 86.1827–01 or as otherwise used to group a product line.

(6) Identification and description of all vehicles for which testing is required by §§ 86.1822–01 and 86.1828–01 to obtain a certificate of conformity.

(7) A comprehensive list of all test results, including official certification levels, and the applicable intermediate and full useful life emission standards to which the test group is to be certified as required in § 86.1829. Include the following additional information related to testing:

(i) For vehicles certified to any Tier 3 or Tier 4 emission standards, include a comparison of drive-cycle metrics as specified in 40 CFR 1066.425(j) for each drive cycle or test phase, as appropriate.

(ii) For gasoline-fueled vehicles subject to Tier 3 evaporative emission standards, identify the method of accounting for ethanol in determining evaporative emissions, as described in § 86.1813.

(iii) Identify any aspects of testing for which the regulations obligate EPA testing to conform to your selection of test methods.

(iv) For heavy-duty vehicles subject to air conditioning standards under § 86.1819, include the refrigerant leakage rates (leak scores), describe the type of refrigerant, and identify the refrigerant capacity of the air conditioning systems. If another company will install the air conditioning system, also identify the corporate name of the final installer.

(v) For vehicles with pressurized fuel tanks, attest that vehicles subject to EPA testing with the partial refueling test will meet the refueling emission standard for that testing. Include engineering analysis showing that canister capacity is adequate to account for the increased vapor load from venting the pressurized fuel tank upon fuel cap removal.

(8) A statement that all applicable vehicles will conform to the emission standards for which emission data is not being provided, as allowed under § 86.1806 or § 86.1829. The statement shall clearly identify the standards for which emission testing was not completed and include supporting information as specified in § 86.1806 or § 86.1829.

(9) Information describing each emission control diagnostic system required by § 86.1806, including all of the following:

(i) A description of the functional operation characteristics of the diagnostic system, with additional information demonstrating that the system meets the requirements specified in § 86.1806. Include all testing and demonstration data submitted to the California Air Resources Board for certification.

(ii) The general method of detecting malfunctions for each emission-related powertrain component.

(iii) Any deficiencies, including resolution plans and schedules.

(iv) A statement that the diagnostic system is adequate for the performance warranty test described in 40 CFR part 85, subpart W.

(v) For vehicles certified to meet the leak standard in § 86.1813, a description of the anticipated test procedure. The description must include, at a minimum, a method for accessing the fuel system for measurements and a method for pressurizing the fuel system to perform the procedure specified in 40 CFR 1066.985. The recommended test method must include at least two separate points for accessing the fuel system, with additional access points as appropriate for multiple fuel tanks and multiple evaporative or refueling canisters.

(10) A description of all flexible or dedicated alternate fuel vehicles including, but not limited to, the fuel and/or percentage of alternate fuel for all such vehicles.

(11) A list of all auxiliary emission control devices (AECD) installed on any applicable vehicles, including a justification for each AECD, the parameters they sense and control, a detailed justification of each AECD that results in a reduction in effectiveness of the emission control system, and rationale for why it is not a defeat device as defined under § 86.1809. The following specific provisions apply for AECDs:

(i) For any AECD uniquely used at high altitudes, EPA may request engineering emission data to quantify any emission impact and validity of the AECD.

(ii) For any AECD uniquely used on multi-fuel vehicles when operated on fuels other than gasoline, EPA may request engineering emission data to quantify any emission impact and validity of the AECD.

(iii) For Tier 3 vehicles with spark-ignition engines, describe how AECDs are designed to comply with the requirements of § 86.1811–17(d). Identify which components need protection through enrichment strategies; describe the temperature limitations for those components; and describe how the enrichment strategy corresponds to those temperature limitations. We may also require manufacturers to submit this information for certification related to Tier 2 vehicles.

(iv) For Tier 4 vehicles with spark-ignition engines, describe how AECDs comply with the requirements of §§ 86.1809–12(d)(2) and 86.1811–27(d).

(12) Identification and description of all vehicles covered by each certificate of conformity to be produced and sold within the U.S. The description must be sufficient to identify whether any given in-use vehicle is, or is not, covered by a given certificate of conformity, the test group and the evaporative/refueling family to which it belongs and the standards that are applicable to it, by matching readily observable vehicle characteristics and information given in the emission control information label (and other permanently attached labels) to indicators in the Part 1 Application. In addition, the description must be sufficient to determine for each vehicle covered by the certificate, all appropriate test parameters and any special test procedures necessary to conduct an official certification exhaust or evaporative emission test as was required by this subpart to demonstrate compliance with applicable emission standards. The description shall include, but is not limited to, information such as model name, vehicle classification (light-duty vehicle, light-duty truck, or complete heavy-duty vehicle), sales area, engine displacement, engine code, transmission type, tire size and parameters necessary to conduct exhaust emission tests such as equivalent test weight, curb and gross vehicle weight, test horsepower (with and without air conditioning adjustment), coast down time, shift schedules, cooling fan configuration, etc. and evaporative tests such as canister working capacity, canister bed volume and fuel temperature profile. The Part 1 may include ranges for test parameters in lieu of actual values.

(13) Projected U.S. vehicle sales volumes for each test group and evaporative/refueling family combination organized in such a way to determine projected compliance with any applicable implementation schedules or minimum sales requirements as specified in § 86.1810 or as otherwise required by this chapter.

(14) A request for a certificate of conformity for each test group after all required testing has been completed. The request must be signed by an authorized manufacturer representative and include a statement that the test group complies with all applicable regulations contained within this chapter.

(15) For vehicles with fuel-fired heaters, describe the control system logic of the fuel-fired heater, including an evaluation of the conditions under which it can be operated and an evaluation of the possible operational modes and conditions under which evaporative emissions can exist. Use good engineering judgment to establish an estimated exhaust emission rate from the fuel-fired heater in grams per mile for each pollutant subject to a fleet average standard. Adjust fleet average compliance calculations in §§ 86.1861, 86.1864, and 86.1865 as appropriate to account for emissions from fuel-fired heaters. Describe the testing used to establish the exhaust emission rate.

(16) A statement indicating that the manufacturer has conducted an engineering analysis of the complete exhaust system.

(i) The engineering analysis must ensure that the exhaust system has been designed—

(A) To facilitate leak-free assembly, installation and operation for the full useful life of the vehicle; and

(B) To facilitate that such repairs as might be necessary on a properly maintained and used vehicle can be performed in such a manner as to maintain leak-free operation, using tools commonly available in a motor vehicle dealership or independent repair shop for the full useful life of the vehicle.

(ii) The analysis must cover the exhaust system and all related and attached components including the air injection system, if present, from the engine block manifold gasket surface to a point sufficiently past the last catalyst and oxygen sensor in the system to assure that leaks beyond that point will not permit air to reach the oxygen sensor or catalyst under normal operating conditions.

(iii) A ''leak-free'' system is one in which leakage is controlled so that it will not lead to a failure of the certification exhaust emission standards in-use.

(17) The name of an agent for service located in the United States. Service on this agent constitutes service on you or any of your officers or employees for any action by EPA or otherwise by the United States related to the requirements of this part.

(18) For vehicles equipped with RESS, the recharging procedures and methods for determining battery performance, such as state of charge and charging capacity.

(19) For battery electric vehicles and plug-in hybrid electric vehicles, a description of each monitor family and battery durability family as described in § 86.1815–27(f)(1). Note that a single test group may include multiple monitor families and battery durability families, and conversely that individual monitor families and battery durability families may be associated with multiple test groups. Note also that provisions related to monitor families and battery durability families do not apply for certain vehicles as specified in § 86.1815–27(h)(8). Include the following information for each monitor family:

(i) The monitor, battery, and other specifications that are relevant to establishing monitor families and battery durability families to comply with the requirements of this section.

(ii) The certified usable battery energy for each battery durability family. For plug-in hybrid electric vehicles, identify whether the UDDS Full Charge Test or HFET Full Charge Test was used for battery measurements.

(iii) A statement attesting that the SOCE monitor meets the 5 percent accuracy requirement.

(iv) For light-duty program vehicles, a statement that each battery durability family meets the Minimum Performance Requirement.

(20) Acknowledgement, if applicable, that you are including vehicles with engines certified under 40 CFR part 1036 in your calculation to demonstrate compliance with the fleet average CO_2 standard in this subpart as described in § 86.1819–14(j).

(21) Measured NMOG+NO_X emission levels from −7 °C testing with Tier 4 diesel-fueled vehicles as described in § 86.1829–15(g).

(e) *Part 2 Application.* Part 2 must contain the following items:

(1) Identify all emission-related components, including those that can affect GHG emissions. Also identify software, AECDs, and other elements of design that are used to control criteria, GHG, or evaporative/refueling emissions. Identify the emission-related components by part number. Identify software by part number or other convention, as appropriate. Organize part numbers by engine code or other similar classification scheme.

(2) Basic calibration information, organized by engine code (or other similar classification scheme), for the major components of the fuel system, EGR system, ignition system, oxygen sensor(s) and thermostat. Examples of major components and associated calibration information include, but are not limited to; fuel pump and fuel pump

flow rate, fuel pressure regulator and regulated fuel pressure, EGR valve and EGR exhaust gas flow rate at specified vacuum levels, EGR vacuum regulator and regulated vacuum, EGR orifice and orifice diameter, basic engine timing, timing RPM, idle rpm, spark plug gap, oxygen sensor output (mV), and thermostat opening temperature.

(3) Identification and description of all vehicles covered by each certificate of conformity to be produced and sold within the U.S. The description must be sufficient to identify whether any given in-use vehicle is, or is not, covered by a given certificate of conformity, the test group and the evaporative/refueling family to which it belongs and the standards that are applicable to it, by matching readily observable vehicle characteristics and information given in the emission control information label (and other permanently attached labels) to indicators in the Part 1 Application. For example, the description must include any components or features that contribute to measured or demonstrated control of emissions for meeting criteria, GHG, or evaporative/refueling standards under this subpart. In addition, the description must be sufficient to determine for each vehicle covered by the certificate, all appropriate test parameters and any special test procedures necessary to conduct an official certification exhaust or evaporative emission test as was required by this subpart to demonstrate compliance with applicable emission standards. The description shall include, but is not limited to, information such as model name, vehicle classification (light-duty vehicle, light-duty truck, or complete heavy-duty vehicle), sales area, engine displacement, engine code, transmission type, tire size and parameters necessary to conduct exhaust emission tests such as equivalent test weight, curb and gross vehicle weight, test horsepower (with and without air conditioning adjustment), coast down time, shift schedules, cooling fan configuration, etc. and evaporative tests such as canister working capacity, canister bed volume, and fuel temperature profile. Actual values must be provided for all parameters.

(4) Final U.S. vehicle sales volumes for each test group and evaporative/refueling family combination organized in such a way to verify compliance with any applicable implementation schedules. Final sales are not required until the final update to the Part 2 Application at the end of the model year.

(i) The manufacturer may petition the Administrator to allow actual volume produced for U.S. sale to be used in lieu of actual U.S. sales. The petition must establish that production volume is functionally equivalent to sales volume.

(ii) The U.S. sales volume shall be based on the location of the point of sale to a dealer, distributor, fleet operator, broker, or any other entity which comprises the point of first sale.

(5) Copies of all service manuals, service bulletins and instructions regarding the use, repair, adjustment, maintenance, or testing of such vehicles relevant to the control of crankcase, exhaust or evaporative emissions, as applicable, issued by the manufacturer for use by other manufacturers, assembly plants, distributors, dealers, and ultimate purchasers. These shall be submitted in electronic form to the Agency when they are made available to the public and must be updated as appropriate throughout the useful life of the corresponding vehicles.

(6) The NMOG-to-NMHC and HCHO-to-NMHC ratios established according to § 86.1845–04.

(7) The results of any production vehicle evaluation testing required for OBD systems under § 86.1806.

* * * * *

(g) * * *

(11) A description of all procedures, including any special procedures, used to comply with applicable test requirements of this subpart. Any special procedures used to establish durability data or emission deterioration factors required to be determined under §§ 86.1823, 86.1824 and 86.1825 and to conduct emission tests required to be performed on applicable emission data vehicles under § 86.1829 according to test procedures contained within this Title must also be included.

* * * * *

(h) Manufacturers must submit the in-use testing information required in § 86.1847.

■ 72. Revise and republish § 86.1845–04 to read as follows:

§ 86.1845–04 Manufacturer in-use verification testing requirements.

(a) *General requirements.* (1) Manufacturers of LDV, LDT, MDPV and complete HDV must test, or cause to have tested, a specified number of vehicles. Such testing must be conducted in accordance with the provisions of this section.

(2) Unless otherwise approved by the Administrator, no emission measurements made under the requirements of this section may be adjusted by Reactivity Adjustment Factors (RAFs).

(3) The following provisions apply regarding the possibility of residual effects from varying fuel sulfur levels:

(i) Vehicles certified under § 86.1811 must always measure emissions over the FTP, then over the HFET (if applicable), then over the US06. If a vehicle meets all the applicable emission standards except the FTP or HFET emission standard for $NMOG+NO_X$, and a fuel sample from the tested vehicle (representing the as-received condition) has a measured fuel sulfur level exceeding 15 ppm when measured as described in 40 CFR 1065.710, the manufacturer may repeat the FTP and HFET measurements and use the new emission values as the official results for that vehicle. For all other cases, measured emission levels from the first test will be considered the official results for the test vehicle, regardless of any test results from additional test runs. Where repeat testing is allowed, the vehicle may operate for up to two US06 cycles (with or without measurement) before repeating the FTP and HFET measurements. The repeat measurements must include both FTP and HFET, even if the vehicle failed only one of those tests, unless the HFET is not required for a particular vehicle. Vehicles may not undergo any other vehicle preconditioning to eliminate fuel sulfur effects on the emission control system, unless we approve it in advance. This paragraph (a)(3)(i) does not apply for Tier 2 vehicles.

(ii) Upon a manufacturer's written request, prior to in-use testing, that presents information to EPA regarding pre-conditioning procedures designed solely to remove the effects of high sulfur in gasoline from vehicles produced through the 2007 model year, EPA will consider allowing such procedures on a case-by-case basis. EPA's decision will apply to manufacturer in-use testing conducted under this section and to any in-use testing conducted by EPA. Such procedures are not available for complete HDV. For model year 2007 and later Tier 2 vehicles, this provision can be used only in American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, and then only if low sulfur gasoline is determined by the Administrator to be unavailable in that specific location.

(4) Battery-related in-use testing requirements apply for battery electric vehicles and plug-in hybrid electric vehicles as described in paragraph (g) of this section.

(5) Certain medium-duty vehicles are also subject to in-use testing requirements to demonstrate compliance with off-cycle emission

standards as described in paragraph (h) of this section.

(b) *Low-mileage testing*—(1) *Test groups.* Testing must be conducted for each test group and evaporative/refueling family as specified.

(2) *Vehicle mileage.* All test vehicles must have a minimum odometer mileage of 10,000 miles.

(3) *Procuring test vehicles.* For each test group, the minimum number of vehicles that must be tested is specified in table 1 (Table S04–06) and table 2 (Table S04–07) to this paragraph (b)(3). After testing the minimum number of vehicles of a specific test group as specified in Table S04–06 or S04–07, a manufacturer may test additional vehicles upon request and approval by the Agency prior to the initiation of the additional testing. Any additional testing must be completed within the testing completion requirements shown in § 86.1845–04(b)(4). The request and Agency approval (if any) shall apply to test groups on a case-by-case basis and apply only to testing under this paragraph (b). Separate approval will be required to test additional vehicles under paragraph (c) of this section. In addition to any testing that is required under Table S04–06 and Table S04–07, a manufacturer shall test one vehicle from each evaporative/refueling family for evaporative/refueling emissions. If a manufacturer believes it is unable to procure the required number of test vehicles meeting the specifications of this section, the manufacturer may request Administrator approval to either test a smaller number of vehicles or include vehicles that don't fully meet specifications. The request shall include a description of the methods the manufacturer has used to procure the required number of vehicles meeting specifications. The approval of any such request will be based on a review of the procurement efforts made by the manufacturer to determine if all reasonable steps have been taken to procure the required number of test vehicles meeting the specifications of this section.

TABLE 1 TO PARAGRAPH (b)(3)—TABLE S04–06—SMALL VOLUME MANUFACTURERS

49 and 50 State total sales[1]	1–5000	5001–14,999
Low Mileage	Voluntary	0
High Mileage	Voluntary	2

[1] Manufacturer's total annual sales.

TABLE 2 TO PARAGRAPH (b)(3)—TABLE S04–07—LARGE VOLUME MANUFACTURERS

49 and 50 State annual sales[1]	1–5000[2]	5001–14,999[2]	1–50,000[3]	50,001–250,000	>250,000
Low Mileage	Voluntary	0	2	3	4
High Mileage	Voluntary	2	4	5	6

[1] Sales by test group.
[2] Total annual production of groups eligible for testing under small volume sampling plan is capped at a maximum of 14,999 vehicle 49 or 50 state annual sales, or a maximum of 4,500 vehicle California only sales per model year, per large volume manufacturer.
[3] Sampling plan applies to all of a manufacturer's remaining groups in this sales volume category when the maximum annual cap on total sales of small groups eligible for the small volume sampling plan is exceeded.

(4) *Completion of testing.* Testing of the vehicles in a test group and evaporative/refueling family must be completed within 12 months of the end of production of that test group (or evaporative/refueling family) for that model year or a later date that we approve.

(5) *Testing.* (i) Each test vehicle of a test group shall be tested in accordance with the FTP and the US06 as described in subpart B of this part, when such test vehicle is tested for compliance with applicable exhaust emission standards under this subpart. Test vehicles subject to applicable exhaust CO_2 emission standards under this subpart shall also be tested in accordance with the HFET as described in 40 CFR 1066.840.

(ii) For vehicles subject to Tier 3 p.m. standards, manufacturers must measure PM emissions over the FTP and US06 driving schedules for at least 50 percent of the vehicles tested under paragraph (b)(5)(i) of this section. For vehicles subject to Tier 4 p.m. standards, this test rate increases to 100 percent.

(iii) Starting with model year 2018 vehicles, manufacturers must demonstrate compliance with the Tier 3 leak standard specified in § 86.1813, if applicable, as described in this paragraph (b)(5)(iii). Manufacturers must evaluate each vehicle tested under paragraph (b)(5)(i) of this section, except that leak testing is not required for vehicles tested under paragraph (b)(5)(iv) of this section for diurnal emissions. In addition, manufacturers must evaluate at least one vehicle from each leak family for a given model year. Manufacturers may rely on OBD monitoring instead of testing as follows:

(A) A vehicle is considered to pass the leak test if the OBD system completed a leak check within the previous 750 miles of driving without showing a leak fault code.

(B) Whether or not a vehicle's OBD system has completed a leak check within the previous 750 miles of driving, the manufacturer may operate the vehicle as needed to force the OBD system to perform a leak check. If the OBD leak check does not show a leak fault, the vehicle is considered to pass the leak test.

(C) If the most recent OBD leak check from paragraph (b)(5)(iii)(A) or (B) of this section shows a leak-related fault code, the vehicle is presumed to have failed the leak test. Manufacturers may perform the leak measurement procedure described in 40 CFR 1066.985 for an official result to replace the finding from the OBD leak check.

(D) Manufacturers may not perform repeat OBD checks or leak measurements to over-ride a failure under paragraph (b)(5)(iii)(C) of this section.

(iv) For vehicles other than gaseous-fueled vehicles and electric vehicles, one test vehicle of each evaporative/refueling family shall be tested in accordance with the supplemental 2-diurnal-plus-hot-soak evaporative emission and refueling emission procedures described in subpart B of this part, when such test vehicle is tested for compliance with applicable evaporative emission and refueling standards under this subpart. For gaseous-fueled vehicles, one test vehicle of each evaporative/refueling family shall be tested in accordance with the 3-

diurnal-plus-hot-soak evaporative emission and refueling emission procedures described in subpart B of this part, when such test vehicle is tested for compliance with applicable evaporative emission and refueling standards under this subpart. The test vehicles tested to fulfill the evaporative/refueling testing requirement of this paragraph (b)(5)(iv) will be counted when determining compliance with the minimum number of vehicles as specified in Table S04–06 and Table S04–07 (tables 1 and 2 to paragraph (b)(3) of this section) for testing under paragraph (b)(5)(i) of this section only if the vehicle is also tested for exhaust emissions under the requirements of paragraph (b)(5)(i) of this section.

(6) *Test condition.* Each test vehicle not rejected based on the criteria specified in appendix II to this subpart shall be tested in as-received condition.

(7) *Diagnostic maintenance.* A manufacturer may conduct subsequent diagnostic maintenance and/or testing of any vehicle. Any such maintenance and/or testing shall be reported to the Agency as specified in § 86.1847.

(c) *High-mileage testing*—(1) *Test groups.* Testing must be conducted for each test group and evaporative/refueling family as specified.

(2) *Vehicle mileage.* All test vehicles must have a minimum odometer mileage of 50,000 miles. At least one vehicle of each test group must have a minimum odometer mileage of 105,000 miles or 75 percent of the full useful life mileage, whichever is less. See § 86.1838–01(c)(2) for small-volume manufacturer mileage requirements.

(3) *Procuring test vehicles.* For each test group, the minimum number of vehicles that must be tested is specified in Table S04–06 and Table S04–07 (tables 1 and 2 to paragraph (b)(3) of this section). After testing the minimum number of vehicles of a specific test group as specified in Table S04–06 and Table S04–07, a manufacturer may test additional vehicles upon request and approval by the Agency prior to the initiation of the additional testing. Any additional testing must be completed within the testing completion requirements shown in § 86.1845–04(c)(4). The request and Agency approval (if any) shall apply to test groups on a case-by-case basis and apply only to testing under this paragraph (c). In addition to any testing that is required under Table S04–06 and Table S04–07, a manufacturer shall test one vehicle from each evaporative/refueling family for evaporative/refueling emissions. If a manufacturer believes it is unable to procure the required number of test vehicles meeting the specifications of this section, the manufacturer may request Administrator approval to either test a smaller number of vehicles or include vehicles that don't fully meet specifications. The request shall include a description of the methods the manufacturer has used to procure the required number of vehicles meeting specifications. The approval of any such request will be based on a review of the procurement efforts made by the manufacturer to determine if all reasonable steps have been taken to procure the required number of test vehicles meeting the specifications of this section.

(4) *Initiation and completion of testing.* Testing of a test group (or evaporative refueling family) must commence within 4 years of the end of production of the test group (or evaporative/refueling family) and be completed within 5 years of the end of production of the test group (or evaporative/refueling family) or a later date that we approve.

(5) *Testing.* (i) Each test vehicle shall be tested in accordance with the FTP and the US06 as described in subpart B of this part when such test vehicle is tested for compliance with applicable exhaust emission standards under this subpart. Test vehicles subject to applicable exhaust CO_2 emission standards under this subpart shall also be tested in accordance with the HFET as described in 40 CFR 1066.840. One test vehicle from each test group shall be tested over the FTP at high altitude. The test vehicle tested at high altitude is not required to be one of the same test vehicles tested at low altitude. The test vehicle tested at high altitude is counted when determining the compliance with the requirements shown in Table S04–06 and Table S04–07 (tables 1 and 2 to paragraph (b)(3) of this section) or the expanded sample size as provided for in this paragraph (c).

(ii) For vehicles subject to Tier 3 p.m. standards, manufacturers must measure PM emissions over the FTP and US06 driving schedules for at least 50 percent of the vehicles tested under paragraph (c)(5)(i) of this section. For vehicles subject to Tier 4 p.m. standards, this test rate increases to 100 percent.

(iii) Starting with model year 2018 vehicles, manufacturers must evaluate each vehicle tested under paragraph (c)(5)(i) of this section to demonstrate compliance with the Tier 3 leak standard specified in § 86.1813, except that leak testing is not required for vehicles tested under paragraph (c)(5)(iv) of this section for diurnal emissions. In addition, manufacturers must evaluate at least one vehicle from each leak family for a given model year. Manufacturers may rely on OBD monitoring instead of testing as described in paragraph (b)(5)(iii) of this section.

(iv) For vehicles other than gaseous-fueled vehicles and electric vehicles, one test vehicle of each evaporative/refueling family shall be tested in accordance with the supplemental 2-diurnal-plus-hot-soak evaporative emission procedures described in subpart B of this part, when such test vehicle is tested for compliance with applicable evaporative emission and refueling standards under this subpart. For gaseous-fueled vehicles, one test vehicle of each evaporative/refueling family shall be tested in accordance with the 3-diurnal-plus-hot-soak evaporative emission procedures described in subpart B of this part, when such test vehicle is tested for compliance with applicable evaporative emission and refueling standards under this subpart. The vehicles tested to fulfill the evaporative/refueling testing requirement of this paragraph (c)(5)(iv) will be counted when determining compliance with the minimum number of vehicles as specified in Tables S04–06 and S04–07 (tables 1 and 2 to paragraph (b)(3) of this section) for testing under paragraph (c)(5)(i) of this section only if the vehicle is also tested for exhaust emissions under the requirements of paragraph (c)(5)(i) of this section .

(6) *Test condition.* Each test vehicle not rejected based on the criteria specified in appendix II to this subpart shall be tested in as-received condition.

(7) *Diagnostic maintenance.* A manufacturer may conduct subsequent diagnostic maintenance and/or testing on any vehicle. Any such maintenance and/or testing shall be reported to the Agency as specified in § 86.1847–01.

(d) *Test vehicle procurement.* Vehicles tested under this section shall be procured as follows:

(1) *Vehicle ownership.* Vehicles shall be procured from the group of persons who own or lease vehicles registered in the procurement area. Vehicles shall be procured from persons which own or lease the vehicle, excluding commercial owners/lessees owned or controlled by the vehicle manufacturer, using the procedures described in appendix I to this subpart. See § 86.1838–01(c)(2)(i) for small volume manufacturer requirements.

(2) *Geographical limitations.* (i) Test groups certified to 50-state standards: For low altitude testing no more than fifty percent of the test vehicles may be procured from California. The test vehicles procured from the 49-state area

must be procured from a location with a heating degree day 30-year annual average equal to or greater than 4,000.

(ii) Test groups certified to 49-state standards: The test vehicles procured from the 49-state area must be procured from a location with a heating degree day 30-year annual average equal to or greater than 4,000.

(iii) Vehicles procured for high altitude testing may be procured from any area located above 4,000 feet.

(3) *Rejecting candidate vehicles.* Vehicles may be rejected for procurement or testing under this section if they meet one or more of the rejection criteria in appendix II to this subpart. Vehicles may also be rejected after testing under this section if they meet one or more of the rejection criteria in appendix II to this subpart. Any vehicle rejected after testing must be replaced in order that the number of test vehicles in the sample comply with the sample size requirements of this section. Any post-test vehicle rejection and replacement procurement and testing must take place within the testing completion requirements of this section.

(e) *Testing facilities, procedures, quality assurance and quality control* —(1) *Lab equipment and procedural requirements.* The manufacturer shall utilize a test laboratory that is in accordance with the equipment and procedural requirements of subpart B of this part to conduct the testing required by this section.

(2) *Notification of test facility.* The manufacturer shall notify the Agency of the name and location of the testing laboratory(s) to be used to conduct testing of vehicles of each model year conducted pursuant to this section. Such notification shall occur at least thirty working days prior to the initiation of testing of the vehicles of that model year.

(3) *Correlation.* The manufacturer shall document correlation traceable to the Environmental Protection Agency's National Vehicle and Fuel Emission Laboratory for its test laboratory utilized to conduct the testing required by this section.

(f) *NMOG and formaldehyde.* The following provisions apply for measuring NMOG and formaldehyde:

(1) A manufacturer must conduct in-use testing on a test group by determining NMOG exhaust emissions using the same methodology used for certification, as described in 40 CFR 1066.635.

(2) For flexible-fueled vehicles certified to NMOG (or NMOG+NO_X) standards, the manufacturer may ask for EPA approval to demonstrate compliance using an equivalent NMOG emission result calculated from a ratio of ethanol NMOG exhaust emissions to gasoline NMHC exhaust emissions. Ethanol NMOG exhaust emissions are measured values from testing with the ethanol test fuel, expressed as NMOG. Gasoline NMHC exhaust emissions are measured values from testing with the gasoline test fuel, expressed as NMHC. This ratio must be established during certification for each emission-data vehicle for the applicable test group. Use good engineering judgment to establish a different ratio for each duty cycle or test interval as appropriate. Identify the ratio values you develop under this paragraph (f)(2) and describe the duty cycle or test interval to which they apply in the Part II application for certification. Calculate the equivalent NMOG emission result by multiplying the measured gasoline NMHC exhaust emissions for a given duty cycle or test interval by the appropriate ratio.

(3) If the manufacturer measures NMOG as described in 40 CFR 1066.635(a), it must also measure and report HCHO emissions. As an alternative to measuring the HCHO content, if the manufacturer measures NMOG as permitted in 40 CFR 1066.635(c), the Administrator may approve, upon submission of supporting data by a manufacturer, the use of HCHO to NMHC ratios. To request the use of HCHO to NMHC ratios, the manufacturer must establish during certification testing the ratio of measured HCHO exhaust emissions to measured NMHC exhaust emissions for each emission-data vehicle for the applicable test group. The results must be submitted to the Administrator with the Part II application for certification. Following approval of the application for certification, the manufacturer may conduct in-use testing on the test group by measuring NMHC exhaust emissions rather than HCHO exhaust emissions. The measured NMHC exhaust emissions must be multiplied by the HCHO to NMHC ratio submitted in the application for certification for the test group to determine the equivalent HCHO exhaust emission values for the test vehicle. The equivalent HCHO exhaust emission values must be compared to the HCHO exhaust emission standard applicable to the test group.

(g) *Battery testing.* Manufacturers of battery electric vehicles and plug-in hybrid electric vehicles must perform in-use testing related to battery monitor accuracy and battery durability for those vehicles as described in § 86.1815–27. Except as otherwise provided in § 86.1815–27(h), perform Part A testing for each monitor family as follows to verify that SOCE monitors meet accuracy requirements:

(1) Determine accuracy by measuring SOCE from in-use vehicles using the procedures specified in § 86.1815–27(c) and comparing the measured values to the SOCE value displayed on the monitor at the start of testing.

(2) Perform low-mileage testing of the vehicles in a monitor family within 24 months of the end of production of that monitor family for that model year. All test vehicles must have a minimum odometer mileage of 20,000 miles.

(3) Perform high-mileage testing of the vehicles in a monitor family by starting the test program within 4 years of the end of production of the monitor family and completing the test program within 5 years of the end of production of the monitor family. All test vehicles must have a minimum odometer mileage of 40,000 miles.

(4) Select test vehicles as described in paragraphs (b)(6), (c)(6), and (d)(1) and (3) of this section from the United States. Send notification regarding test location as described in paragraph (e)(2) of this section.

(5) You may perform diagnostic maintenance as specified in paragraph (b)(7) and (c)(7) of this section.

(6) See § 86.1838–01(b)(2) for a testing exemption that applies for small-volume monitor families.

(h) *Off-cycle testing for high-GCWR medium-duty vehicles.* Medium-duty vehicles that are subject to off-cycle standards under § 86.1811–27(e) are subject to in-use testing requirements described in 40 CFR part 1036, subpart E, and 40 CFR 1036.530, with the following exceptions and clarifications:

(1) In-use testing requirements apply for both vehicles with spark-ignition engines and vehicles with compression-ignition engines.

(2) References to ''engine family'' should be understood to mean ''test group''.

(3) In our test order we may include the following requirements and specifications:

(i) We may select any vehicle configuration for testing. We may also specify that the selected vehicle have certain optional features.

(ii) We may allow the vehicle manufacturer to arrange for the driver of a test vehicle to be an employee or a hired contractor, rather than the vehicle owner.

(iii) We may specify certain routes or types of driving.

(4) Within 45 days after we direct you to perform testing under this paragraph (h), send us a proposed test plan that meets the provisions in this paragraph

(h)(4) in addition to what we specify in 40 CFR 1036.410. EPA must approve the test plan before the manufacturer may start testing. EPA approval will be based on a determination that the test plan meets all applicable requirements. The test plan must include the following information:

(i) Describe how you will select vehicles, including consideration of available options and features, to properly represent in-use performance for the selected vehicle configuration.

(ii) Describe any planned inspection or maintenance before testing the vehicle, along with any criteria for rejecting a candidate vehicle.

(iii) Describe test routes planned for testing. The test route must target a specific total duration or distance, including at least three hours of driving with non-idle engine operation. The test route must represent normal driving, including a broad range of vehicle speeds and accelerations and a reasonable amount of operation at varying grades. If the completed test route does not include enough windows for any bin as specified in paragraph (h)(8) of this section, repeat the drive over the approved test route.

(iv) Describe your plan for vehicle operation to include at least 50 percent of non-idle operation with gross combined weight at least 70 percent of GCWR. Trailers used for testing must meet certain specifications as follows:

(A) Trailers must comply with requirements in Row D through Row L of Table 1 of SAE J2807 (incorporated by reference, see § 86.1); however, the frontal area of the trailer may not exceed the vehicle manufacturer's specified maximum frontal area for towing. Trailers over 24,000 pounds must have a frontal area between 60 and 75 ft^2.

(B) You may ask us to approve the use of a trailer not meeting SAE J2807 specifications. This may apply, for example, if the trailer has tires that are different than but equivalent to the specified tires. In your request, describe the alternative trailer's specifications, why you are using it, and how it is more representative of in-use operation than a trailer meeting the specifications in paragraph (h)(4)(iv)(A) of this section. Rather than demonstrating representativeness, you may instead describe why it is infeasible to use a trailer meeting the specifications in paragraph (h)(4)(iv)(A) of this section. We will consider whether your request is consistent with good engineering judgment.

(5) The accuracy margins in 40 CFR 1036.420(a) do not apply for vehicles with spark-ignition engines, or for vehicles with compression-ignition engines for demonstrating compliance with standards based on measurement procedures with 3-bin moving average windows.

(6) Determine a reference CO_2 emission rate, $e_{CO2FTPFCL}$, as described in 40 CFR 1036.635(a)(1) or based on measured values from any chassis FTP driving cycles under 40 CFR part 1066, subpart I, that is used for reporting data from an emission data vehicle or a fuel economy data vehicle, as follows:

Equation 1 to Paragraph (h)(6)

$$e_{\mathrm{CO2FTPFCL}} = \frac{m_{\mathrm{CO2FTP}}}{W_{\mathrm{FTP}}}$$

Where:

m_{CO2FTP} = CO_2 emission mass in grams emitted over the FTP driving cycle.

d_{FTP} = measured driving distance in miles.

W_{FTP} = work performed over the FTP.

$$W_{\mathrm{FTP}} = \sum_{i=1}^{N} f_{\mathrm{n}i} \cdot T_i \cdot \Delta t$$

i = an indexing variable that represents a 1 Hz OBD time counter over the course of the FTP drive.

N = total number of measurements over the FTP duty cycle = 1874.

f_n = engine speed for each point, i, starting from the start of the FTP drive at i = 1, collected from OBD PID $0C.

T = engine torque in N·m for each point, i, starting from i = 1. Calculate T by subtracting Friction Torque (PID $8E) from Indicated Torque (PID $62) (both PIDs are percentages) and then multiplying by the reference torque (PID $63). Set torque to zero if friction torque is greater than indicated torque.

$\Delta t = 1/f_{record}$

f_{record} = the data recording frequency.

Example:

m_{CO2FTP} = 10,961 g

N = 1874

f_1 = 687.3 r/min = 71.97 rad/s

f_2 = 689.7 r/min = 72.23 rad/s

T_1 = 37.1 ft·lbf = 50.3 N·m

T_2 = 37.2 ft·lbf = 50.4 N·m

f_{record} = 1 Hz

Δt = 1/1 = 1 s = 0.000277 hr

$W_{FTP} = 71.97 \cdot 50.3 \cdot 1.0 + 72.23 \cdot 50.4 \cdot 1.0 + \cdots f_{n1874} \cdot T_{1874} \cdot \Delta t_{1874}$

W_{FTP} = 53,958,852 W·s = 20.1 hp·hr

$$e_{\mathrm{CO2FTPFCL}} = \frac{10{,}961}{20.1}$$

$e_{CO2FTPFCL}$ = 545.3 g/hp·hr

(7) For testing based on the 3-bin moving average windows, identify the appropriate bin for each of the 300 second test intervals based on its normalized CO_2 emission mass, $m_{CO2,norm,testinterval}$, instead of the bin definitions in 40 CFR 1036.530(f), as follows:

TABLE 3 TO PARAGRAPH (h)(7) OF § 86.1845–04—CRITERIA FOR OFF-CYCLE BINS FOR 3-BIN MOVING AVERAGE WINDOWS

Bin	Normalized CO_2 emission mass over the 300 second test interval
Bin 1	$m_{CO2,norm,testinterval} \leq 6.00\%$
Bin 2a	$6.00\% < m_{CO2,norm,testinterval} \leq 20.00\%$
Bin 2b	$m_{CO2,norm,testinterval} > 20.00\%$

(8) For testing based on 3-bin moving average windows, calculate the off-cycle emissions quantity for Bin 2a and Bin 2b using the method described in 40 CFR 1036.530 for Bin 2. Each bin is valid for evaluating test results only if it has at least 2,400 windows.

■ 73. Amend § 86.1846–01 by revising paragraphs (a), (b), (e), and (j) to read as follows:

§ 86.1846–01 Manufacturer in-use confirmatory testing requirements.

(a) *General requirements.* (1) Manufacturers must test, or cause testing to be conducted, under this section when the emission levels shown by a test group sample from testing under § 86.1845 exceeds the criteria specified in paragraph (b) of this section. The testing required under this section applies separately to each test group and at each test point (low and high mileage) that meets the specified criteria. The testing requirements apply separately for each model year. These provisions do not apply to emissions of CH_4 or N_2O.

(2) The provisions of § 86.1845–04(a)(3) regarding fuel sulfur effects apply equally to testing under this section.

(b) *Criteria for additional testing.* (1) A manufacturer shall test a test group, or a subset of a test group, as described in paragraph (j) of this section when the results from testing conducted under § 86.1845 show mean exhaust emissions of any criteria pollutant for that test group to be at or above 1.30 times the applicable in-use standard for at least 50 percent of vehicles tested from the test group. However, under an interim alternative approach for PM emissions, additional testing is required if 80 percent of vehicles from the test group exceed 1.30 times the in-use standard through model year 2030 for light-duty program vehicles and through 2031 for medium-duty vehicles.

(2) A manufacturer shall test a test group, or a subset of a test group, as described in paragraph (j) of this section when the results from testing conducted under § 86.1845 show mean exhaust

emissions of CO_2 (City-highway combined CREE) for that test group to be at or above the applicable in-use standard for at least 50 percent of vehicles tested from the test group.

(3) Additional testing is not required under this paragraph (b) based on evaporative/refueling testing or based on low-mileage US06 testing conducted under § 86.1845–04(b)(5)(i). Testing conducted at high altitude under the requirements of § 86.1845–04(c) will be included in determining if a test group meets the criteria triggering the testing required under this section.

(4) The vehicle designated for testing under the requirements of § 86.1845–04(c)(2) with a minimum odometer reading of 105,000 miles or 75% of useful life, whichever is less, will not be included in determining if a test group meets the triggering criteria.

(5) The SFTP composite emission levels for Tier 3 vehicles shall include the IUVP FTP emissions, the IUVP US06 emissions, and the values from the SC03 Air Conditioning EDV certification test (without DFs applied). The calculations shall be made using the equations prescribed in § 86.164. If more than one set of certification SC03 data exists (due to running change testing or other reasons), the manufacturer shall choose the SC03 result to use in the calculation from among those data sets using good engineering judgment.

(6) If fewer than 50 percent of the vehicles from a leak family pass either the leak test or the diurnal test under § 86.1845, EPA may require further leak testing under this paragraph (b)(6). Testing under this section must include five vehicles from the family. If all five of these vehicles fail the test, the manufacturer must test five additional vehicles.

EPA will determine whether to require further leak testing under this section after providing the manufacturer an opportunity to discuss the results, including consideration of any of the following information, or other items that may be relevant:

(i) Detailed system design, calibration, and operating information, technical explanations as to why the individual vehicles tested failed the leak standard.

(ii) Comparison of the subject vehicles to other similar models from the same manufacturer.

(iii) Data or other information on owner complaints, technical service bulletins, service campaigns, special policy warranty programs, warranty repair data, state I/M data, and data available from other manufacturer-specific programs or initiatives.

(iv) Evaporative emission test data on any individual vehicles that did not pass leak testing during IUVP.

* * * * *

(e) *Emission testing.* Each test vehicle of a test group or Agency-designated subset shall be tested in accordance with the driving cycles performed under § 86.1845 corresponding to emission levels requiring testing under this section) as described in subpart B of this part, when such test vehicle is tested for compliance with applicable exhaust emission standards under this subpart.

* * * * *

(j) *Testing a subset.* EPA may designate a subset of the test group for testing under this section in lieu of testing the entire test group when the results for the entire test group from testing conducted under § 86.1845 show mean emissions and a failure rate which meet these criteria for additional testing.

■ 74. Amend § 86.1847–01 by adding paragraphs (g) and (h) to read as follows:

§ 86.1847–01 Manufacturer in-use verification and in-use confirmatory testing; submittal of information and maintenance of records.

* * * * *

(g) Manufacturers of battery electric vehicles and plug-in hybrid electric vehicles certified under this subpart must meet the following reporting and recordkeeping requirements related to testing performed under §§ 86.1815–27(f)(2) and (3):

(1) Submit the following records organized by monitor family and battery durability family related to Part A testing to verify accuracy of SOCE monitors within 30 days after completing low-mileage, intermediate-mileage, or high-mileage testing:

(i) A complete record of all tests performed, the dates and location of testing, measured SOCE values for each vehicle, along with the corresponding displayed SOCE values at the start of testing.

(ii) Test vehicle information, including model year, make, model, and odometer reading.

(iii) A summary of statistical information showing whether the testing shows a pass or fail result.

(2) Keep the following records related to testing under paragraph (g)(1) of this section:

(i) Test reports submitted under paragraph (g)(1) of this section.

(ii) Test facility information.

(iii) Routine testing records, such as dynamometer trace, and temperature and humidity during testing.

(3) Submit an annual report related to Part B testing to verify compliance with the Minimum Performance Requirement for SOCE, as applicable. Submit the report by October 1 for testing you perform over the preceding year or ask us to approve a different annual reporting period based on your practice for starting a new model year. Include the following information in your annual reports, organized by monitor family and battery durability family:

(i) Displayed values of SOCE for each sampled vehicle, along with a description of each vehicle to identify its model year, make, model, odometer reading, and state of registration. Also include the date for assessing each selected vehicle.

(ii) A summary of results to show whether 90 percent of sampled vehicles from each battery durability family meet the Minimum Performance Requirement.

(iii) A description of how you randomly selected vehicles for testing, including a demonstration that you meet the requirement to select test vehicles from different U.S. states or territories. Provide a more detailed description of your random selection if you test more than 500 vehicles.

(iv) A description of any selected vehicles excluded from the test results and the justification for excluding them.

(v) Information regarding warranty claims and statistics on repairs for batteries and for other components or systems for each battery durability family that might influence a vehicle's electric energy consumption.

(4) Keep the following records related to testing under paragraph (g)(3) of this section:

(i) Test reports submitted under paragraph (g)(3) of this section.

(ii) Documentation related to the method of selecting vehicles.

(5) Keep records required under this paragraph (g) for eight years after submitting reports to EPA.

(h) Manufacturers of high-GCWR vehicles subject to in-use testing under § 86.1845–04(j) must meet the reporting and recordkeeping requirements of 40 CFR 1036.430 and 1036.435 and include the following additional information:

(1) Describe the trailer used for testing.

(2) Identify the driving route, including total time and distance, and explain any departure from the planned driving route.

(3) Demonstrate that you met the specification for loaded operation.

§ 86.1848–01 [Removed]

■ 75. Remove § 86.1848–01.

■ 76. Revise § 86.1848–10 to read as follows:

§ 86.1848–10 Compliance with emission standards for the purpose of certification.

(a)(1) If, after a review of the manufacturer's submitted Part I application, information obtained from any inspection, such other information as the Administrator may require, and any other pertinent data or information, the Administrator determines that the application is complete and that all vehicles within a test group and evaporative/refueling family as described in the application meet the requirements of this part and the Clean Air Act, the Administrator shall issue a certificate of conformity.

(2) If, after review of the manufacturer's application, request for certification, information obtained from any inspection, such other information as the Administrator may require, and any other pertinent data or information, the Administrator determines that the application is not complete or the vehicles within a test group or evaporative/refueling family as described in the application, do not meet applicable requirements or standards of the Act or of this part, the Administrator may deny the issuance of, suspend, or revoke a previously issued certificate of conformity. The Administrator will notify the manufacturer in writing, setting forth the basis for the determination. The manufacturer may request a hearing on the Administrator's determination.

(b) A certificate of conformity will be issued by the Administrator for a period not to exceed one model year and upon such terms as deemed necessary or appropriate to assure that any new motor vehicle covered by the certificate will meet the requirements of the Act and of this part.

(c) Failure to meet any of the following conditions will be considered a failure to satisfy a condition upon which a certificate was issued, and any affected vehicles are not covered by the certificate:

(1) The manufacturer must supply all required information according to the provisions of §§ 86.1843 and 86.1844.

(2) The manufacturer must comply with all certification and in-use emission standards contained in subpart S of this part both during and after model year production. This includes monitor accuracy and battery durability requirements for battery electric vehicles and plug-in hybrid electric vehicles as described in § 86.1815.

(3) The manufacturer must comply with all implementation schedules sales percentages as required in this subpart.

(4) New incomplete vehicles must, when completed by having the primary load-carrying device or container attached, conform to the maximum curb weight and frontal area limitations described in the application for certification as required in § 86.1844.

(5) The manufacturer must meet the in-use testing and reporting requirements contained in §§ 86.1815, 86.1845, 86.1846, and 86.1847, as applicable.

(6) Vehicles must in all material respects be as described in the manufacturer's application for certification (Part I and Part II).

(7) Manufacturers must meet all the provisions of §§ 86.1811, 86.1813, 86.1816, and 86.1860 through 86.1862 both during and after model year production, including compliance with the applicable fleet average standard and phase-in requirements. The manufacturer bears the burden of establishing to the satisfaction of the Administrator that the terms and conditions upon which each certificate was issued were satisfied. For recall and warranty purposes, vehicles not covered by a certificate of conformity will continue to be held to the standards stated or referenced in the certificate that otherwise would have applied to the vehicles. A manufacturer may not sell credits it has not generated.

(8) Manufacturers must meet all provisions related to cold temperature standards in §§ 86.1811 and 86.1864 both during and after model year production, including compliance with the applicable fleet average standard and phase-in requirements. The manufacturer bears the burden of establishing to the satisfaction of the Administrator that the terms and conditions upon which each certificate was issued were satisfied. For recall and warranty purposes, vehicles not covered by a certificate of conformity will continue to be held to the standards stated or referenced in the certificate that otherwise would have applied to the vehicles. A manufacturer may not sell credits it has not generated.

(9) Manufacturers must meet all the provisions of §§ 86.1818, 86.1819, and 86.1865 both during and after model year production, including compliance with the applicable fleet average standard. The manufacturer bears the burden of establishing to the satisfaction of the Administrator that the terms and conditions upon which the certificate(s) was (were) issued were satisfied. For recall and warranty purposes, vehicles not covered by a certificate of conformity will continue to be held to the standards stated or referenced in the certificate that otherwise would have applied to the vehicles. A manufacturer may not sell credits it has not generated.

(i) Manufacturers that are determined to be operationally independent under § 86.1838–01(d) must report a material change in their status within 60 days as required by § 86.1838–01(d)(2).

(ii) Manufacturers subject to an alternative fleet average greenhouse gas emission standard approved under § 86.1818–12(g) must 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.

(10) Manufacturers must meet all the provisions of § 86.1815 both during and after model year production. The manufacturer bears the burden of establishing to the satisfaction of the Administrator that the terms and conditions related to issued certificates were satisfied.

(d) One certificate will be issued for each test group and evaporative/refueling family combination. For diesel fueled vehicles and electric vehicles, one certificate will be issued for each test group. A certificate of conformity is deemed to cover the vehicles named in such certificate and produced during the model year.

(e) A manufacturer of new light-duty vehicles, light-duty trucks, and complete heavy-duty vehicles must obtain a certificate of conformity covering such vehicles from the Administrator prior to selling, offering for sale, introducing into commerce, delivering for introduction into commerce, or importing into the United States the new vehicle. Vehicles produced prior to the effective date of a certificate of conformity may also be covered by the certificate, once it is effective, if the following conditions are met:

(1) The vehicles conform in all respects to the vehicles described in the application for the certificate of conformity.

(2) The vehicles are not sold, offered for sale, introduced into commerce, or delivered for introduction into commerce prior to the effective date of the certificate of conformity.

(3) EPA is notified prior to the beginning of production when such production will start, and EPA is provided a full opportunity to inspect and/or test the vehicles during and after their production. EPA must have the opportunity to conduct SEA production line testing as if the vehicles had been produced after the effective date of the certificate.

(f) Vehicles imported by an original equipment manufacturer after December 31 of the calendar year for which the model year is named are still covered by the certificate of conformity as long as the production of the vehicle was completed before December 31 of that year.

(g) For test groups required to have an emission control diagnostic system, certification will not be granted if, for any emission data vehicle or other test vehicle approved by the Administrator in consultation with the manufacturer, the malfunction indicator light does not illuminate as required under § 86.1806.

(h) Vehicles equipped with aftertreatment technologies such as catalysts, otherwise covered by a certificate, which are driven outside the United States, Canada, and Mexico will be presumed to have been operated on leaded gasoline resulting in deactivation of such components as catalysts and oxygen sensors. If these vehicles are imported or offered for importation without retrofit of the catalyst or other aftertreatment technology, they will be considered not to be within the coverage of the certificate unless included in a catalyst or other aftertreatment technology control program operated by a manufacturer or a United States Government agency and approved by the Administrator.

§ 86.1860–04 [Removed]

■ 77. Remove § 86.1860–04.

■ 78. Amend § 86.1860–17 by:

■ a. Revising the section heading and paragraphs (a) and (b); and

■ b. Removing paragraph (c)(4).

The revisions read as follows:

§ 86.1860–17 How to comply with the Tier 3 and Tier 4 fleet average standards.

(a) You must show that you meet the applicable Tier 3 fleet average $NMOG+NO_X$ standards from §§ 86.1811–17 and 86.1816–18, the Tier 3 fleet average evaporative emission standards from § 86.1813–17, and the Tier 4 fleet average $NMOG+NO_X$ standards from § 86.1811–27 as described in this section. Note that separate fleet average calculations are required for Tier 3 FTP and SFTP exhaust emission standards under § 86.1811–17.

(b) Calculate your fleet average value for each model year for all vehicle models subject to a separate fleet average standard using the following equation, rounded to the nearest 0.001 g/mile for $NMOG+NO_X$ emissions and the nearest 0.001 g/test for evaporative emissions:

Equation 1 to Paragraph (b)

$$\textit{Fleet average value} = \frac{\sum_{i=1}^{b}(N_i \cdot FEL_i)}{N_{total}}$$

Where:

i = A counter associated with each separate test group or evaporative family.

b = The number of separate test groups or evaporative families from a given averaging set to which you certify your vehicles.

N_i = The actual nationwide sales for the model year for test group or evaporative family *i*. Include allowances for evaporative emissions as described in § 86.1813.

FEL_i = The FEL selected for test group or evaporative family *i*. Disregard any separate standards that apply for in-use testing or for testing under high-altitude conditions.

N_{total} = The actual nationwide sales for the model year for all vehicles from the averaging set, except as described in paragraph (c) of this section. The pool of vehicle models included in N_{total} may vary by model year, and it may be different for evaporative standards, FTP exhaust standards, and SFTP exhaust standards in a given model year.

* * * * *

§ 86.1861–04 [Removed]

■ 79. Remove § 86.1861–04.

■ 80. Revise and republish § 86.1861–17 to read as follows:

§ 86.1861–17 How do the $NMOG+NO_X$ and evaporative emission credit programs work?

You may use emission credits for purposes of certification to show compliance with the applicable fleet average $NMOG+NO_X$ standards from §§ 86.1811 and 86.1816 and the fleet average evaporative emission standards from § 86.1813 as described in 40 CFR part 1037, subpart H, with certain exceptions and clarifications as specified in this section. MDPVs are subject to the same provisions of this section that apply to LDT4.

(a) Calculate emission credits as described in this paragraph (a) instead of using the provisions of 40 CFR 1037.705. Calculate positive or negative emission credits relative to the applicable fleet average standard. Calculate positive emission credits if your fleet average level is below the standard. Calculate negative emission credits if your fleet average value is above the standard. Calculate credits separately for each applicable fleet average standard and calculate total credits for each averaging set as specified in paragraph (b) of this section. Convert units from mg/mile to g/mile as needed for performing calculations. Calculate emission credits using the following equation, rounded to the nearest whole number:

Equation 1 to Paragraph (a)

$$\textit{Emission credit} = \textit{Volume} \cdot [\textit{Fleet average standard} - \textit{Fleet average value}]$$

Where:

Emission credit = The positive or negative credit for each discrete fleet average standard, in units of vehicle-grams per mile for $NMOG+NO_x$ and vehicle-grams per test for evaporative emissions.

Volume = Sales volume in a given model year from the collection of test groups or evaporative families covered by the fleet average value, as described in § 86.1860.

(b) The following restrictions apply instead of those specified in 40 CFR 1037.740:

(1) Except as specified in paragraph (b)(2) of this section, emission credits may be exchanged only within an averaging set, as follows:

(i) HDV represent a separate averaging set with respect to all emission standards.

(ii) Except as specified in paragraph (b)(1)(iii) of this section, light-duty program vehicles represent a single averaging set with respect to all emission standards. Note that FTP and SFTP credits for Tier 3 vehicles are not interchangeable.

(iii) LDV and LDT1 certified to standards based on a useful life of 120,000 miles and 10 years together represent a single averaging set with respect to $NMOG+NO_X$ emission standards. Note that FTP and SFTP credits for Tier 3 vehicles are not interchangeable.

(iv) The following separate averaging sets apply for evaporative emission standards:

(A) LDV and LDT1 together represent a single averaging set.

(B) LDT2 represents a single averaging set.

(C) HLDT represents a single averaging set.

(D) HDV represents a single averaging set.

(2) You may exchange evaporative emission credits across averaging sets as follows if you need additional credits to offset a deficit after the final year of maintaining deficit credits as allowed under paragraph (c) of this section:

(i) You may exchange LDV/LDT1 and LDT2 emission credits.

(ii) You may exchange HLDT and HDV emission credits.

(3) Except as specified in paragraph (b)(4) of this section, credits expire after five years.

For example, credits you generate in model year 2018 may be used only through model year 2023.

(4) For the Tier 3 declining fleet average FTP and SFTP emission standards for $NMOG+NO_X$ described in § 86.1811–17(b)(8), credits generated in model years 2017 through 2024 expire after eight years, or after model year 2030, whichever comes first; however, these credits may not be traded after five years. This extended credit life also applies for small-volume manufacturers generating credits under § 86.1811–17(h)(1) in model years 2022 through 2024. Note that the longer credit life does not apply for heavy-duty vehicles, for vehicles certified under the alternate phase-in described in § 86.1811–17(b)(9), or for vehicles generating early Tier 3 credits under § 86.1811–17(b)(11) in model year 2017.

(5) Tier 3 credits for $NMOG+NO_X$ may be used to demonstrate compliance with Tier 4 standards without adjustment, except as specified in § 86.1811–27(b)(6)(ii).

(6) A manufacturer may generate $NMOG+NO_X$ credits from model year 2027 through 2032 electric vehicles that qualify as MDPV and use those credits for certifying medium-duty vehicles, as follows:

(i) Calculate generated credits separately for qualifying vehicles. Calculate generated credits by multiplying the applicable standard for light-duty program vehicles by the sales volume of qualifying vehicles in a given model year.

(ii) Apply generated credits to eliminate any deficit for light-duty program vehicles before using them to certify medium-duty vehicles.

(iii) Apply the credit provisions of this section as specified, except that you may not buy or sell credits generated under this paragraph (b)(6).

(iv) Describe in annual credit reports how you are generating certain credit quantities under this paragraph (b)(6). Also describe in your end of year credit report how you will use those credits for certifying light-duty program vehicles or medium-duty vehicles in a given model year.

(c) The credit-deficit provisions 40 CFR 1037.745 apply to the $NMOG+NO_X$ and evaporative emission standards for Tier 3 and Tier 4 vehicles. Credit-deficit provisions are not affected by the transition from Tier 3 to Tier 4 standards.

(d) The reporting and recordkeeping provisions of § 86.1862 apply instead of those specified in 40 CFR 1037.730 and 1037.735.

(e) The provisions of 40 CFR 1037.645 do not apply.

(f) The enforcement provisions described in § 86.1865–12(j)(3) apply with respect to $NMOG+NO_X$ emission credits under this section for battery electric vehicles that do not conform to battery durability requirements in § 86.1815–27.

■ 81. Amend § 86.1862–04 by revising the section heading and paragraphs (a), (c)(2), and (d) to read as follows:

§ 86.1862–04 Maintenance of records and submittal of information relevant to compliance with fleet average standards.

(a) *Overview.* This section describes reporting and recordkeeping requirements for vehicles subject to the following standards:

(1) Tier 4 criteria exhaust emission standards, including cold temperature $NMOG+NO_X$ standards, in § 86.1811–27.

(2) Tier 3 evaporative emission standards in § 86.1813–17.

(3) Tier 3 FTP emission standard for $NMOG+NO_X$ for LDV and LDT in § 86.1811–17.

(4) Tier 3 SFTP emission standard for $NMOG+NO_X$ for LDV and LDT (including MDPV) in § 86.1811–17.

(5) Tier 3 FTP emission standard for $NMOG+NO_X$ for HDV (other than MDPV) in § 86.1816–18.

(6) Cold temperature NMHC standards in § 86.1811–17 for vehicles subject to Tier 3 $NMOG+NO_X$ standards.

* * * * *

(c) * * *

(2) When a manufacturer calculates compliance with the fleet average standard using the provisions in § 86.1860–17(f), the annual report must state that the manufacturer has elected to use such provision and must contain the fleet average standard as the fleet average value for that model year.

* * * * *

(d) *Notice of opportunity for hearing.* Any voiding of the certificate under this section will be made only after EPA has offered the manufacturer concerned an opportunity for a hearing conducted in accordance with 40 CFR part 1068, subpart G, and, if a manufacturer requests such a hearing, will be made only after an initial decision by the Presiding Officer.

§ 86.1863–07 [Removed]

■ 82. Remove § 86.1863–07.

■ 83. Revise § 86.1864–10 to read as follows:

§ 86.1864–10 How to comply with cold temperature fleet average standards.

(a) *Applicability.* Cold temperature fleet average standards apply for NMHC or $NMOG+NO_X$ emissions as described in § 86.1811. Certification testing provisions described in this subpart apply equally for meeting cold temperature exhaust emission standards except as specified.

(b) *Calculating the cold temperature fleet average standard.* Manufacturers must compute separate sales-weighted cold temperature fleet average emissions at the end of the model year using actual sales and certifying test groups to FELs, as defined in § 86.1803–01. The FEL becomes the standard for each test group, and every test group can have a different FEL. The certification resolution for the FEL is 0.1 grams/mile for NMHC and 0.010 grams/mile for $NMOG+NO_X$. Determine fleet average emissions separately for each set of vehicles subject to different fleet average emission standards. Do not include electric vehicles or fuel cell vehicles when calculating fleet average emissions. Starting with Tier 4 vehicles, determine fleet average emissions based on separate averaging sets for light-duty program vehicles and medium-duty vehicles. Convert units between mg/mile and g/mile as needed for performing calculations. Calculate the sales-weighted cold temperature fleet averages using the following equation, rounded to the nearest 0.1 grams/mile for NMHC and to the nearest 0.001 grams/mile for $NMOG+NO_X$:

Equation 1 to Paragraph (b)

$$Cold\ temperature\ fleet\ average\ exhaust\ emissions = \frac{\Sigma\,(N \times FEL)}{Volume}$$

Where:

N = The number of vehicles subject to a given fleet average emission standard based on vehicles counted at the point of first sale.

FEL = Family Emission Limit (grams/mile).

Volume = Total number of vehicles sold from the applicable cold temperature averaging set.

(c) *Certification compliance and enforcement requirements for cold temperature fleet average standards.* Each manufacturer must comply on an annual basis with fleet average standards as follows:

(1) Manufacturers must report in their annual reports to the Agency that they met the relevant fleet average standard by showing that their sales-weighted cold temperature fleet average emissions are at or below the applicable fleet average standard for each averaging set.

(2) If the sales-weighted average is above the applicable fleet average standard, manufacturers must obtain and apply sufficient credits as permitted under paragraph (d)(8) of this section. A manufacturer must show via the use of credits that they have offset any exceedance of the cold temperature fleet average standard. Manufacturers must also include their credit balances or deficits.

(3) If a manufacturer fails to meet the cold temperature fleet average standard for two consecutive years, the vehicles causing the exceedance will be considered not covered by the certificate of conformity (see paragraph (d)(8) of this section). A manufacturer will be subject to penalties on an individual-vehicle basis for sale of vehicles not covered by a certificate.

(4) EPA will review each manufacturer's sales to designate the vehicles that caused the exceedance of the fleet average standard. EPA will designate as nonconforming those vehicles in test groups with the highest certification emission values first, continuing until reaching a number of vehicles equal to the calculated number of noncomplying vehicles as determined above. In a group where only a portion of vehicles would be deemed nonconforming, EPA will determine the actual nonconforming vehicles by counting backwards from the last vehicle produced in that test group. Manufacturers will be liable for penalties for each vehicle sold that is not covered by a certificate.

(d) *Requirements for the cold temperature averaging, banking, and trading (ABT) program.* (1) Manufacturers must average the cold temperature fleet average emissions of their vehicles and comply with the cold temperature fleet average standard. A manufacturer whose cold temperature fleet average emissions exceed the applicable standard must complete the calculation in paragraph (d)(4) of this section to determine the size of its credit deficit. A manufacturer whose cold temperature fleet average emissions are less than the applicable standard must complete the calculation in paragraph (d)(4) of this section to generate credits.

(2) There are no property rights associated with cold temperature credits generated under this subpart. Credits are a limited authorization to emit the designated amount of emissions. Nothing in this part or any other provision of law should be construed to limit EPA's authority to terminate or limit this authorization through rulemaking.

(3) The following transition provisions apply:

(i) Cold temperature NMHC credits may be used to demonstrate compliance with the cold temperature $NMOG+NO_X$ emission standards for Tier 4 vehicles. The value of a cold temperature NMHC credit is deemed to be equal to the value of a cold temperature $NMOG+NO_X$ credit.

(ii) Credits earned from any light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles may be used for any light-duty program vehicles, even if they were originally generated for a narrower averaging set.

(4) Credits are earned on the last day of the model year. Manufacturers must calculate, for a given model year, the number of credits or debits it has generated according to the following equation, rounded to the nearest 0.1 vehicle-grams/mile:

Equation 2 to Paragraph (d)(4)

$$\textit{Fleet average Credits or Debits} = (\textit{Standard} - \textit{Emissions}) \times \textit{Volume}$$

Where:

Standard = the cold temperature NMHC or $NMOG+NO_X$ standard.

Emissions = the manufacturer's sales-weighted cold temperature fleet average emissions, calculated according to paragraph (b) of this section.

Volume = total number of 50-state vehicles sold, based on the point of first sale.

(5) NMHC and $NMOG+NO_X$ credits are not subject to any discount or expiration date except as required under the deficit carryforward provisions of paragraph (d)(8) of this section. There is no discounting of unused credits. NMHC and $NMOG+NO_X$ credits have unlimited lives, subject to the limitations of paragraph (d)(2) of this section.

(6) Credits may be used as follows:

(i) Credits generated and calculated according to the method in paragraph (d)(4) of this section may be used only to offset deficits accrued with respect to the standard in § 86.1811–10(g)(2). Credits may be banked and used in a future model year in which a manufacturer's average cold temperature fleet average level exceeds the applicable standard. Credits may be exchanged only within averaging sets. Credits may also be traded to another manufacturer according to the provisions in paragraph (d)(9) of this section. Before trading or carrying over credits to the next model year, a manufacturer must apply available credits to offset any credit deficit, where the deadline to offset that credit deficit has not yet passed.

(ii) The use of credits shall not be permitted to address Selective Enforcement Auditing or in-use testing failures. The enforcement of the averaging standard occurs through the vehicle's certificate of conformity. A manufacturer's certificate of conformity is conditioned upon compliance with the averaging provisions. The certificate will be void ab initio if a manufacturer fails to meet the corporate average standard and does not obtain appropriate credits to cover its shortfalls in that model year or in the subsequent model year (see deficit carryforward provision in paragraph (d)(8) of this section). Manufacturers must track their certification levels and sales unless they produce only vehicles certified with FELs at or below the applicable to cold temperature fleet average levels below the standard and have chosen to forgo credit banking.

(7) The following provisions apply if debits are accrued:

(i) If a manufacturer calculates that it has negative credits (also called "debits" or a "credit deficit") for a given model year, it may carry that deficit forward into the next model year. Such a carry-forward may only occur after the manufacturer exhausts any supply of banked credits. At the end of that next model year, the deficit must be covered with an appropriate number of credits that the manufacturer generates or purchases. Any remaining deficit is subject to an enforcement action, as described in this paragraph (d)(8). Manufacturers are not permitted to have a credit deficit for two consecutive years.

(ii) If debits are not offset within the specified time period, the number of vehicles not meeting the cold temperature fleet average standards (and therefore not covered by the certificate) must be calculated by dividing the total amount of debits for the model year by the cold temperature fleet average standard applicable for the model year in which the debits were first incurred.

(iii) EPA will determine the number of vehicles for which the condition on the certificate was not satisfied by designating vehicles in those test groups with the highest certification cold temperature NMHC or $NMOG+NO_X$ emission values first and continuing until reaching a number of vehicles equal to the calculated number of noncomplying vehicles as determined above. If this calculation determines that only a portion of vehicles in a test group contribute to the debit, EPA will designate actual vehicles in that test group as not covered by the certificate, starting with the last vehicle produced and counting backwards.

(iv)(A) If a manufacturer ceases production of vehicles affected by a debit balance, 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 (d)(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 (d)(8)(ii) and (iii) of this section.

(B) If a manufacturer is purchased by, merges with, or otherwise combines with another manufacturer, the controlling entity is responsible for offsetting any debits outstanding within the required time period. Any failure to offset the debits will be considered a violation of paragraph (d)(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 (d)(8)(ii) and (iii) of this section.

(v) For purposes of calculating the statute of limitations, a violation of the requirements of paragraph (d)(8)(i) of this section, a failure to satisfy the conditions upon which a certificate(s) was issued and hence a sale of vehicles not covered by the certificate, all occur upon the expiration of the deadline for offsetting debits specified in paragraph (d)(8)(i) of this section.

(8) The following provisions apply for trading cold temperature credits:

(i) EPA may reject credit trades if the involved manufacturers fail to submit the credit trade notification in the annual report. A manufacturer may not sell credits that are not available for sale pursuant to the provisions in paragraphs (d)(7)(i) of this section.

(ii) In the event of a negative credit balance resulting from a transaction that a manufacturer could not cover by the reporting deadline for the model year in which the trade occurred, both the buyer and seller are liable, except in cases involving fraud by either the buyer or seller. EPA may void ab initio the certificates of conformity of all engine families participating in such a trade.

(iii) A manufacturer may only trade credits that it has generated pursuant to paragraph (d)(4) of this section or acquired from another party.

■ 84. Amend § 86.1865–12 by:

■ a. Revising paragraphs (h)(1) and (j);

■ b. Removing and reserving paragraph (k)(7)(iii); and

■ c. Adding paragraph (k)(10).

The revisions and addition read as follows:

§ 86.1865–12 How to comply with the fleet average CO_2 standards.

* * * * *

(h) * * *

(1) The test procedures for demonstrating compliance with CO_2 exhaust emission standards are described at § 86.101 and 40 CFR part 600, subpart B. Note that these test procedures involve measurement of carbon-related exhaust emissions to demonstrate compliance with the fleet average CO_2 standards in § 86.1818–12.

* * * * *

(j) *Certification compliance and enforcement requirements for CO_2 exhaust emission standards.* (1) Compliance and enforcement requirements are provided in this section and § 86.1848–10.

(2) The certificate issued for each test group requires all model types within that test group to meet the in-use emission standards to which each model type is certified. The in-use standards for passenger automobiles and light trucks (including MDPV) are described in § 86.1818–12(d). The in-use standards for medium-duty vehicles are described in § 86.1819–14(b).

(3) EPA will issue a notice of nonconformity as described in 40 CFR part 85, subpart S, if EPA or the manufacturer determines that a substantial number of a class or category of vehicles produced by that manufacturer, although properly maintained and used, do not conform to in-use CO_2 emission standards, or do not conform to the monitor accuracy and battery durability requirements in § 86.1815–27. The manufacturer must submit a remedial plan in response to a notice of nonconformity as described in 40 CFR 85.1803. The manufacturer's remedial plan would generally be a recall intended to remedy repairable problems to bring nonconforming vehicles into compliance; however, if there is no demonstrable, repairable problem that could be remedied to bring the vehicles into compliance, the manufacturer must submit an alternative plan to address the noncompliance and notify owners. For example, manufacturers may need to calculate a correction to its emission credit balance based on the GHG emissions of the actual number of vehicles produced. Manufacturers may voluntarily recall vehicles to remedy a noncompliance and submit a voluntary recall report as described in 40 CFR part 85, subpart T. Manufacturers may also voluntarily pursue a credit-based or other alternative approach to remedy a noncompliance where appropriate.

(4) Any remedial plan under paragraph (j)(3) of this section, whether voluntary or in response to a notice of nonconformity, must fully correct the difference between the measured in-use CREE of the affected class or category of vehicles and the reported CREE used to calculate the manufacturer's fleet average and credit balances.

(5) The manufacturer may request a hearing under 40 CFR part 1068, subpart G, regarding any voiding of credits or adjustment of debits under paragraph (j)(3) of this section. Manufacturers must submit such a request in writing describing the objection and any supporting data within 30 days after we make a decision.

(6) Each manufacturer must comply with the applicable CO_2 fleet average standard on a production-weighted average basis, at the end of each model year. Use the procedure described in paragraph (i) of this section for passenger automobiles and light trucks (including MDPV). Use the procedure described in § 86.1819–14(d)(9)(iv) for medium-duty vehicles.

(7) Each manufacturer must comply on an annual basis with the fleet average standards as follows:

(i) Manufacturers must report in their annual reports to the Agency that they met the relevant corporate average standard by showing that the applicable production-weighted average CO_2 emission levels are at or below the applicable fleet average standards; or

(ii) If the production-weighted average is above the applicable fleet average standard, manufacturers must obtain and apply sufficient CO_2 credits as authorized under paragraph (k)(8) of this section. A manufacturer must show that they have offset any exceedance of the corporate average standard via the use of credits. Manufacturers must also include their credit balances or deficits in their annual report to the Agency.

(iii) If a manufacturer fails to meet the corporate average CO_2 standard for four consecutive years, the vehicles causing the corporate average exceedance will be considered not covered by the certificate of conformity (see paragraph (k)(8) of this section). A manufacturer will be subject to penalties on an individual-vehicle basis for sale of vehicles not covered by a certificate.

(iv) EPA will review each manufacturer's production to designate the vehicles that caused the exceedance of the corporate average standard. EPA will designate as nonconforming those vehicles in test groups with the highest certification emission values first, continuing until reaching a number of vehicles equal to the calculated number of noncomplying vehicles as determined in paragraph (k)(8) of this section. In a group where only a portion of vehicles would be deemed nonconforming, EPA will determine the actual nonconforming vehicles by counting backwards from the last vehicle produced in that test group. Manufacturers will be liable for penalties for each vehicle sold that is not covered by a certificate.

(k) * * *

(10) A manufacturer may generate CO_2 credits from model year 2027 through 2032 electric vehicles that qualify as MDPV and use those credits for certifying medium-duty vehicles, as follows:

(i) Determine the emission standards from § 86.1818–12 for qualifying vehicles based on the CO_2 target values for light trucks and the footprint for each vehicle.

(ii) Calculate generated credits separately for qualifying vehicles as described in paragraph (k)(4) of this section based on the emission standards from paragraph (k)(10)(i) of this section, the mileage values for light trucks, and the total number of qualifying vehicles produced, with fleet average CO_2 emissions set to 0.

(iii) Apply generated credits to eliminate any deficit for light trucks before using them to certify medium-duty vehicles.

(iv) Apply the credit provisions of this section as specified, except that you may not buy or sell credits generated under this paragraph (k)(10).

(v) Describe in the annual credit reports how you are generating certain credit quantities under this paragraph (k)(10). Also describe in your end of year credit report how you will use those credits for certifying light trucks or medium-duty vehicles in a given model year.

* * * * *

■ 85. Amend § 86.1866–12 by revising paragraphs (a) and (c)(3) to read as follows:

§ 86.1866–12 CO_2 credits for advanced technology vehicles.

* * * * *

(a) Battery electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles that are certified and produced for sale in the states and territories of the United States may use a value of zero grams CO_2 per mile to represent the proportion of electric operation of a vehicle that is derived from electricity generated from sources that are not onboard the vehicle.

* * * * *

(c) * * *

(3) Multiplier-based credits for model years 2022 through 2024 may not exceed credit caps, as follows:

(i) Calculate a nominal annual credit cap in Mg using the following equation, rounded to the nearest whole number:

$$CAP_{\text{annual}} = 5.0\,\frac{\text{g}}{\text{mile}} \cdot \left[195{,}264\ \text{miles} \cdot P_{\text{auto}} + 225{,}865 \cdot P_{\text{truck}}\right] \cdot 10^{-6}\ \frac{\text{tonne}}{\text{g}}$$

Where:

P_{auto} = total number of certified passenger automobiles the manufacturer produced in a given model year for sale in any state or territory of the United States.

P_{truck} = total number of certified light trucks (including MDPV) the manufacturer produced in a given model year for sale in any state or territory of the United States.

(ii) Calculate an annual g/mile equivalent value for the multiplier-based credits using the following equation, rounded to the nearest 0.1 g/mile:

$$annual\ g\ per\ mile\ equivalent\ value\ =\ 5.0 \cdot \frac{annual\ credits}{CAP_{\text{annual}}}$$

Where:

annual credits = a manufacturer's total multiplier-based credits in a given model year from all passenger automobiles and light trucks as calculated under this paragraph (c).

(iii) Calculate a cumulative g/mile equivalent value for the multiplier-based credits in each year by adding the annual g/mile equivalent values calculated under paragraph (c)(3)(ii) of this section.

(iv) The cumulative g/mile equivalent value may not exceed 10.0 in any year.

(v) For every year of certifying with multiplier-based credits, the annual credit report must include the calculated values for the nominal annual credit cap in Mg and the cumulative g/mile equivalent value.

■ 86. Revise and republish § 86.1867–12 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 (including MDPV); only the provisions of paragraph (a) of this section apply for non-MDPV heavy-duty vehicles. Credits shall be calculated according to this section for each air conditioning system that the manufacturer is using to generate CO_2 credits.

(a) Calculate an annual rate of refrigerant leakage from an air conditioning system as follows, expressed to the nearest 0.1 grams per year:

(1) Through model year 2026, calculate leakage rates according to the procedures specified in SAE J2727 FEB2012 (incorporated by reference, see § 86.1). In doing so, the refrigerant permeation rates for hoses shall be determined using the procedures specified in SAE J2064 (incorporated by reference, § 86.1). 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.

(2) For model years 2027 through 2030, calculate leakage rates according to the procedures specified in SAE J2727 SEP2023 (incorporated by reference, § 86.1).

(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:

Equation 1 to Paragraph (b)(1)

$$Leakage\ Credit = MaxCredit \cdot \left[1 - \frac{LeakScore}{16.6} \times \frac{GWP_{REF}}{1430}\right] - HiLeakDis$$

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 paragraph (a) of this section. 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 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:

Equation 2 to Paragraph (b)(1)

$$HiLeakDis = 1.8 \cdot \frac{(LeakScore - LeakThreshold)}{3.3}$$

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 *Refrigerant Capacity* is the maximum refrigerant capacity specified for the air conditioning system, in grams.

(2) Light truck leakage credit for an air conditioning system:

Equation 3 to Paragraph (b)(2)

$$Leakage\ Credit = MaxCredit \cdot \left[1 - \frac{LeakScore}{20.7} \times \frac{GWP_{REF}}{1430}\right] - HiLeakDis$$

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 paragraph (a) of this section. 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 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:

Equation 4 to Paragraph (b)(2)

$$HiLeakDis = 2.1 \cdot \frac{(LeakScore - LeakThreshold)}{3.3}$$

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 *Refrigerant Capacity* is the maximum refrigerant capacity specified for the air conditioning system, in grams.

(c) Calculate the total leakage credits generated by the air conditioning system as follows:

(1) Calculate a total leakage credit in megagrams separately for passenger automobiles and light trucks using the following equation:

Equation 5 to Paragraph (c)(1)

$$Total\ Credits = \frac{Leakage \cdot Production \cdot VLM}{1{,}000{,}000}$$

Where:

Leakage = the CO_2-equivalent leakage credit value in grams per mile determined in paragraph (b) of this section, subject to the maximum values specified in paragraph (c)(2) of this section.

Production = The total number of passenger automobiles or light trucks, whichever is applicable, produced with the air conditioning system to which to the leakage credit value from paragraph (b)(1) or (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.

(2) Total leakage credits may not exceed the following maximum per-vehicle values in model years 2027 through 2030:

TABLE 1 TO PARAGRAPH (c)(2)—MAXIMUM LEAKAGE CREDIT VALUES

[g/mile]

Model year	Passenger automobiles	Light trucks
2027	11.0	13.8
2028	8.3	10.3
2029	5.5	6.9
2030	2.8	3.4

(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} 1; and

(4) For CO_2, GWP_{REF} = 1.

■ 87. Add § 86.1867–31 to read as follows:

§ 86.1867–31 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 light trucks (including MDPV). Calculate credits for each air conditioning system used to generate CO_2 credits. This section applies starting with model year 2031.

(a) Calculate an annual rate of refrigerant leakage from an air conditioning system in grams per year for refrigerants with GWP at or below 150 according to the procedures specified in SAE J2727 SEP2023 (incorporated by reference, see § 86.1).

(b) Determine the CO_2-equivalent gram per mile leakage reduction separately for passenger automobiles and light trucks, as follows:

(1) Calculate the leakage credit to the nearest 0.1 g/mile using the following equation:

Equation 1 to Paragraph (b)(1)

$$Leakage\ Credit = MaxCredit \cdot \left[1 - \frac{GWP_{REF}}{150}\right] - HiLeakDis$$

Where:

MaxCredit is the maximum per-vehicle value of the leakage credit. Use 1.6 g/mile for passenger automobiles and 2.0 g/mile for light trucks.

GWP_{REF} means the global warming potential of the refrigerant as indicated in paragraph (e) of this section.

HiLeakDis is the high leak disincentive, as determined in paragraph (b)(2) of this section.

(2) Calculate the high leak disincentive, *HiLeakDis,* using the following equation, except that if the calculated result is less than zero, set *HiLeakDis* equal to zero:

Equation 2 to Paragraph (b)(2)

$$HiLeakDis = K \cdot \frac{(LeakScore - LeakThreshold)}{3.3}$$

Where:

K = a constant. Use 1.6 for passenger automobiles and 2.0 for light trucks.

LeakScore means the annual refrigerant leakage rate as described in paragraph (a) of this section, expressed to the nearest 0.1 grams per year. If the calculated rate for passenger automobiles is less than 8.3 grams/year (or 4.1 grams/year for systems using only electric compressors), use 8.3 grams/year (or 4.1 grams/year for systems using only electric compressors). If the calculated rate for light trucks is less than 10.4 grams/year (or 5.2 grams/year for systems using only electric compressors), use 10.4 grams/year (or 5.2 grams/year for systems using only electric compressors).

LeakThreshold = 11.0 or [*Refrigerant Capacity* × 0.015], whichever is greater, where *Refrigerant Capacity* is the maximum refrigerant capacity specified for the air conditioning system, in grams.

(c) Calculate the total leakage reduction credits generated by the air conditioning system separately for passenger automobiles and light trucks to the nearest whole megagram using the following equation:

Equation 3 to Paragraph (c)

$$Total\ Credits = \frac{Leakage \cdot Production \cdot VLM}{1{,}000{,}000}$$

Where:

Leakage = the CO_2-equivalent leakage credit value in grams per mile determined in paragraph (b) of this section for passenger automobiles or light trucks.

Production = The total number of passenger automobiles or light trucks, produced with the air conditioning system to which to the leakage credit value from paragraph (b) of this section applies.

VLM = vehicle lifetime miles. Use 195,264 for passenger automobiles and 225,865 for light trucks.

(d) Include the results of paragraph (c) of this section in your credit totals calculated in § 86.1865–12(k)(5).

(e) Calculate leakage credits using values for refrigerant global warming potential (GWP_{REF}) as follows:

(1) Use the following values for the specific refrigerants:

(i) For HFC–152a, GWP_{REF} = 124.

(ii) For HFO–1234yf, GWP_{REF} = 1.

(iii) For CO_2, GWP_{REF} = 1.

(2) EPA will assign values for GWP_{REF}, up to a value of 150, for other refrigerants upon request.

■ 88. Revise and republish § 86.1868–12 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 light trucks (including MDPV). The provisions of this section do not apply for medium-duty vehicles. Credits shall be calculated according to this section for each air conditioning system that the manufacturer is using to generate CO_2 credits. Manufacturers must validate credits under this section based on testing as described in paragraph (g) of this section. Starting in model year 2027, manufacturers may generate credits under this section only for vehicles propelled by internal combustion engines.

(a) 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:

TABLE 1 TO PARAGRAPH (a)—TECHNOLOGY-SPECIFIC AIR CONDITIONING EFFICIENCY CREDITS

[g/mile]

Air conditioning technology	Passenger automobiles	Light trucks
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
Advanced technology air conditioning compressor with improved efficiency relative to fixed-displacement compressors achieved through the addition of a variable crankcase suction valve	1.1	1.1

(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) for each item that applies to the air conditioning system. 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 in megagrams separately for passenger automobiles and light trucks according to the following formula:

Equation 1 to Paragraph (c)

$$Total\ Credits = \frac{Credit \cdot Production \cdot VLM}{1{,}000{,}000}$$

Where:

Credit = the CO_2 efficiency credit value in grams per mile determined in paragraph (b) of this section, whichever is applicable. Starting in model year 2027, multiply the credit value for PHEV by (1–UF), where *UF* = the fleet utility factor established under 40 CFR 600.116–12(c)(1) or (c)(10)(iii) (weighted 55 percent city, 45 percent highway.

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)–(f) [Reserved]

(g) For AC17 validation testing and reporting requirements, manufacturers must validate air conditioning credits by using the AC17 Test Procedure in 40 CFR 1066.845 as follows:

(1) For each air conditioning system (as defined in § 86.1803) selected by the manufacturer to generate air conditioning efficiency credits, the manufacturer shall perform the AC17 Air Conditioning Efficiency Test Procedure specified in 40 CFR 1066.845, 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 air conditioning system (as those terms are defined in § 86.1803). 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.

(5) AC17 testing requirements apply as follows for electric vehicles and plug-in hybrid electric vehicles:

(i) Manufacturers may omit AC17 testing for electric vehicles. Electric vehicles may qualify for air conditioning efficiency credits based on identified technologies, without testing. The application for certification must include a detailed description of the vehicle's air conditioning system and identify any technology items eligible for air conditioning efficiency credits. Include additional supporting information to justify the air conditioning credit for each technology.

(ii) The provisions of paragraph (g)(5)(i) of this section also apply for plug-in hybrid electric vehicles if they have an all electric range of at least 60 miles (combined city and highway) after adjustment to reflect actual in-use driving conditions (see 40 CFR 600.311(j)), and they do not rely on the engine to cool the vehicle's cabin for the ambient and driving conditions represented by the AC17 test.

(iii) If AC17 testing is required for plug-in hybrid electric vehicles, perform this testing in charge-sustaining mode.

(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 (incorporated by reference, see § 86.1), when compared to a system using standard, or prior model year, component designs. 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.

(7) *Advanced technology air conditioning compressor* means an air conditioning compressor with improved efficiency relative to fixed-displacement compressors. Efficiency gains are derived from improved internal valve systems that optimize the internal refrigerant flow across the range of compressor operator conditions through the addition of a variable crankcase suction valve.

■ 89. Amend § 86.1869–12 by revising the introductory text and paragraphs (b)(2) and (f) to read as follows:

§ 86.1869–12 CO_2 credits for off-cycle CO_2 reducing technologies.

This section describes how manufacturers may generate credits for off-cycle CO_2-reducing technologies through model year 2032. The provisions of this section do not apply for medium-duty vehicles, except that § 86.1819–14(d)(13) describes how to apply paragraphs (c) and (d) of this section for those vehicles. Manufacturers may no longer generate credits under this section starting in model year 2027 for vehicles deemed to have zero tailpipe emissions and in model year 2033 for all other vehicles. Manufacturers may no longer generate credits under paragraphs (c) and (d) of this section for any type of vehicle starting in model year 2027.

* * * * *

(b) * * *

(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 specified in paragraph (b)(2)(v) of this section. If the total of the CO_2 g/mi credit values from paragraph (b)(1) of this section does not exceed the specified off-cycle credit cap 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 paragraph (b)(1) of this section exceeds the specified off-cycle credit cap 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)(ii) of this section to determine whether the applicable 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 United States. Starting in model year 2027, include only vehicles with internal combustion engines.

$Prod_T$ = The number of light trucks produced by the manufacturer and delivered for sale in the United States. Starting in model year 2027, include only vehicles with internal combustion engines.

(ii) If the value determined in paragraph (b)(2)(i) of this section is greater than the off-cycle credit cap specified in paragraph (b)(2)(v) of this section, 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:

$$Credit = \frac{cap \times \left((Prod_{C} \times 195{,}264) + (Prod_{T} \times 225{,}865)\right)}{1{,}000{,}000}$$

Where:

cap = the off-cycle credit cap specified in paragraph (b)(2)(v) of this section.

(iii) If the value determined in paragraph (b)(2)(i) of this section is not greater than the off-cycle credit cap specified in paragraph (b)(2)(v) of this section, 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 the off-cycle credit cap specified in paragraph (b)(2)(v) of this section, 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.

(v) 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 may not exceed the following specific values:

Model year	Off-cycle credit cap (g/mile)
(A) 2023–2026	15
(B) 2027–2030	10
(C) 2031	8.0
(D) 2032	6.0

* * * * *

(f) *Calculation of total off-cycle credits.* Total off-cycle credits in Megagrams of CO_2 (rounded to the nearest whole megagram) shall be calculated separately for passenger automobiles and light trucks according to the following formula:

$$Total\ Credits = \frac{Credit \cdot Production \cdot VLM}{1{,}000{,}000}$$

Where:

Credit = the credit value in grams per mile determined in paragraph (b), (c), or (d) of this section. Starting in model year 2027, multiply the credit value for PHEV by (1–UF), where

UF = the fleet utility factor established under 40 CFR 600.116–12(c)(1) or (c)(10)(iii) (weighted 55 percent city, 45 percent highway).

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.

§ 86.1871–12 [Removed]

■ 90. Remove § 86.1871–12.

PART 600—FUEL ECONOMY AND GREENHOUSE GAS EXHAUST EMISSIONS OF MOTOR VEHICLES

■ 91. The authority citation for part 600 continues to read as follows:

Authority: 49 U.S.C. 32901–23919q, Pub. L. 109–58.

■ 92. Amend § 600.001 by revising paragraph (a) to read as follows:

§ 600.001 General applicability.

(a) The provisions of this part apply to 2008 and later model year automobiles that are not medium duty passenger vehicles ($MDPV_{FE}$), and to 2011 and later model year automobiles including $MDPV_{FE}$. The test procedures in subpart B of this part also apply to 2014 and later heavy-duty vehicles subject to standards under 40 CFR part 86, subpart S.

* * * * *

■ 93. Amend § 600.002 by revising the definitions for ''Engine code'', ''Light truck'', ''Medium-duty passenger vehicle'', ''Subconfiguration'', and ''Vehicle configuration'' to read as follows:

§ 600.002 Definitions.

* * * * *

Engine code means one of the following:

(1) For LDV, LDT, and $MDPV_{FE}$, *engine code* means a unique combination, within a test group (as defined in § 86.1803 of this chapter), of displacement, fuel injection (or carburetion or other fuel delivery system), calibration, distributor calibration, choke calibration, auxiliary emission control devices, and other engine and emission control system components specified by the Administrator. For electric vehicles, *engine code* means a unique combination of manufacturer, electric traction motor, motor configuration, motor controller, and energy storage device.

(2) For HDV, engine code has the meaning given in § 86.1819–14(d)(12) of this chapter.

* * * * *

Light truck means an automobile that is not a passenger automobile, as defined by the Secretary of Transportation at 49 CFR 523.5. This term is interchangeable with ''non-passenger automobile.'' The term ''light truck'' includes medium-duty passenger vehicles ($MDPV_{FE}$) manufactured during 2011 and later model years.

Medium-duty passenger vehicle ($MDPV_{FE}$) means a vehicle that would satisfy the criteria for light trucks as defined by the Secretary of Transportation at 49 CFR 523.5 but for its gross vehicle weight rating or its curb weight, is rated at more than 8,500 lbs GVWR or has a vehicle curb weight of more than 6,000 pounds or has a basic vehicle frontal area in excess of 45 square feet, and is designed primarily to transport passengers, but does not include a vehicle that—

(1) Is an ''incomplete truck'' as defined in 40 CFR 86.1803–01; 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.

* * * * *

Subconfiguration means one of the following:

(1) For LDV, LDT, and $MDPV_{FE}$, *subconfiguration* means a unique combination within a vehicle configuration of equivalent test weight, road-load horsepower, and any other operational characteristics or parameters which the Administrator determines may significantly affect fuel economy or CO_2 emissions within a vehicle configuration.

(2) For HDV, subconfiguration has the meaning given in § 86.1819–14(d)(12) of this chapter.

* * * * *

Vehicle configuration means one of the following:

(1) For LDV, LDT, and $MDPV_{FE}$, *vehicle configuration* means a unique combination of basic engine, engine code, inertia weight class, transmission configuration, and axle ratio within a base level.

(2) For HDV, vehicle configuration has the meaning given for "configuration" in § 86.1819–14(d)(12) of this chapter.

* * * * *

■ 94. Amend § 600.007 by revising paragraph (b)(4) introductory text to read as follows:

§ 600.007 Vehicle acceptability.

* * * * *

(b) * * *

(4) Each fuel economy data vehicle must meet the same exhaust emission standards as certification vehicles of the respective engine-system combination during the test in which the fuel economy test results are generated. This may be demonstrated using one of the following methods:

* * * * *

§ 600.008 [Amended]

■ 95. Amend § 600.008 by removing paragraphs (b)(1)(iii), (iv), and (v).

■ 96. Revise and republish § 600.011 to read as follows:

§ 600.011 Incorporation by reference.

Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, EPA must publish a document in the **Federal Register** and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at EPA and at the National Archives and Records Administration (NARA). Contact EPA at: U.S. EPA, Air and Radiation Docket Center, WJC West Building, Room 3334, 1301 Constitution Ave. NW, Washington, DC 20004; *www.epa.gov/dockets*; (202) 202–1744. For information on inspecting this material at NARA, visit *www.archives.gov/federal-register/cfr/ibr-locations.html* or email *fr.inspection@nara.gov*. The material may be obtained from the following sources:

(a) *ASTM International (ASTM).* ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959; (610) 832–9585; *www.astm.org*.

(1) ASTM D86–23, Standard Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure; Approved March 1, 2023; IBR approved for § 600.113–12(f).

(2) ASTM D975–13a, Standard Specification for Diesel Fuel Oils, Approved December 1, 2013; IBR approved for § 600.107–08(b).

(3) ASTM D1298–12b, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method, Approved June 1, 2012; IBR approved for §§ 600.113–12(f); 600.510–12(g).

(4) ASTM D1319–20a, Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption, Approved August 1, 2020; IBR approved for § 600.113–12(f).

(5) ASTM D1945–03 (Reapproved 2010), Standard Test Method for Analysis of Natural Gas By Gas Chromatography, Approved January 1, 2010; IBR approved for § 600.113–12(f) and (k).

(6) ASTM D3338/D3338M–20a, Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels, Approved December 1, 2020; IBR approved for § 600.113–12(f).

(7) ASTM D3343–22, Standard Test Method for Estimation of Hydrogen Content of Aviation Fuels, Approved November 1, 2022; IBR approved for § 600.113–12(f).

(8) ASTM D4052–22, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter, Approved May 1, 2022; IBR approved for § 600.113–12(f).

(9) ASTM D4815–22, Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C_1 to C_4 Alcohols in Gasoline by Gas Chromatography, Approved April 1, 2022; IBR approved for § 600.113–12(f).

(10) ASTM D5599–22, Standard Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection, Approved April 1, 2022; IBR approved for § 600.113–12(f).

(11) ASTM D5769–22, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry, Approved July 1, 2022; IBR approved for § 600.113–12(f).

(b) *International Organization for Standardization (ISO).* International Organization for Standardization, Case Postale 56, CH–1211 Geneva 20, Switzerland; (41) 22749 0111; *central@iso.org*; *www.iso.org*.

(1) ISO/IEC 18004:2006(E), Information technology—Automatic identification and data capture techniques—QR Code 2005 bar code symbology specification, Second Edition, September 1, 2006; IBR approved for § 600.302–12(b).

(2) [Reserved]

(c) *SAE International (SAE).* SAE International, 400 Commonwealth Dr., Warrendale, PA 15096–0001; (877) 606–7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada); *www.sae.org*.

(1) Motor Vehicle Dimensions—Recommended Practice SAE 1100a (Report of Human Factors Engineering Committee, Society of Automotive Engineers, approved September 1973 as revised September 1975); IBR approved for § 600.315–08(c).

(2) SAE J1634 JUL2017, Battery Electric Vehicle Energy Consumption and Range Test Procedure, Revised July 2017; IBR approved for §§ 600.116–12(a); 600.210–12(d); 600.311–12(j) and (k).

(3) SAE J1711 FEB2023, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles; Revised February 2023; IBR approved for §§ 600.114–12(c) and (f); 600.116–12(b) and (c); 600.311–12(c), (j), and (k).

■ 97. Add § 600.101 to subpart B to read as follows:

§ 600.101 Testing overview.

Perform testing under this part as described in § 600.111. This involves the following specific requirements:

(a) Perform the following tests and calculations for LDV, LDT, and $MDPV_{FE}$:

(1) Testing to demonstrate compliance with Corporate Average Fuel Economy standards and greenhouse gas emission standards generally involves a combination of two cycles—the Federal Test Procedure and the Highway Fuel Economy Test (see 40 CFR 1066.801). Testing to determine values for fuel economy labeling under subpart D of this part generally involves testing with three additional test cycles; § 600.210 describes circumstances in which testing with these additional test cycles does not apply for labeling purposes.

(2) Calculate fuel economy and CREE values for vehicle subconfigurations, configurations, base levels, and model types as described in §§ 600.206 and 600.208. Calculate fleet average values for fuel economy and CREE as described in § 600.510.

(3) Determine fuel economy values for labeling as described in § 600.210 using either the vehicle-specific 5-cycle method or the derived 5-cycle method as described in § 600.115.

(i) For vehicle-specific 5-cycle labels, the test vehicle (subconfiguration) data are adjusted to better represent in-use fuel economy and CO_2 emissions based on the vehicle-specific equations in § 600.114. Sections 600.207 and 600.209

describe how to use the ''adjusted'' city and highway subconfiguration values to calculate adjusted values for the vehicle configuration, base level, and the model type. These ''adjusted'' city, highway, and combined fuel economy estimates and the combined CO_2 emissions for the model type are shown on fuel economy labels.

(ii) For derived 5-cycle labels, calculate ''unadjusted'' fuel economy and CO_2 values for vehicle subconfigurations, configurations, base levels, and model types as described in §§ 600.206 and 600.208. Section 600.210 describes how to use the unadjusted model type values to calculate ''adjusted'' model type values for city, highway, and combined fuel economy and CO_2 emissions using the derived 5-cycle equations for the fuel economy label.

(4) Diesel-fueled Tier 3 vehicles are not subject to cold temperature emission standards; however, you must test at least one vehicle in each test group over the cold temperature FTP to comply with requirements of this part. This paragraph (a)(4) does not apply for Tier 4 vehicles.

(b) Perform the following tests and calculations for all chassis-tested vehicles other than LDV, LDT, and $MDPV_{FE}$ that are subject to standards under 40 CFR part 86, subpart S:

(1) Test vehicles as described in 40 CFR 86.1811, 86.1816, and 86.1819. Testing to demonstrate compliance with CO_2 emission standards generally involves a combination of two cycles for each test group—the Federal Test Procedure and the Highway Fuel Economy Test (see 40 CFR 1066.801). Fuel economy labeling requirements do not apply for vehicles above 8,500 pounds GVWR, except for $MDPV_{FE}$.

(2) Determine fleet average CO_2 emissions as described in 40 CFR 86.1819–14(d)(9). These CO_2 emission results are used to calculate corresponding fuel consumption values to demonstrate compliance with fleet average fuel consumption standards under 49 CFR part 535.

(c) Manufacturers must use E10 gasoline test fuel as specified in 40 CFR 1065.710(b) for new testing to demonstrate compliance with all emission standards and to determine fuel economy values. This requirement starts in model year 2027. Interim provisions related to test fuel apply as described in § 600.117.

■ 98. Amend § 600.113–12 by:

■ a. Revising the introductory text and paragraphs (f)(1) and (n).

■ b. Redesignating paragraph (o) as paragraph (p).

■ c. Adding new paragraph (o).

The revisions and addition 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.

The Administrator will use the calculation procedure set forth in this section for all official EPA testing of vehicles fueled with gasoline, diesel, alcohol-based or natural gas fuel. The calculations of the weighted fuel economy and carbon-related exhaust emission values require input of the weighted grams/mile values for total hydrocarbons (HC), carbon monoxide (CO), and carbon dioxide (CO_2); and, additionally for methanol-fueled automobiles, methanol (CH_3OH) and formaldehyde (HCHO); and, additionally for ethanol-fueled automobiles, methanol (CH_3OH), ethanol (C_2H_5OH), acetaldehyde (C_2H_4O), and formaldehyde (HCHO); and additionally for natural gas-fueled vehicles, non-methane hydrocarbons (NMHC) and methane (CH_4). For manufacturers selecting the fleet averaging option for N_2O and CH_4 as allowed under § 86.1818 of this chapter the calculations of the carbon-related exhaust emissions require the input of grams/mile values for nitrous oxide (N_2O) and methane (CH_4). Emissions shall be determined for the FTP, HFET, US06, SC03, and cold temperature FTP tests. Additionally, the specific gravity, carbon weight fraction and net heating value of the test fuel must be determined. The FTP, HFET, US06, SC03, and cold temperature FTP fuel economy and carbon-related exhaust emission values shall be calculated as specified in this section. An example fuel economy calculation appears in appendix II to this part.

* * * * *

(f) * * *

(1) Gasoline test fuel properties shall be determined by analysis of a fuel sample taken from the fuel supply. A sample shall be taken after each addition of fresh fuel to the fuel supply. Additionally, the fuel shall be resampled once a month to account for any fuel property changes during storage. Less frequent resampling may be permitted if EPA concludes, on the basis of manufacturer-supplied data, that the properties of test fuel in the manufacturer's storage facility will remain stable for a period longer than one month. The fuel samples shall be analyzed to determine fuel properties as follows for neat gasoline (E0) and for a low-level ethanol-gasoline blend (E10):

(i) *Specific gravity.* Determine specific gravity using ASTM D4052 (incorporated by reference, see § 600.011). Note that ASTM D4052 refers to specific gravity as relative density.

(ii) *Carbon mass fraction.* (A) For E0, determine hydrogen mass percent using ASTM D3343 (incorporated by reference, see § 600.011), then determine carbon mass fraction as $CMF = 1 - 0.01 \times$ hydrogen mass percent.

(B) For E10, determine carbon mass fraction of test fuel, CMF_f, using the following equation, rounded to three decimal places:

$$CMF_f = VF_e \cdot \frac{SG_e}{SG_f} \cdot CMF_e + \left(1 - VF_e \cdot \frac{SG_e}{SG_f}\right) \cdot CMF_h$$

Where:

VF_e = volume fraction of ethanol in the test fuel as determined from ASTM D4815 or ASTM D5599 (both incorporated by reference, see § 600.011). Calculate the volume fraction by dividing the volume percent of ethanol by 100.

SG_e = specific gravity of pure ethanol. Use $SG_e = 0.7939$.

SG_f = specific gravity of the test fuel as determined by ASTM D1298 or ASTM D4052 (both incorporated by reference, see § 600.011).

CMF_e = carbon mass fraction of pure ethanol. Use $CMF_e = 0.5214$.

CMF_h = carbon mass fraction of the hydrocarbon fraction of the test fuel as determined using ASTM D3343 (incorporated by reference, see § 600.011) with the following inputs, using V_{Tier3} or V_{LEVIII} as appropriate:

$$A = \text{aromatics content of the hydrocarbon fraction} = \frac{VP_{\text{aro,f}}}{1 - VF_{\text{e}}}.$$

$$G = \text{API gravity of the hydrocarbon fraction} = \frac{141.5}{SG_{\text{h}}} - 131.5.$$

$$V_{\text{Tier3}} = \text{average volatility of the hydrocarbon fraction for EPA's E10 test fuel.}$$

$$V_{\text{Tier3}} = \frac{T_{10} + T_{50} + T_{90}}{3} + 14.8.$$

$$V_{\text{LEVIII}} = \text{average volatility of the LEV III hydrocarbon fraction.}$$

$$V_{\text{LEVIII}} = \frac{T_{10} + T_{50} + T_{90}}{3} + 11.8.$$

Where:

$VP_{aro,f}$ = volume percent aromatics in the test fuel as determined by ASTM D1319 (incorporated by reference, see § 600.011). An acceptable alternative method is ASTM D5769 (incorporated by reference, see § 600.011), as long as the result is bias-corrected as described in ASTM D1319.

$$SG_{\text{h}} = \text{specific gravity of the hydrocarbon fraction} = \frac{SG_{\text{f}} - SG_{\text{e}} \cdot VF_{\text{e}}}{1 - VF_{\text{e}}}.$$

T_{10}, T_{50}, T_{90} = the 10, 50, and 90 percent distillation temperatures of the test fuel, respectively, in degrees Fahrenheit, as determined by ASTM D86 (incorporated by reference, see § 600.011).

(iii) *Net heat of combustion.* (A) For E0, determine net heat of combustion in MJ/kg using ASTM D3338/D3338M (incorporated by reference, see § 600.011).

(B) For E10, determine net heat of combustion, NHC_f, in MJ/kg using the following equation, rounding the result to the nearest whole number:

$$NHC_{\text{f}} = VF_{\text{e}} \cdot \frac{SG_{\text{e}}}{SG_{\text{f}}} \cdot NHC_{\text{e}} + \left(1 - VF_{\text{e}} \cdot \frac{SG_{\text{e}}}{SG_{\text{f}}}\right) \cdot NHC_{\text{h}}$$

Where:

NHC_e = net heat of combustion of pure ethanol. Use NHC_e = 11,530 Btu/lb.

NHC_h = net heat of combustion of the hydrocarbon fraction of the test fuel as determined using ASTM D3338 (incorporated by reference, see § 600.011) using input values as specified in paragraph (f)(1)(ii) of this section.

* * * * *

(n) Manufacturers may use a value of 0 grams CO_2 and CREE per mile to represent the emissions of electric vehicles and the electric operation of plug-in hybrid electric vehicles derived from electricity generated from sources that are not onboard the vehicle.

(o)(1) For testing with E10, calculate fuel economy using the following equation, rounded to the nearest 0.1 miles per gallon:

$$FE_{[\text{interval}]} = \frac{(CMF_{\text{testfuel}} \cdot SG_{\text{testfuel}}) \cdot (\rho_{\text{H2O}} \cdot SG_{\text{basefuel}} \cdot NHC_{\text{basefuel}})}{[(CMF_{\text{testfuel}} \cdot \text{NMOG}) + (0.749 \cdot \text{CH}_4) + (0.429 \cdot \text{CO}) + (0.273 \cdot \text{CO}_2)] \cdot [(R_a \cdot SG_{\text{testfuel}} \cdot NHC_{\text{testfuel}}) + (SG_{\text{basefuel}} \cdot NHC_{\text{basefuel}} \cdot (1 - R_a))]}$$

Where:

$CMF_{testfuel}$ = carbon mass fraction of the test fuel, expressed to three decimal places.

$SG_{testfuel}$ = the specific gravity of the test fuel as obtained in paragraph (f)(1) of this section, expressed to three decimal places.

ρ_{H2O} = the density of pure water at 60 °F. Use ρ_{H2O} = 3781.69 g/gal.

$SG_{basefuel}$ = the specific gravity of the 1975 base fuel. Use $SG_{basefuel}$ = 0.7394.

$NHC_{basefuel}$ = net heat of combustion of the 1975 base fuel. Use $NHC_{basefuel}$ = 43.047 MJ/kg.

NMOG = NMOG emission rate over the test interval or duty cycle in grams/mile.

CH_4 = CH_4 emission rate over the test interval or duty cycle in grams/mile.

CO = CO emission rate over the test interval or duty cycle in grams/mile.

CO_2 = measured tailpipe CO_2 emission rate over the test interval or duty cycle in grams/mile.

R_a = sensitivity factor that represents the response of a typical vehicle's fuel economy to changes in fuel properties, such as volumetric energy content. Use R_a = 0.81.

$NHC_{testfuel}$ = net heat of combustion by mass of test fuel as obtained in paragraph (f)(1) of this section, expressed to three decimal places.

(2) Use one of the following methods to calculate the carbon-related exhaust emissions for testing model year 2027 and later vehicles with the E10 test fuel specified in 40 CFR 1065.710(b):

(i) For manufacturers not complying with the fleet averaging option for N_2O and CH_4 as allowed under 40 CFR 86.1818–12(f)(2), calculate CREE using the following equation, rounded to the nearest whole gram per mile:

$$CREE = (CMF/0.273 \cdot NMOG) + (1.571 \cdot CO) + CO_2 + (0.749 \cdot CH_4)$$

Where:

CREE = carbon-related exhaust emissions.
CMF = carbon mass fraction of test fuel as obtained in paragraph (f)(1) of this section and rounded according to paragraph (g)(3) of this section.
NMOG = NMOG emission rate obtained in 40 CFR 1066.635 in grams/mile.
CO = CO emission rate obtained in paragraph (g)(2) of this section in grams/mile.
CO_2 = measured tailpipe CO_2 emission rate obtained in paragraph (g)(2) of this section in grams/mile.
CH_4 = CH_4 emission rate obtained in paragraph (g)(2) of this section in grams/mile.

(ii) For manufacturers complying with the fleet averaging option for N_2O and CH_4 as allowed under 40 CFR 86.1818–12(f)(2), calculate CREE using the following equation, rounded to the nearest whole gram per mile:

$$CREE = [(CMF/0.273) \cdot NMOG] + (1.571 \cdot CO) + CO_2 + (298 \cdot N_2O) + (25 \cdot CH_4)$$

Where:

CREE = the carbon-related exhaust emissions as defined in § 600.002.
NMOG = NMOG emission rate obtained in 40 CFR 1066.635 in grams/mile.
CO = CO emission rate obtained in paragraph (g)(2) of this section in grams/mile.
CO_2 = measured tailpipe CO_2 emission rate obtained in paragraph (g)(2) of this section in grams/mile.
N_2O = N_2O emission rate obtained in paragraph (g)(2) of this section in grams/mile.
CH_4 = CH_4 emission rate obtained in paragraph (g)(2) of this section in grams/mile.
CMF = carbon mass fraction of test fuel as obtained in paragraph (f)(1) of this section and rounded according to paragraph (g)(3) of this section.

* * * * *

■ 99. Amend § 600.114–12 by revising paragraphs (d)(2), (e)(3), (f)(1) introductory text, (f)(2) introductory text, and (f)(4) to read as follows:

§ 600.114–12 Vehicle-specific 5-cycle fuel economy and carbon-related exhaust emission calculations.

* * * * *

(d) * * *

(2) To determine City CO_2 emissions, use the appropriate CO_2 gram/mile values expressed to the nearest 0.1 gram/mile instead of CREE values in the equations in this paragraph (d). The appropriate CO_2 values for fuel economy labels based on testing with E10 test fuel are the measured tailpipe CO_2 emissions for the test cycle multiplied by 1.0166.

* * * * *

(e) * * *

(3) To determine Highway CO_2 emissions, use the appropriate CO_2 gram/mile values expressed to the nearest 0.1 gram/mile instead of CREE values in the equations in this paragraph (e) The appropriate CO_2 values for fuel economy labeling based on testing with E10 test fuel are the measured tailpipe CO_2 emissions for the test cycle multiplied by 1.0166.

* * * * *

(f) * * *

(1) If the 4-bag sampling method is used, manufacturers may use the equations in paragraphs (a) and (b) of this section to determine city and highway CO_2 and carbon-related exhaust emissions values. The appropriate CO_2 emission input values for fuel economy labeling based on testing with E10 test fuel are the measured tailpipe CO_2 emissions for the test cycle multiplied by 1.0166. If this method is chosen, it must be used to determine both city and highway CO_2 emissions and carbon-related exhaust emissions. Optionally, the following calculations may be used, provided that they are used to determine both city and highway CO_2 and carbon-related exhaust emissions values:

* * * * *

(2) If the 2-bag sampling method is used for the 75 °F FTP test, it must be used to determine both city and highway CO_2 emissions and carbon-related exhaust emissions. The appropriate CO_2 emission input values for fuel economy labeling based on testing with E10 test fuel are the measured tailpipe CO_2 emissions for the test cycle multiplied by 1.0166. The following calculations must be used to determine both city and highway CO_2 emissions and carbon-related exhaust emissions:

* * * * *

(4) To determine City and Highway CO_2 emissions, use the appropriate CO_2 gram/mile values expressed to the nearest 0.1 gram/mile instead of CREE values in the equations in paragraphs (f)(1) through (3) of this section.

* * * * *

■ 100. Amend § 600.115–11 by revising the introductory text to read as follows:

§ 600.115–11 Criteria for determining the fuel economy label calculation method.

This section provides the criteria to determine if the derived 5-cycle method for determining fuel economy label values, as specified in § 600.210–08(a)(2) or (b)(2) or § 600.210–12(a)(2) or (b)(2), as applicable, may be used to determine label values. Separate criteria apply to city and highway fuel economy for each test group. The provisions of this section are optional. If this option is not chosen, or if the criteria provided in this section are not met, fuel economy label values must be determined according to the vehicle-specific 5-cycle method specified in § 600.210–08(a)(1) or (b)(1) or § 600.210–12(a)(1) or (b)(1), as applicable. However, dedicated alternative-fuel vehicles (other than battery electric vehicles and fuel cell vehicles), dual fuel vehicles when operating on the alternative fuel, $MDPV_{FE}$, and vehicles imported by Independent Commercial Importers may use the derived 5-cycle method for determining fuel economy label values whether or not the criteria provided in this section are met. Manufacturers may alternatively account for this effect for battery electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles (when operating in the charge-depleting mode) by multiplying 2-cycle fuel economy values by 0.7 and dividing 2-cycle CO_2 emission values by 0.7.

* * * * *

■ 101. Amend § 600.116–12 by revising paragraphs (b), (c)(1), (2), (5), (6), (7), and (10), and adding paragraph (c)(11) to read as follows:

§ 600.116–12 Special procedures related to electric vehicles and hybrid electric vehicles.

* * * * *

(b) Determine performance values for hybrid electric vehicles that have no plug-in capability as specified in §§ 600.210 and 600.311 using the procedures for charge-sustaining operation from SAE J1711 (incorporated by reference in § 600.011). We may approve alternate measurement procedures with respect to these vehicles if that is necessary or appropriate for meeting the objectives of this part. For example, we may approve alternate Net Energy Change/Fuel Ratio tolerances for charge-sustaining operation as described in paragraph (c)(5) of this section.

(c) * * *

(1) To determine CREE values to demonstrate compliance with GHG standards, calculate composite values representing combined operation during charge-depleting and charge-sustaining operation using the following utility factors, except as otherwise specified in this paragraph (c):

TABLE 1 TO PARAGRAPH (c)(1)—FLEET UTILITY FACTORS FOR URBAN "CITY" DRIVING

Schedule range for UDDS phases, miles	Model year 2030 and earlier		Model year 2031 and later	
	Cumulative UF	Sequential UF	Cumulative UF	Sequential UF
3.59	0.125	0.125	0.062	0.062
7.45	0.243	0.117	0.125	0.062
11.04	0.338	0.095	0.178	0.054
14.90	0.426	0.088	0.232	0.053
18.49	0.497	0.071	0.278	0.046
22.35	0.563	0.066	0.324	0.046
25.94	0.616	0.053	0.363	0.040
29.80	0.666	0.049	0.403	0.040
33.39	0.705	0.040	0.437	0.034
37.25	0.742	0.037	0.471	0.034
40.84	0.772	0.030	0.500	0.029
44.70	0.800	0.028	0.530	0.029
48.29	0.822	0.022	0.555	0.025
52.15	0.843	0.021	0.580	0.025
55.74	0.859	0.017	0.602	0.022
59.60	0.875	0.016	0.624	0.022
63.19	0.888	0.013	0.643	0.019
67.05	0.900	0.012	0.662	0.019
70.64	0.909	0.010	0.679	0.017

TABLE 2 TO PARAGRAPH (c)(1)—FLEET UTILITY FACTORS FOR HIGHWAY DRIVING

Schedule range for HFET, miles	Model year 2030 and earlier		Model year 2031 and later	
	Cumulative UF	Sequential UF	Cumulative UF	Sequential UF
10.3	0.123	0.123	0.168	0.168
20.6	0.240	0.117	0.303	0.136
30.9	0.345	0.105	0.414	0.110
41.2	0.437	0.092	0.503	0.090
51.5	0.516	0.079	0.576	0.073
61.8	0.583	0.067	0.636	0.060
72.1	0.639	0.056	0.685	0.049

(2) Determine fuel economy values to demonstrate compliance with CAFE standards as follows:

(i) For vehicles that are not dual fueled automobiles, determine fuel economy using the utility factors specified in paragraph (c)(1) of this section for model year 2030 and earlier vehicles. Do not use the petroleum-equivalence factors described in 10 CFR 474.3.

(ii) Except as described in paragraph (c)(2)(iii) of this section, determine fuel economy for dual fueled automobiles from the following equation, separately for city and highway driving:

Equation 2 to Paragraph (c)(2)(ii)

$$MPGe_{CAFE} = \frac{1}{\left(\frac{0.5}{MPG_{gas}} + \frac{0.5}{MPG_{elec}}\right)}$$

Where:

MPG_{gas} = The miles per gallon measured while operating on gasoline during charge-sustaining operation as determined using the procedures of SAE J1711.

$MPGe_{elec}$ = The miles per gallon equivalent measured while operating on electricity. Calculate this value by dividing the equivalent all-electric range determined from the equation in § 86.1866–12(b)(2)(ii) by the corresponding measured Watt-hours of energy consumed; apply the appropriate petroleum-equivalence factor from 10 CFR 474.3 to convert Watt-hours to gallons equivalent. Note that if vehicles use no gasoline during charge-depleting operation, $MPGe_{elec}$ is the same as the charge-depleting fuel economy specified in SAE J1711.

(iii) For 2016 and later model year dual fueled automobiles, you may determine fuel economy based on the following equation, separately for city and highway driving:

Equation 3 to Paragraph (c)(2)(iii)

$$MPGe_{CAFE} = \frac{1}{\left(\frac{UF}{MPG_{elec}} + \frac{(1-UF)}{MPGe_{gas}}\right)}$$

Where:

UF = The appropriate utility factor for city or highway driving specified in paragraph (c)(1) of this section for model year 2030 and earlier vehicles.

* * * * *

(5) Instead of the utility factors specified in paragraphs (c)(1) through (3) of this section, calculate utility factors using the following equation for vehicles whose maximum speed is less than the maximum speed specified in the driving schedule, where the vehicle's maximum speed is determined, to the nearest 0.1 mph, from observing the highest speed over the first duty cycle (FTP, HFET, etc.):

Equation 4 to Paragraph (c)(5)

$$UF_i = 1 - \left[\exp\left(-\sum_{j=1}^{k} \left(\left(\frac{d_i}{ND} \right)^j \times C_j \right) \right) \right] - \sum_{i=1}^{n} UF_{i-1}$$

Where:

UF_i = the utility factor for phase *i*. Let UF_0 = 0.

j = a counter to identify the appropriate term in the summation (with terms numbered consecutively).

k = the number of terms in the equation (see Table 5 of this section).

d_i = the distance driven in phase *i*.

ND = the normalized distance. Use 399 for both FTP and HFET operation for CAFE and GHG fleet values, except that *ND* = 583 for both FTP and HFET operation for GHG fleet values starting in model year 2031. Use 399 for both FTP and HFET operation for multi-day individual values for labeling.

C_j = the coefficient for term *j* from the following table:

TABLE 5 TO PARAGRAPH (c)(5)—CITY/HIGHWAY SPECIFIC UTILITY FACTOR COEFFICIENTS

j	Fleet values for CAFE for all model years, and for GHG through MY 2030		Fleet values for GHG starting in MY 2031	Multi-day individual values for labeling
	City	Highway	City or highway	City or highway
1	14.86	4.8	10.52	13.1
2	2.965	13	−7.282	−18.7
3	−84.05	−65	−26.37	5.22
4	153.7	120	79.08	8.15
5	−43.59	−100.00	−77.36	3.53
6	−96.94	31.00	26.07	−1.34
7	14.47			−4.01
8	91.70			−3.90
9	−46.36			−1.15
10				3.88

n = the number of test phases (or bag measurements) before the vehicle reaches the end-of-test criterion.

(6) Determine End-of-Test as follows:

(i) Base End-of-Test on a 2 percent State of Charge as specified in Section 3.5.1 of SAE J1711.

(ii) Base End-of-Test on a 1 percent Net Energy Change/Fuel Ratio as specified in Section 3.5.2 of SAE J1711.

(iii) For charge-sustaining tests, we may approve alternate Net Energy Change/Fuel Ratio tolerances as specified in Appendix C of SAE J1711 to correct final fuel economy values, CO_2 emissions, and carbon-related exhaust emissions. For charge-sustaining tests, do not use alternate Net Energy Change/Fuel Ratio tolerances to correct emissions of criteria pollutants. Additionally, if we approve an alternate End-of-Test criterion or Net Energy Change/Fuel Ratio tolerances for a specific vehicle, we may use the alternate criterion or tolerances for any testing we conduct on that vehicle.

(7) Use the vehicle's Actual Charge-Depleting Range, Rcda, as specified in Section 7.1.4 of SAE J1711 for evaluating the end-of-test criterion.

* * * * *

(10) The utility factors described in this paragraph (c) and in § 600.510 are derived from equations in SAE J2841. You may alternatively calculate utility factors from the corresponding equations in SAE J2841 as follows:

(i) Calculate utility factors for labeling directly from the equation in SAE J2841 Section 6.2 using the Table 2 MDIUF Fit Coefficients (C1 through C10) and a normalized distance (norm_dist) of 399 miles.

(ii) Calculate utility factors for fuel economy standards from the equation in SAE J2841 Section 6.2 using the Table 5 Fit Coefficients for city/Hwy Specific FUF curves weighted 55 percent city, 45 percent highway and a normalized distance (norm_dist) of 399 miles.

(iii) Starting in model year 2031, calculate utility factors for GHG compliance with emission standards from the equation in SAE J2841 Section 6.2 using the Table 2 FUF Fit Coefficients (C1 through C6) and a normalized distance (norm_dist) of 583 miles. For model year 2026 and earlier, calculate utility factors for compliance with GHG emission standards as described in paragraph (c)(10)(ii) of this section.

(11) The following methodology is used to determine the usable battery energy (UBE) for a PHEV using data obtained during either the UDDS Full Charge Test (FCT) or the HFET FCT as described in SAE J1711:

(i) Perform the measurements described in SAE J1711 Section 5.1.3.d. Record initial and final SOC of the RESS for each cycle in the FCT.

(ii) Perform the measurements described in SAE J1711 Section 5.1.3.c. Continuously measure the voltage of the RESS throughout the entire cycle, or record initial and final voltage measurements of the RESS for each test cycle.

(iii) Determine average voltage of the RESS during each FCT cycle by averaging the results of the continuous voltage measurement or by determining the average of the initial and final voltage measurement.

(iv) Determine the DC discharge energy for each cycle of the FCT by multiplying the change in SOC of each cycle by the average voltage for the cycle.

(v) Instead of independently measuring current and voltage and calculating the resulting DC discharge energy, you may use a DC wideband Watt-hour meter (power analyzer) to directly measure the DC discharge energy of the RESS during each cycle of the FCT. The meter used for this measurement must meet the requirements in SAE J1711 Section 4.4.

(vi) After completing the FCT, determine the cycles comprising the Charge-Depleting Cycle Range (Rcdc) as described in SAE J1711 Section 3.1.14. Charge-sustaining cycles are not included in the Rcdc. Rcdc includes any number of transitional cycles where the vehicle may have operated in both charge-depleting and charge-sustaining modes.

(vii) Determine the UBE of the PHEV by summing the measured DC discharge energy for each cycle comprising Rcdc. Following the charge-depleting cycles and during the transition to charge-sustaining operation, one or more of the transition cycles may result in negative DC discharge energy measurements that result from the vehicle charging and not discharging the RESS. Include these negative discharge results in the summation.

* * * * *

■ 102. Revise § 600.117 to read as follows:

§ 600.117 Interim provisions.

(a) The following provisions apply instead of other provisions specified in this part through model year 2026:

(1) Except as specified in paragraphs (a)(5) and (6) of this section, manufacturers must demonstrate compliance with greenhouse gas emission standards and determine fuel economy values using E0 gasoline test fuel as specified in 40 CFR 86.113–04(a)(1), regardless of any testing with E10 test fuel specified in 40 CFR 1065.710(b) under paragraph (a)(2) of this section.

(2) Manufacturers may demonstrate that vehicles comply with emission standards for criteria pollutants as specified in 40 CFR part 86, subpart S, during fuel economy measurements using the E0 gasoline test fuel specified in 40 CFR 86.113–04(a)(1), as long as this test fuel is used in fuel economy testing for all applicable duty cycles specified in 40 CFR part 86, subpart S. If a vehicle fails to meet an emission standard for a criteria pollutant using the E0 gasoline test fuel specified in 40 CFR 86.113–04(a)(1), the manufacturer must retest the vehicle using the E10 test fuel specified in 40 CFR 1065.710(b) (or the equivalent LEV III test fuel for California) to demonstrate compliance with all applicable emission standards over that test cycle.

(3) If a manufacturer demonstrates compliance with emission standards for criteria pollutants over all five test cycles using the E10 test fuel specified in 40 CFR 1065.710(b) (or the equivalent LEV III test fuel for California), the manufacturer may use test data with the same test fuel to determine whether a test group meets the criteria described in § 600.115 for derived 5-cycle testing for fuel economy labeling. Such vehicles may be tested over the FTP and HFET cycles with the E0 gasoline test fuel specified in 40 CFR 86.113–04(a)(1) under this paragraph (a)(3); the vehicles must meet the emission standards for criteria pollutants over those test cycles as described in paragraph (a)(2) of this section.

(4) Manufacturers may perform testing with the appropriate gasoline test fuels specified in 40 CFR 86.113–04(a)(1), 40 CFR 86.213(a)(2), and in 40 CFR 1065.710(b) to evaluate whether their vehicles meet the criteria for derived 5-cycle testing under § 600.115. All five tests must use test fuel with the same nominal ethanol concentration.

(5) For IUVP testing under 40 CFR 86.1845, manufacturers may demonstrate compliance with greenhouse gas emission standards using a test fuel meeting specifications for demonstrating compliance with emission standards for criteria pollutants.

(6) Manufacturers may alternatively demonstrate compliance with greenhouse gas emission standards and determine fuel economy values using E10 gasoline test fuel as specified in 40 CFR 1065.710(b). However, manufacturers must then multiply measured CO_2 results by 1.0166 and round to the nearest 0.01 g/mile and calculate fuel economy using the equations appropriate equation for testing with E10 test fuel.

(7) If a vehicle uses an E10 test fuel for evaporative emission testing and E0 is the applicable test fuel for exhaust emission testing, exhaust measurement and reporting requirements apply over the course of the evaporative emission test, but the vehicle need not meet the exhaust emission standards during the evaporative emission test run.

(b) Manufacturers may certify model year 2027 through 2029 vehicles to greenhouse gas emission standards using data with E0 test fuel from testing for earlier model years, subject to the carryover provisions of 40 CFR 86.1839. In the case of the fleet average CO_2 standard, manufacturers must divide the measured CO_2 results by 1.0166 and round to the nearest 0.01 g/mile.

(c) Manufacturers may perform testing under § 600.115–11 using E0 gasoline test fuel as specified in 40 CFR 86.113–04(a)(1) or E10 test fuel as specified in 40 CFR 1065.710(b) until EPA publishes guidance under § 600.210–12(a)(2)(iv) describing when and how to apply 5-cycle adjustment factors based on testing with the E10 test fuel.

■ 103. Amend § 600.206–12 by revising and republishing paragraph (a) to read as follows:

§ 600.206–12 Calculation and use of FTP-based and HFET-based fuel economy, CO_2 emissions, and carbon-related exhaust emission values for vehicle configurations.

(a) Fuel economy, CO_2 emissions, and carbon-related exhaust emissions values determined for each vehicle under § 600.113–08(a) and (b) and as approved in § 600.008(c), are used to determine FTP-based city, HFET-based highway, and combined FTP/Highway-based fuel economy, CO_2 emissions, and carbon-related exhaust emission values for each vehicle configuration for which data are available. Note that fuel economy for some alternative fuel vehicles may mean miles per gasoline gallon equivalent and/or miles per unit of fuel consumed. For example, electric vehicles will determine miles per kilowatt-hour in addition to miles per gasoline gallon equivalent, and fuel cell vehicles will determine miles per kilogram of hydrogen.

(1) If only one set of FTP-based city and HFET-based highway fuel economy values is accepted for a subconfiguration at which a vehicle configuration was tested, these values, rounded to the nearest tenth of a mile per gallon, comprise the city and highway fuel economy values for that subconfiguration. If only one set of FTP-based city and HFET-based highway CO_2 emissions and carbon-related exhaust emission values is accepted for a subconfiguration at which a vehicle configuration was tested, these values, rounded to the nearest gram per mile, comprise the city and highway CO_2 emissions and carbon-related exhaust emission values for that subconfiguration. The appropriate CO_2 values for fuel economy labels based on testing with E10 test fuel are the measured tailpipe CO_2 emissions for the test cycle multiplied by 1.0166.

(2) If more than one set of FTP-based city and HFET-based highway fuel economy and/or carbon-related exhaust emission values are accepted for a vehicle configuration:

(i) All data shall be grouped according to the subconfiguration for which the data were generated using sales projections supplied in accordance with § 600.208–12(a)(3).

(ii) Within each group of data, all fuel economy values are harmonically averaged and rounded to the nearest 0.0001 of a mile per gallon and all CO_2 emissions and carbon-related exhaust emission values are arithmetically averaged and rounded to the nearest tenth of a gram per mile in order to determine FTP-based city and HFET-based highway fuel economy, CO_2 emissions, and carbon-related exhaust emission values for each subconfiguration at which the vehicle configuration was tested. The appropriate CO_2 values for fuel economy labels based on testing with E10 test fuel are the measured tailpipe

CO_2 emissions for the test cycle multiplied by 1.0166.

(iii) All FTP-based city fuel economy, CO_2 emissions, and carbon-related exhaust emission values and all HFET-based highway fuel economy and carbon-related exhaust emission values calculated in paragraph (a)(2)(ii) of this section are (separately for city and highway) averaged in proportion to the sales fraction (rounded to the nearest 0.0001) within the vehicle configuration (as provided to the Administrator by the manufacturer) of vehicles of each tested subconfiguration. Fuel economy values shall be harmonically averaged, and CO_2 emissions and carbon-related exhaust emission values shall be arithmetically averaged. The resultant fuel economy values, rounded to the nearest 0.0001 mile per gallon, are the FTP-based city and HFET-based highway fuel economy values for the vehicle configuration. The resultant CO_2 emissions and carbon-related exhaust emission values, rounded to the nearest tenth of a gram per mile, are the FTP-based city and HFET-based highway CO_2 emissions and carbon-related exhaust emission values for the vehicle configuration. Note that the appropriate vehicle subconfiguration CO_2 values for fuel economy labels based on testing with E10 test fuel are adjusted as described in paragraph (a)(1) or (a)(2)(ii) of this section.

(3)(i) For the purpose of determining average fuel economy under § 600.510, the combined fuel economy value for a vehicle configuration is calculated by harmonically averaging the FTP-based city and HFET-based highway fuel economy values, as determined in paragraph (a)(1) or (2) of this section, weighted 0.55 and 0.45 respectively, and rounded to the nearest 0.0001 mile per gallon. A sample of this calculation appears in appendix II to this part.

(ii) For the purpose of determining average carbon-related exhaust emissions under § 600.510, the combined carbon-related exhaust emission value for a vehicle configuration is calculated by arithmetically averaging the FTP-based city and HFET-based highway carbon-related exhaust emission values, as determined in paragraph (a)(1) or (2) of this section, weighted 0.55 and 0.45 respectively, and rounded to the nearest tenth of gram per mile.

(4) For alcohol dual fuel automobiles and natural gas dual fuel automobiles the procedures of paragraphs (a)(1) or (2) of this section, as applicable, shall be used to calculate two separate sets of FTP-based city, HFET-based highway, and combined values for fuel economy, CO_2 emissions, and carbon-related exhaust emissions for each configuration.

(i) Calculate the city, highway, and combined fuel economy, CO_2 emissions, and carbon-related exhaust emission values from the tests performed using gasoline or diesel test fuel.

(ii) Calculate the city, highway, and combined fuel economy, CO_2 emissions, and carbon-related exhaust emission values from the tests performed using alcohol or natural gas test fuel.

* * * * *

■ 104. Amend § 600.207–12 by revising the section heading and revising and republishing paragraph (a) to read as follows:

§ 600.207–12 Calculation and use of vehicle-specific 5-cycle-based fuel economy and CO_2 emission values for vehicle configurations.

(a) Fuel economy and CO_2 emission values determined for each vehicle under § 600.114 and as approved in § 600.008(c), are used to determine vehicle-specific 5-cycle city and highway fuel economy and CO_2 emission values for each vehicle configuration for which data are available.

(1) If only one set of 5-cycle city and highway fuel economy and CO_2 emission values is accepted for a vehicle configuration, these values, where fuel economy is rounded to the nearest 0.0001 of a mile per gallon and the CO_2 emission value in grams per mile is rounded to the nearest tenth of a gram per mile, comprise the city and highway fuel economy and CO_2 emission values for that configuration. Note that the appropriate vehicle-specific CO_2 values for fuel economy labels based on 5-cycle testing with E10 test fuel are adjusted as described in § 600.114–12.

(2) If more than one set of 5-cycle city and highway fuel economy and CO_2 emission values are accepted for a vehicle configuration:

(i) All data shall be grouped according to the subconfiguration for which the data were generated using sales projections supplied in accordance with § 600.209–12(a)(3).

(ii) Within each subconfiguration of data, all fuel economy values are harmonically averaged and rounded to the nearest 0.0001 of a mile per gallon in order to determine 5-cycle city and highway fuel economy values for each subconfiguration at which the vehicle configuration was tested, and all CO_2 emissions values are arithmetically averaged and rounded to the nearest tenth of gram per mile to determine 5-cycle city and highway CO_2 emission values for each subconfiguration at which the vehicle configuration was tested. Note that the appropriate vehicle-specific CO_2 values for fuel economy labels based on 5-cycle testing with E10 test fuel are adjusted as described in § 600.114–12.

(iii) All 5-cycle city fuel economy values and all 5-cycle highway fuel economy values calculated in paragraph (a)(2)(ii) of this section are (separately for city and highway) averaged in proportion to the sales fraction (rounded to the nearest 0.0001) within the vehicle configuration (as provided to the Administrator by the manufacturer) of vehicles of each tested subconfiguration. The resultant values, rounded to the nearest 0.0001 mile per gallon, are the 5-cycle city and 5-cycle highway fuel economy values for the vehicle configuration.

(iv) All 5-cycle city CO_2 emission values and all 5-cycle highway CO_2 emission values calculated in paragraph (a)(2)(ii) of this section are (separately for city and highway) averaged in proportion to the sales fraction (rounded to the nearest 0.0001) within the vehicle configuration (as provided to the Administrator by the manufacturer) of vehicles of each tested subconfiguration. The resultant values, rounded to the nearest 0.1 grams per mile, are the 5-cycle city and 5-cycle highway CO_2 emission values for the vehicle configuration.

(3) [Reserved]

(4) For alcohol dual fuel automobiles and natural gas dual fuel automobiles, the procedures of paragraphs (a)(1) and (2) of this section shall be used to calculate two separate sets of 5-cycle city and highway fuel economy and CO_2 emission values for each configuration.

(i) Calculate the 5-cycle city and highway fuel economy and CO_2 emission values from the tests performed using gasoline or diesel test fuel.

(ii) Calculate the 5-cycle city and highway fuel economy and CO_2 emission values from the tests performed using alcohol or natural gas test fuel, if 5-cycle testing has been performed. Otherwise, the procedure in § 600.210–12(a)(3) or (b)(3) applies.

* * * * *

■ 105. Amend § 600.208–12 by revising paragraph (a)(4) and adding paragraph (b)(3)(iii)(C) to read as follows:

§ 600.208–12 Calculation of FTP-based and HFET-based fuel economy, CO_2 emissions, and carbon-related exhaust emissions for a model type.

(a) * * *

(4) Vehicle configuration fuel economy, CO_2 emissions, and carbon-related exhaust emissions, as determined in § 600.206–12(a), (b) or (c),

as applicable, are grouped according to base level.

(i) If only one vehicle configuration within a base level has been tested, the fuel economy, CO_2 emissions, and carbon-related exhaust emissions from that vehicle configuration will constitute the fuel economy, CO_2 emissions, and carbon-related exhaust emissions for that base level. Note that the appropriate vehicle subconfiguration CO_2 values for fuel economy labels based on testing with E10 test fuel are adjusted as referenced in § 600.206–12(a)(2)(iii); those values are used to calculate the base level CO_2 values in this paragraph (a)(4)(i).

(ii) If more than one vehicle configuration within a base level has been tested, the vehicle configuration fuel economy values are harmonically averaged in proportion to the respective sales fraction (rounded to the nearest 0.0001) of each vehicle configuration and the resultant fuel economy value rounded to the nearest 0.0001 mile per gallon; and the vehicle configuration CO_2 emissions and carbon-related exhaust emissions are arithmetically averaged in proportion to the respective sales fraction (rounded to the nearest 0.0001) of each vehicle configuration and the resultant carbon-related exhaust emission value rounded to the nearest tenth of a gram per mile. Note that the appropriate vehicle subconfiguration CO_2 values for fuel economy labels based on testing with E10 test fuel are adjusted as referenced in § 600.206–12(a)(2)(iii); those values are used to calculate the base level CO_2 values in this paragraph (a)(4)(ii).

* * * * *

(b) * * *

(3) * * *

(iii) * * *

(C) Note that the appropriate base level CO_2 values for fuel economy labels based on testing with E10 test fuel are adjusted as referenced in paragraph (a)(4)(i) and (ii) of this section; those values are used to calculate the model type FTP-based city CO_2 values in this paragraph (b)(3)(iii).

* * * * *

■ 106. Amend § 600.209–12 by revising paragraphs (a) introductory text and (b) introductory text to read as follows:

§ 600.209–12 Calculation of vehicle-specific 5-cycle fuel economy and CO_2 emission values for a model type.

(a) *Base level.* 5-cycle fuel economy and CO_2 emission values for a base level are calculated from vehicle configuration 5-cycle fuel economy and CO_2 emission values as determined in § 600.207 for low-altitude tests. Note that the appropriate vehicle-specific CO_2 values for fuel economy labels based on 5-cycle testing with E10 test fuel are adjusted as described in § 600.114–12.

* * * * *

(b) *Model type.* For each model type, as determined by the Administrator, city and highway fuel economy and CO_2 emissions values will be calculated by using the projected sales and fuel economy and CO_2 emission values for each base level within the model type. Separate model type calculations will be done based on the vehicle configuration fuel economy and CO_2 emission values as determined in § 600.207–12, as applicable. Note that the appropriate vehicle-specific CO_2 values for fuel economy labels based on 5-cycle testing with E10 test fuel are adjusted as described in § 600.114–12.

* * * * *

■ 107. Amend § 600.210–12 by revising paragraphs (a)(2)(i)(B), (a)(2)(ii)(B), (b)(2)(i)(B), and (b)(2)(ii)(B) to read as follows:

§ 600.210–12 Calculation of fuel economy and CO_2 emission values for labeling.

(a) * * *

(2) * * *

(i) * * *

(B) For each model type, determine the derived five-cycle city CO_2 emissions using the following equation and coefficients determined by the Administrator:

Derived 5-cycle City CO_2 = City Intercept · A + City Slope · MT FTP CO_2

Where:

City Intercept = Intercept determined by the Administrator based on historic vehicle-specific 5-cycle city fuel economy data.
A = 8,887 for gasoline-fueled vehicles, 10,180 for diesel-fueled vehicles, or an appropriate value specified by the Administrator for other fuels.
City Slope = Slope determined by the Administrator based on historic vehicle-specific 5-cycle city fuel economy data.
MT FTP CO_2 = the model type FTP-based city CO_2 emissions determined under § 600.208–12(b), rounded to the nearest 0.1 grams per mile. Note that the appropriate MT FTP CO_2 input values for fuel economy labels based on testing with E10 test fuel are adjusted as referenced in § 600.208–12(b)(3)(iii).

(ii) * * *

(B) For each model type, determine the derived five-cycle highway CO_2 emissions using the equation below and coefficients determined by the Administrator:

Derived 5-cycle Highway CO_2 = Highway Intercept · A + Highway Slope · MT HFET CO_2

Where:

Highway Intercept = Intercept determined by the Administrator based on historic vehicle-specific 5-cycle highway fuel economy data.
A = 8,887 for gasoline-fueled vehicles, 10,180 for diesel-fueled vehicles, or an appropriate value specified by the Administrator for other fuels.
Highway Slope = Slope determined by the Administrator based on historic vehicle-specific 5-cycle highway fuel economy data.
MT HFET CO_2 = the model type highway CO_2 emissions determined under § 600.208–12(b), rounded to the nearest 0.1 grams per mile. Note that the appropriate the MT HFET CO_2 input values for fuel economy labels based on testing with E10 test fuel are adjusted as referenced in § 600.208–12(b)(3)(iii) and (b)(4).

* * * * *

(b) * * *

(2) * * *

(i) * * *

(B) Determine the derived five-cycle city CO_2 emissions of the configuration using the equation below and coefficients determined by the Administrator:

Derived 5-cycle City CO_2 = City Intercept + City Slope ·Config FTP CO_2

Where:

City Intercept = Intercept determined by the Administrator based on historic vehicle-specific 5-cycle city fuel economy data.
City Slope = Slope determined by the Administrator based on historic vehicle-specific 5-cycle city fuel economy data.
Config FTP CO_2 = the configuration FTP-based city CO_2 emissions determined under § 600.206, rounded to the nearest 0.1 grams per mile. Note that the appropriate Config FTP CO_2 input values for fuel economy labels based on testing with E10 test fuel are adjusted as referenced in § 600.206–12(a)(2)(iii).

(ii) * * *

(B) Determine the derived five-cycle highway CO_2 emissions of the configuration using the equation below and coefficients determined by the Administrator:

Derived 5-cycle city Highway CO_2 = Highway Intercept + Highway Slope · Config HFET CO_2

Where:

Highway Intercept = Intercept determined by the Administrator based on historic vehicle-specific 5-cycle highway fuel economy data.
Highway Slope = Slope determined by the Administrator based on historic vehicle-specific 5-cycle highway fuel economy data.
Config HFET CO_2 = the configuration highway fuel economy determined under § 600.206, rounded to the nearest tenth. Note that the appropriate Config HFET CO_2 input values for fuel economy labels

based on testing with E10 test fuel are adjusted as referenced in § 600.206–12(a)(2)(iii).

* * * * *

■ 108. Amend § 600.311–12 by revising paragraph (g) to read as follows:

§ 600.311–12 Determination of values for fuel economy labels.

* * * * *

(g) *Smog rating.* Establish a rating for exhaust emissions other than CO_2 based on the applicable emission standards for the appropriate model year as shown in tables 1 through 3 to this paragraph (g). Unless specified otherwise, use the California emission standards to select the smog rating only for vehicles not certified to any EPA standards. For Independent Commercial Importers that import vehicles not subject to the identified emission standards, the vehicle's smog rating is 1. Similarly, if a manufacturer certifies vehicles to emission standards that are less stringent than all the identified standards for any reason, the vehicle's smog rating is 1. If EPA or California emission standards change in the future, we may revise the emission levels corresponding to each rating for future model years as appropriate to reflect the changed standards. If this occurs, we would publish the revised ratings as described in § 600.302–12(k), allowing sufficient lead time to make the changes; we would also expect to initiate a rulemaking to update the smog rating in the regulation.

TABLE 1 TO PARAGRAPH (g)—CRITERIA FOR ESTABLISHING SMOG RATING FOR MODEL YEAR 2030 AND LATER

Rating	U.S. EPA emission standard	California Air Resources Board emission standard
1		ULEV 125.
2	Bin 65 or Bin 70	ULEV70.
3	Bin 55 or Bin 60	ULEV60.
4	Bin 45 or Bin 50	ULEV50.
5	Bin 35 or Bin 40	ULEV40.
6	Bin 25 or Bin 30	SULEV25 or SULEV30.
7	Bin 15 or Bin 20	SULEV15 or SULEV20.
8	Bin 10.	
9	Bin 5.	
10	Bin 0	ZEV.

TABLE 2 TO PARAGRAPH (g)—CRITERIA FOR ESTABLISHING SMOG RATING FOR MODEL YEARS 2025 THROUGH 2029

Rating	U.S. EPA Tier 3 or Tier 4 emission standard	California Air Resources Board LEV III or LEV IV emission standard
1	Bin 160	LEV 160.
2	Bin 125	ULEV125.
4	Bin 55 through Bin 70	ULEV70 or ULEV60.
5	Bin 35 through Bin 50	ULEV50 or ULEV40.
6	Bin 25 or Bin 30	SULEV 25 or SULEV30.
7	Bin 15 or Bin 20	SULEV 15 or SULEV20.
8	Bin 10.	
9	Bin 5.	
10	Bin 0	ZEV.

TABLE 3 TO PARAGRAPH (g)—CRITERIA FOR ESTABLISHING SMOG RATING FOR MODEL YEARS 2018 THROUGH 2024

Rating	U.S. EPA Tier 3 emission standard	U.S EPA Tier 2 emission standard	California Air Resources Board LEV III emission standard
1	Bin 160	Bin 5 through Bin 8	LEV 160.
3	Bin 125, Bin 110	Bin 4	ULEV125.
5	Bin 85, Bin 70	Bin 3	ULEV70.
6	Bin 50		ULEV50.
7	Bin 30	Bin 2	SULEV30.
8	Bin 20		SULEV20.
10	Bin 0	Bin 1	ZEV.

* * * * *

PART 1036—CONTROL OF EMISSIONS FROM NEW AND IN-USE HEAVY-DUTY HIGHWAY ENGINES

■ 109. The authority citation for part 1036 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 110. Amend § 1036.110 by revising paragraph (a) to read as follows:

§ 1036.110 Diagnostic controls.

* * * * *

(a) The requirements of this section apply for engines certified under this part, except in the following circumstances:

(1) Heavy-duty engines intended to be installed in heavy-duty vehicles at or below 14,000 pounds GVWR must meet the OBD requirements in 40 CFR 86.1806–27. Note that 40 CFR 86.1806–27 allows for using later versions of specified OBD requirements from the California Air Resources Board, which includes meeting the 2019 heavy-duty OBD requirements adopted for California and updated emission thresholds as described in this section.

(2) Heavy-duty spark-ignition engines intended to be installed in heavy-duty vehicles above 14,000 pounds GVWR may instead meet the OBD requirements in 40 CFR 86.1806–27 if the same engines are also installed in vehicles

certified under 40 CFR part 86, subpart S, where both sets of vehicles share similar emission controls.

* * * * *

■ 111. Add § 1036.635 to read as follows:

§ 1036.635 Certification requirements for high-GCWR medium-duty vehicles.

Engines that will be installed in Vehicles at or below 14,000 pounds GVWR that have GCWR above 22,000 pounds may be optionally certified under this part instead of vehicle certification under 40 CFR part 86, subpart S.

(a) Affected engines must meet the criteria pollutant standards specified in § 1036.104. The following specific provisions apply if engines are exempt from greenhouse gas standards under paragraph (b) or (c) of this section:

(1) Determine brake-specific CO_2 emissions over the FTP, $e_{CO2FTPFCL}$, from the emission-data engine used for demonstrating compliance with criteria pollutant standards. You may alternatively determine $e_{CO2FTPFCL}$ based on chassis testing as described in 40 CFR 86.1845–04(h)(6). Use $e_{CO2FTPFCL}$ for calculating emission rates from in-use engines under § 1036.530. Report the measured CO_2 emission rate and the method of testing in your application for certification.

(2) For plug-in hybrid electric vehicles, meet battery monitor requirements under 40 CFR 1037.115(f) instead of the battery-related requirements under 40 CFR 86.1815–27.

(b) Affected engines that will be installed in complete vehicles are exempt from the greenhouse gas emission standards in § 1036.108, but engine certification under this part 1036 depends on the following conditions:

(1) The vehicles in which the engines are installed must meet the following vehicle-based standards under 40 CFR part 86, subpart S:

(i) Evaporative and refueling emission standards as specified in 40 CFR 86.1813–17.

(ii) Greenhouse gas emission standards as specified in 40 CFR 86.1819–14.

(2) Additional provisions related to relevant requirements from 40 CFR part 86, subpart S, apply for certifying engines under this part, as illustrated in the following examples:

(i) The engine's emission control information label must state that the vehicle meets evaporative and refueling emission standards under 40 CFR 86.1813–17 and greenhouse gas emission standards under 40 CFR 86.1819–14.

(ii) The application for certification must include the information related to complying with evaporative, refueling, and greenhouse gas emission standards.

(iii) We may require you to perform testing on in-use vehicles and report test results as specified in 40 CFR 86.1845–04, 86.1846–01, and 86.1847–01.

(iv) Demonstrate compliance with the fleet average CO_2 standard as described in 40 CFR 86.1865–12 by including vehicles certified under this section in the compliance calculations as part of the fleet averaging calculation for medium-duty vehicles certified under 40 CFR part 86, subpart S.

(3) State in the application for certification that you are using the provisions of this section to meet the fleet average CO_2 standard in 40 CFR 86.1819–14 instead of meeting the standards of § 1036.108 and instead of certifying the vehicle to standards under 40 CFR part 1037.

(c) The provisions in paragraph (b) of this section are optional for affected engines that will be installed in incomplete vehicles. If vehicles do not meet all the requirements described in paragraph (b) of this section, the engines must meet the greenhouse gas emission standards of § 1036.108 and the vehicles must be certified under 40 CFR part 1037.

PART 1037—CONTROL OF EMISSIONS FROM NEW HEAVY-DUTY MOTOR VEHICLES

■ 112. The authority citation for part 1037 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 113. Amend § 1037.150 by revising paragraph (l) to read as follows:

§ 1037.150 Interim provisions.

* * * * *

(l) *Optional certification to GHG standards under 40 CFR part 86.* The greenhouse gas standards in 40 CFR part 86, subpart S, may apply instead of the standards of § 1037.105 as follows:

(1) Complete or cab-complete vehicles may optionally meet alternative standards as described in 40 CFR 86.1819–14(j).

(2) Complete high-GCWR vehicles must meet the greenhouse gas standards of 40 CFR part 86, subpart S, as described in 40 CFR 1036.635.

(3) Incomplete high-GCWR vehicles may meet the greenhouse gas standards of 40 CFR part 86, subpart S, as described in 40 CFR 1036.635.

* * * * *

PART 1066—VEHICLE-TESTING PROCEDURES

■ 114. The authority citation for part 1066 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 115. Amend § 1066.301 by revising paragraph (b) to read as follows:

§ 1066.301 Overview of road-load determination procedures.

* * * * *

(b) The general procedure for determining road-load force is performing coastdown tests and calculating road-load coefficients. This procedure is described in SAE J1263 and SAE J2263 (incorporated by reference, see § 1066.1010). Continued testing based on the 2008 version of SAE J2263 is optional, except that it is no longer available for testing starting with model year 2026. This subpart specifies certain deviations from those procedures for certain applications.

* * * * *

■ 116. Amend § 1066.305 by revising paragraph (a) to read as follows:

§ 1066.305 Procedures for specifying road-load forces for motor vehicles at or below 14,000 pounds GVWR.

(a) For motor vehicles at or below 14,000 pounds GVWR, develop representative road-load coefficients to characterize each vehicle covered by a certificate of conformity. Calculate road-load coefficients by performing coastdown tests using the provisions of SAE J1263 and SAE J2263 (incorporated by reference, see § 1066.1010). This protocol establishes a procedure for determination of vehicle road load force for speeds between 115 and 15 km/hr (71.5 and 9.3 mi/hr); the final result is a model of road-load force (as a function of speed) during operation on a dry, level road under reference conditions of 20 °C, 98.21 kPa, no wind, no precipitation, and the transmission in neutral. You may use other methods that are equivalent to SAE J2263, such as equivalent test procedures or analytical modeling, to characterize road load using good engineering judgment. Determine dynamometer settings to simulate the road-load profile represented by these road-load target coefficients as described in § 1066.315. Supply representative road-load forces for each vehicle at speeds above 15 km/hr (9.3 mi/hr), and up to 115 km/hr (71.5 mi/hr), or the highest speed from the range of applicable duty cycles.

* * * * *

■ 117. Amend § 1066.310 by revising paragraph (b) introductory text to read as follows:

§ 1066.310 Coastdown procedures for vehicles above 14,000 pounds GVWR.

* * * * *

(b) Follow the provisions of Sections 1 through 9 of SAE J1263 and SAE J2263 (incorporated by reference, see § 1066.1010), except as described in this paragraph (b). The terms and variables identified in this paragraph (b) have the meaning given in SAE J1263 or J2263 unless specified otherwise.

* * * * *

■ 118. Revise § 1066.315 to read as follows:

§ 1066.315 Dynamometer road-load setting.

Determine dynamometer road-load settings for chassis testing by following SAE J2264 (incorporated by reference, see § 1066.1010).

■ 119. Amend § 1066.425 by revising paragraph (j)(1) introductory text to read as follows:

§ 1066.425 Performing emission tests.

* * * * *

(j) * * *

(1) Compare the following drive-cycle metrics, based on measured vehicle speeds, to a reference value based on the target cycle that would have been generated by driving exactly to the target trace as described in SAE J2951 (incorporated by reference, see § 1066.1010):

* * * * *

■ 120. Amend § 1066.501 by revising paragraph (a) to read as follows:

§ 1066.501 Overview.

* * * * *

(a) Correct the results for Net Energy Change of the RESS as follows:

(1) For all sizes of EV, follow SAE J1634 (incorporated by reference, see § 1066.1010).

(2) For HEV at or below 14,000 pounds GVWR, follow SAE J1711 (incorporated by reference, see § 1066.1010) except as described in this paragraph (a). Disregard provisions of SAE J1711 that differ from this part or the standard-setting part if they are not specific to HEV. Apply the following adjustments and clarifications to SAE J1711:

(i) If the procedure calls for charge-sustaining operation, start the drive with a State of Charge that is appropriate to ensure charge-sustaining operation for the duration of the drive. Take steps other than emission measurements to confirm that vehicles are in charge-sustaining mode for the duration of the drive.

(ii) You may use Appendix C of SAE J1711 for charge-sustaining tests to correct final fuel economy values, CO_2 emissions, and carbon-related exhaust emissions, but not to correct measured values for criteria pollutant emissions.

(iii) You may test subject to a measurement accuracy of ±0.3% of full scale in place of the measurement accuracy specified in Section 4.4 of SAE J1711.

(3) For HEV above 14,000 pounds GVWR, follow SAE J2711 (incorporated by reference, see § 1066.1010) for requirements related to charge-sustaining operation.

* * * * *

■ 121. Amend § 1066.630 by revising paragraph (a)(2) to read as follows:

§ 1066.630 PDP, SSV, and CFV flow rate calculations.

* * * * *

(a) * * *

(2) Calculate V_{rev} using the following equation:

$$V_{\text{rev}} = \frac{a_1}{f_{\text{nPDP}}} \cdot \sqrt{\frac{p_{\text{out}} - p_{\text{in}}}{p_{\text{out}}}} + a_0$$

Eq. 1066.630–2

Where:

p_{out} = static absolute pressure at the PDP outlet.

Example:

a_1 = 0.8405 m³/s

f_{nPDP} = 12.58 r/s

p_{out} = 99.950 kPa

p_{in} = 98.575 kPa

a_0 = 0.056 m³/r

T_{in} = 323.5 K

$$V_{\text{rev}} = \frac{0.8405}{12.58} \cdot \sqrt{\frac{99.950 - 98.575}{99.950}} + 0.056$$

$$V_{\text{rev}} = 0.063 \text{ m}^3/\text{r}$$

$$\dot{V} = 12.58 \cdot \frac{0.06383 \cdot 293.15 \cdot 98.575}{323.5 \cdot 101.3}$$

$$\dot{V} = 0.7079 \text{ m}^3/\text{s}$$

* * * * *

■ 122. Amend § 1066.635 by revising the introductory text to read as follows:

§ 1066.635 NMOG determination.

For vehicles subject to an NMOG standard, determine NMOG as described in paragraph (a) of this section. Except as specified in the standard-setting part, you may alternatively calculate NMOG results based on measured NMHC emissions as described in paragraphs (c) through (f) of this section. Note that references to the FTP in this section apply for testing over the FTP test cycle at any ambient temperature.

* * * * *

■ 123. Amend § 1066.710 by revising the section heading, introductory text, and paragraphs (a)(6), (b)(2), and (d)(2) to read as follows:

§ 1066.710 Cold temperature testing procedures for measuring NMOG, NO_X, PM, and CO emissions and determining fuel economy.

This section describes procedures for measuring emissions of nonmethane organic gas (NMOG), oxides of nitrogen (NO_X), particulate matter (PM), and carbon monoxide (CO) and determining fuel economy on a cold day using the FTP test cycle (see § 1066.801). For Tier 3 and earlier motor vehicles, measurement procedures are based on nonmethane hydrocarbon (NMHC) emissions instead of NMOG emissions; NO_X and PM measurement requirements do not apply.

(a) * * *

(6) Analyze samples for NMOG, NO_X, PM, CO, and CO_2.

(b) * * *

(2) *Ambient temperature for preconditioning.* Instantaneous ambient temperature values may be above −4.0 °C or below −9.0 °C but not for more than 3 minutes at a time during the preconditioning period. At no time may ambient temperatures be below −12.0 °C or above −1.0 °C. The average ambient temperature during preconditioning must be (−7.0 ±2.8) °C. You may precondition vehicles at temperatures above −7.0 °C or with a temperature tolerance greater than that described in this section (or both) if you determine that this will not cause NMOG, NO_X, PM, CO, or CO_2 emissions to decrease; if you modify the temperature specifications for vehicle preconditioning, adjust the procedures described in this section appropriately for your testing.

* * * * *

(d) * * *

(2) Fill the fuel tank to approximately 40% of the manufacturer's nominal fuel tank capacity. Use the appropriate gasoline test fuel for low-temperature testing as specified 40 CFR 1065.710 or use ultra low-sulfur diesel fuel as specified in 40 CFR 1065.703. However, you may ask us to approve an alternative formulation of diesel fuel under 40 CFR 1065.10(c)(1) if that better represents in-use diesel fuel in winter conditions. The temperature of the dispensed test fuel must be at or below 15.5 °C. If the leftover fuel in the fuel tank before the refueling event does not meet these specifications, drain the fuel tank before refueling. You may operate the vehicle prior to the preconditioning drive to eliminate fuel effects on adaptive memory systems.

* * * * *

■ 124. Revise and republish § 1066.801 to read as follows:

§ 1066.801 Applicability and general provisions.

This subpart I specifies how to apply the test procedures of this part for light-duty vehicles, light-duty trucks, and heavy-duty vehicles at or below 14,000 pounds GVWR that are subject to chassis testing for exhaust emissions under 40 CFR part 86, subpart S. For these vehicles, references in this part 1066 to the standard-setting part include subpart H of this part and this subpart I.

(a) Use the procedures detailed in this subpart to measure vehicle emissions over a specified drive schedule in conjunction with subpart E of this part. Where the procedures of subpart E of this part differ from this subpart I, the provisions in this subpart I take precedence.

(b) Collect samples of every pollutant for which an emission standard applies, unless specified otherwise.

(c) This subpart covers the following test procedures:

(1) The Federal Test Procedure (FTP), which includes the general driving cycle. This procedure is also used for measuring evaporative emissions. This may be called the conventional test since it was adopted with the earliest emission standards.

(i) The FTP consists of one Urban Dynamometer Driving Schedule (UDDS) as specified in paragraph (a) of appendix I to 40 CFR part 86, followed by a 10-minute soak with the engine off and repeat driving through the first 505 seconds of the UDDS. Note that the UDDS represents about 7.5 miles of driving in an urban area. Engine startup (with all accessories turned off), operation over the initial UDDS, and engine shutdown make a complete cold-start test. The hot-start test consists of the first 505 seconds of the UDDS following the 10-minute soak and a hot-running portion of the UDDS after the first 505 seconds. The first 505 seconds of the UDDS is considered the transient portion; the remainder of the UDDS is considered the stabilized (or hot-stabilized) portion. The hot-stabilized portion for the hot-start test is generally measured during the cold-start test; however, in certain cases, the hot-start test may involve a second full UDDS following the 10-minute soak, rather than repeating only the first 505 seconds. See §§ 1066.815 and 1066.820.

(ii) Evaporative emission testing includes a preconditioning drive with the UDDS and a full FTP cycle, including exhaust measurement, followed by evaporative emission measurements. In the three-day diurnal test sequence, the exhaust test is followed by a running loss test consisting of a UDDS, then two New York City Cycles as specified in paragraph (e) of appendix I to 40 CFR part 86, followed by another UDDS; see 40 CFR 86.134. Note that the New York City Cycle represents about 1.18 miles of driving in a city center. The running loss test is followed by a high-temperature hot soak test as described in 40 CFR 86.138 and a three-day diurnal emission test as described in 40 CFR 86.133. In the two-day diurnal test sequence, the exhaust test is followed by a low-temperature hot soak test as described in 40 CFR 86.138–96(k) and a two-day diurnal emission test as described in 40 CFR 86.133–96(p).

(iii) Refueling emission tests for vehicles that rely on integrated control of diurnal and refueling emissions includes vehicle operation over the full FTP test cycle corresponding to the three-day diurnal test sequence to precondition and purge the evaporative canister. For non-integrated systems, there is a preconditioning drive over the UDDS and a refueling event, followed by repeated UDDS driving to purge the evaporative canister. The refueling emission test procedures are described in 40 CFR 86.150 through 86.157.

(2) The US06 driving cycle is specified in paragraph (g) of appendix I to 40 CFR part 86. Note that the US06 driving cycle represents about 8.0 miles of relatively aggressive driving.

(3) The SC03 driving cycle is specified in paragraph (h) of appendix I to 40 CFR part 86. Note that the SC03 driving schedule represents about 3.6 miles of urban driving with the air conditioner operating.

(4) The hot portion of the LA–92 driving cycle is specified in paragraph (c) of appendix I to 40 CFR part 86. Note that the hot portion of the LA–92 driving cycle represents about 9.8 miles of relatively aggressive driving for commercial trucks. This driving cycle applies for heavy-duty vehicles above 10,000 pounds GVWR and at or below 14,000 pounds GVWR only for vehicles subject to Tier 3 standards.

(5) The Highway Fuel Economy Test (HFET) is specified in appendix I to 40 CFR part 600. Note that the HFET represents about 10.2 miles of rural and freeway driving with an average speed of 48.6 mi/hr and a maximum speed of 60.0 mi/hr. See § 1066.840.

(6) Cold temperature standards apply for NMOG+NO_X (or NMHC), PM, and CO emissions when vehicles operate over the FTP at a nominal temperature of −7 °C. See subpart H of this part.

(7) Emission measurement to determine air conditioning credits for greenhouse gas standards. In this optional procedure, manufacturers operate vehicles over repeat runs of the AC17 test sequence to allow for calculating credits as part of demonstrating compliance with CO_2 emission standards. The AC17 test sequence consists of a UDDS preconditioning drive, followed by emission measurements over the SC03 and HFET driving cycles. See § 1066.845.

(8) The mid-temperature intermediate soak FTP is specified as the procedure for Partial Soak Emission Testing in Section E4.4 of California ARB's PHEV Test Procedures for plug-in hybrid electric vehicles, in Part II Section I.7 of California ARB's LMDV Test Procedures for other hybrid electric vehicles, and in Part II, Section B.9.1 and B.9.3 of California ARB's LMDV Test Procedures

for other vehicles (both incorporated by reference, see § 1066.1010).

(9) The early driveaway FTP is specified as the procedure for Quick Drive-Away Emission Testing in Section E4.5 of California ARB's PHEV Test Procedures for plug-in hybrid electric vehicles, in Part II Section I.8 of California ARB's LMDV Test Procedures for other hybrid electric vehicles, and in Part II, Section B.9.2 and B.9.4 of California ARB's LMDV Test Procedures for other vehicles (both incorporated by reference, see § 1066.1010). Additionally, vehicle speed may not exceed 0.0 mi/hr until 7.0 seconds into the driving schedule and vehicle speed may not exceed 2.0 mi/hr from 7.1 through 7.9 seconds.

(10) The high-load PHEV engine starts US06 is specified in Section E7.2 of California ARB's PHEV Test Procedures using the cold-start US06 Charge-Depleting Emission Test (incorporated by reference, see § 1066.1010).

(d) The following provisions apply for all testing:

(1) Ambient temperatures encountered by the test vehicle must be (20 to 30) °C, unless otherwise specified. Where ambient temperature specifications apply before or between test measurements, the vehicle may be exposed to temperatures outside of the specified range for up to 10 minutes to account for vehicle transport or other actions to prepare for testing. The temperatures monitored during testing must be representative of those experienced by the test vehicle. For example, do not measure ambient temperatures near a heat source.

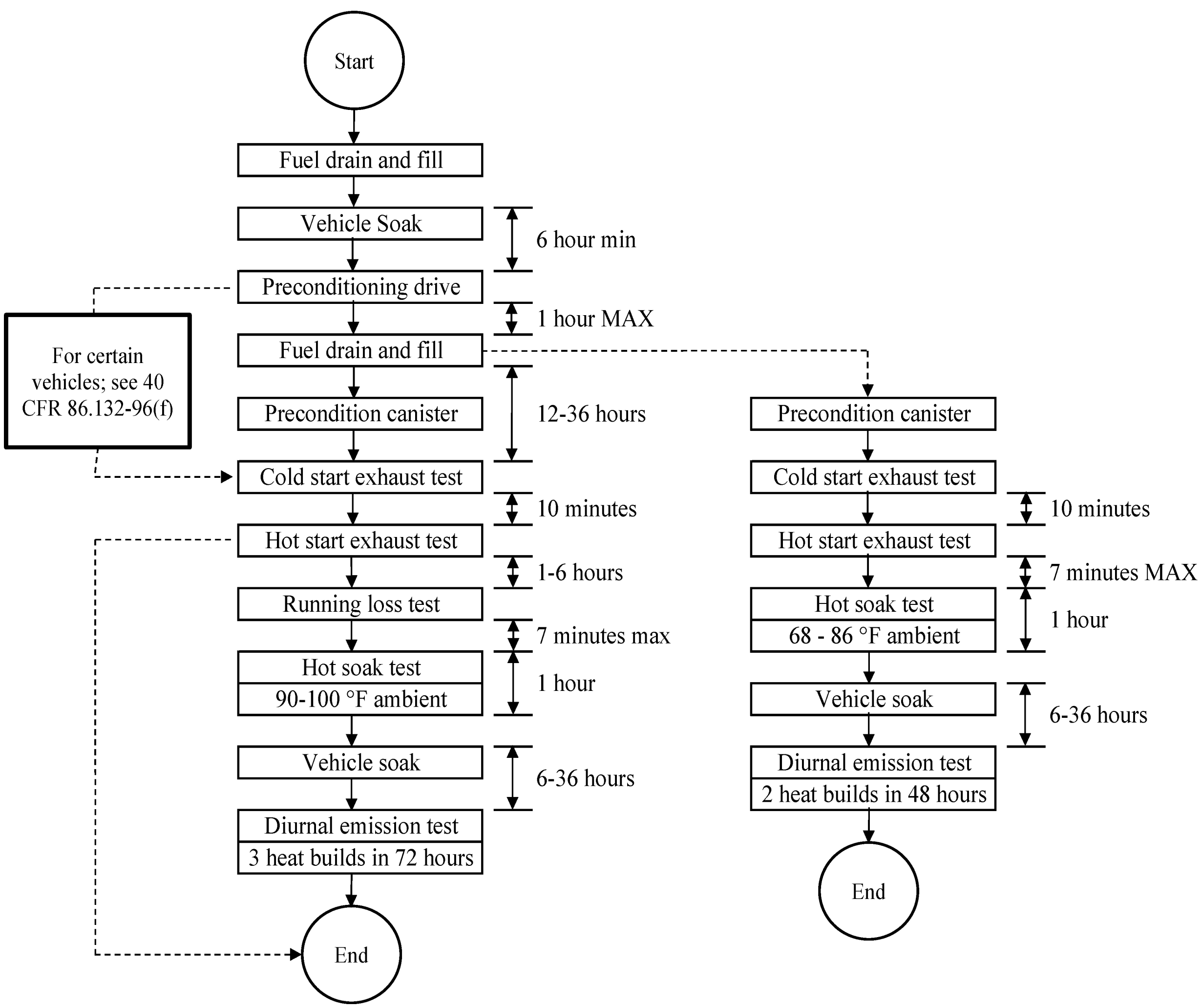
(2) Do not operate or store the vehicle at an incline if good engineering judgment indicates that it would affect emissions.

(3) If a test is void after collecting emission data from previous test segments, the test may be repeated to collect only those data points needed to complete emission measurements. You may combine emission measurements from different test runs to demonstrate compliance with emission standards.

(4) Prepare vehicles for testing as described in § 1066.810.

(e) The following figure illustrates the FTP test sequence for measuring exhaust and evaporative emissions:

Figure 1 to Paragraph (e)—FTP Test Sequence



■ 125. Amend § 1066.805 by revising paragraph (c) to read as follows:

§ 1066.805 Road-load power, test weight, and inertia weight class determination.

* * * * *

(c) For FTP, US06, SC03, New York City Cycle, HFET, and LA–92 testing, determine road-load forces for each test vehicle at speeds between 9.3 and 71.5 miles per hour. The road-load force must represent vehicle operation on a smooth, level road with no wind or calm winds, no precipitation, an ambient temperature of approximately 20 °C, and atmospheric pressure of

98.21 kPa. You may extrapolate road-load force for speeds below 9.3 mi/hr.

■ 126. Revise § 1066.830 to read as follows:

§ 1066.830 Supplemental Federal Test Procedures; overview.

Sections 1066.831 and 1066.835 describe the detailed procedures for the Supplemental Federal Test Procedure (SFTP). This testing applies for Tier 3 vehicles subject to the SFTP standards in 40 CFR 86.1811–17 or 86.1816–18. The SFTP test procedure consists of FTP testing and two additional test elements—a sequence of vehicle operation with more aggressive driving and a sequence of vehicle operation that accounts for the impact of the vehicle's air conditioner. Tier 4 vehicles subject to 40 CFR 86.1811–27 must meet standards for each individual driving cycle.

(a) The SFTP standard applies as a composite representing the three test elements. The emission results from the aggressive driving test element (§ 1066.831), the air conditioning test element (§ 1066.835), and the FTP test element (§ 1066.820) are analyzed according to the calculation methodology and compared to the applicable SFTP emission standards as described in 40 CFR part 86, subpart S.

(b) The test elements of the SFTP may be run in any sequence that includes the specified preconditioning steps.

■ 127. Amend § 1066.831 by revising paragraph (e)(2) to read as follows:

§ 1066.831 Exhaust emission test procedures for aggressive driving.

* * * * *

(e) * * *

(2) Operate the vehicle over the full US06 driving schedule, with the following exceptions that apply only for Tier 3 vehicles:

(i) For heavy-duty vehicles above 10,000 pounds GVWR, operate the vehicle over the Hot LA–92 driving schedule.

(ii) Heavy-duty vehicles at or below 10,000 pounds GVWR with a power-to-weight ratio at or below 0.024 hp/pound may be certified using only the highway portion of the US06 driving schedule as described in 40 CFR 86.1816.

* * * * *

■ 128. Amend § 1066.1001 by removing the definition for ''SFTP'' and adding a definition for ''Supplemental FTP (SFTP)'' in alphabetical order to read as follows:

§ 1066.1001 Definitions.

* * * * *

Supplemental FTP (SFTP) means the collection of test cycles as given in § 1066.830.

* * * * *

■ 129. Amend § 1066.1010 by:

■ a. Revising paragraph (b)(3); and

■ b. Adding paragraph (c).

The revision and addition read as follows:

§ 1066.1010 Incorporation by reference.

* * * * *

(b) * * *

(3) SAE J1711 FEB2023, Recommended Practice for Measuring the Exhaust Emissions and Fuel Economy of Hybrid-Electric Vehicles, Including Plug-In Hybrid Vehicles; Revised February 2023, (''SAE J1711''); IBR approved for §§ 1066.501(a); 1066.1001.

* * * * *

(c) *California Air Resources Board (California ARB).* California Air Resources Board, 1001 I Street, Sacramento, CA 95812; (916) 322–2884; *www.arb.ca.gov:*

(1) California 2026 and Subsequent Model Year Criteria Pollutant Exhaust Emission Standards and Test Procedures for Passenger Cars, Light-Duty Trucks, And Medium-Duty Vehicles (''California ARB's LMDV Test Procedures''); Adopted August 25, 2022; IBR approved for § 1066.801(c).

(2) California Test Procedures for 2026 and Subsequent Model Year Zero-Emission Vehicles and Plug-In Hybrid Electric Vehicles, in the Passenger Car, Light-Duty Truck and Medium-Duty Vehicle Classes (''California ARB's PHEV Test Procedures''); Adopted August 25, 2022; IBR approved for § 1066.801(c).

PART 1068—GENERAL COMPLIANCE PROVISIONS FOR HIGHWAY, STATIONARY, AND NONROAD PROGRAMS

■ 130. The authority citation for part 1068 continues to read as follows:

Authority: 42 U.S.C. 7401–7671q.

■ 131. Amend § 1068.30 by revising the definitions for ''Family'' and ''Void'' to read as follows:

§ 1068.30 Definitions.

* * * * *

Family means engine family, emission family, or test group, as applicable, under the standard-setting part.

* * * * *

Void means, with respect to a certificate of conformity or an exemption, to invalidate the certificate or the exemption ab initio (''from the beginning''). If we void a certificate, all the engines/equipment introduced into U.S. commerce under that family for that model year are considered uncertified (or nonconforming) and are therefore not covered by a certificate of conformity, and you are liable for all engines/equipment introduced into U.S. commerce under the certificate and may face civil or criminal penalties or both. This applies equally to all engines/equipment in the family, including engines/equipment introduced into U.S. commerce before we voided the certificate. If we void an exemption, all the engines/equipment introduced into U.S. commerce under that exemption are considered uncertified (or nonconforming), and you are liable for engines/equipment introduced into U.S. commerce under the exemption and may face civil or criminal penalties or both. You may not sell, offer for sale, or introduce or deliver into commerce in the United States or import into the United States any additional engines/equipment using the voided exemption.

* * * * *

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