2014-2017 Progress Report

Vehicle & Engine Compliance Activities

EPA
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2014-2017 Progress Report

Vehicle & Engine Compliance Activities

Compliance Division
Office of Transportation and Air Quality
U.S. Environmental Protection Agency

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Table of Contents

List of Tables

List of Figures

Forward by the Compliance Division Director

This report is the fifth in a series of vehicle and engine compliance reports issued by U.S. Environmental Protection Agency's Office of Transportation and Air Quality (EPA OTAQ). These reports provide a compendium of data that EPA OTAQ's Compliance Division collects as we work to help ensure that vehicles, engines, and other motorized equipment comply with emissions and fuel economy regulations. The environmental programs the Compliance Division implements apply to virtually every vehicle, engine, and gallon of transportation fuel sold in the United States. Previous reports cover the years 2007, 2008, 2009-2011, and 2012-2013.

This report covers the years 2014 - 2017. It focuses on a subset of the compliance data we collect in implementing EPA regulations designed to reduce and control vehicle and engine emissions of certain air pollutants that EPA regulates, such as nitrogen oxides, volatile organic compounds, and particulate matter. We include data about certificates issued, production volumes, defect reports and recalls for the various sectors of vehicles and engines.[1]

The Compliance Division has been busy in these years. In 2015, Volkswagen admitted to equipping U.S. diesel passenger cars dating back to the 2009 model year with software designed to circumvent the emissions control system – sacrificing pollution control for other features important to the company. The deceit involved software that detected when vehicles were undergoing emissions testing and directed full activation of emission controls only during the test. During normal vehicle operation, the software switched off certain emission controls, allowing the cars to emit nitrogen oxides at levels up to 40 times the standard.[2] This type of software is known as a "defeat device" because it defeats the purpose of the vehicles' emissions control systems.

As a result of the 2015 experience with Volkswagen, we decided to adapt and change our compliance programs to become less predictable. In September 2015, we announced that we would be keeping manufacturers' vehicles longer and that our testing would include additional evaluations not disclosed to manufacturers. Since that time, we have screened more than 300 vehicles using nonstandard tests and have taken action as appropriate when the testing identified potential issues.

EPA takes deliberate acts to circumvent emissions regulations very seriously. Not only does cheating increase public exposure to harmful pollutants, it erodes trust in the regulated industry and EPA's compact with the public to protect people from harmful pollution. We expect manufacturers to produce vehicles and engines that serve a public good while meeting the spirit and letter of EPA regulations, thereby protecting human health and the environment. We will continue to adapt our approaches to prevent cheating and to take appropriately strong action where we find it.

The Volkswagen case presented a clear violation of law, unusual in the depth and scope of cheating involved. But EPA's compliance program is also on alert to other forms of noncompliance which may stem from unintentional failures by manufacturers. In the 2014 – 2017 time period, we undertook

[1] This report does not cover vehicle/engine fuel economy and greenhouse gas emissions compliance data, or transportation fuel quality/compliance programs as these are covered in other EPA publications -- see Section 1.1 for more information.

[2] More information can be found on EPA's website, at www.epa.gov/vw.

several significant compliance and recall actions across a broad range of vehicle and engine sectors, as described in this report.

EPA OTAQ is always looking at ways we can assess and improve manufacturer compliance throughout the life of the vehicles and engines produced. Given that vehicles and engines are manufactured all over the world, we engage with manufacturers all over the world. We send teams to manufacturing locations abroad to test vehicles and engines just as they are coming off the assembly line. We also partner with other federal agencies, such as U.S. Customs and Border Protection, to leverage their activities to inspect vehicles and engines at the point they're entering the U.S.

We've also improved the systems we use to collect and verify data from manufacturers. Disparate systems of data collection had evolved for the various vehicle and engine sectors, but as of 2015, EPA OTAQ consolidated them into one umbrella system, called "Engine and Vehicles – Compliance Information System," or EV-CIS. This comprehensive data management system facilitates issuance of certificates of conformity and allows vehicle and engine manufacturers to submit data efficiently and securely, while also allowing EPA to share emissions data with a broad range of partners and stakeholders. Indeed, much of the information presented in this report is accessible because of these expanded EV-CIS functionalities. EV-CIS is not just a secure means to store compliance data. It includes built-in validation of manufacturer and EPA data, thus helping to prevent data entry errors and even to identify potential noncompliant products.

In the United States, we have seen tremendous improvement in air quality since the Clean Air Act Amendments of 1990, even while the U.S. economy, our collective vehicle miles travelled, and the number of vehicles and engines produced for the U.S. have grown significantly. Certainly, the Clean Air Act and EPA's regulations to implement it have created the framework for achieving these results.

But regulations are just the first part of the success story. As the Volkswagen case and other actions described in this report illustrate, the mere existence of regulations is not sufficient to reduce pollution. The environmental results promised by regulation can only be achieved if manufacturers are held accountable for meeting emission standards and fixing any defects when emissions problems show up after their products are in customer use.

That's why EPA is invested in compliance. We see our mission as two-fold: to deliver on the air quality promise of regulations, and to maintain a level playing field among manufacturers. EPA's role in helping to ensure compliance with regulations is key to our mission to limit pollution coming from vehicles and equipment that individuals and companies use every day – cars, trucks, construction equipment, agricultural machinery, recreational vehicles, lawn and garden equipment, and others – to ensure that even as we use these products, our air quality continues to be protected. New and improving technologies will enable the twin virtues of ever improving environmental and economic performance. Manufacturers that invest in developing new environmentally beneficial technologies to meet emission standards will be at a competitive disadvantage if they see those investments undermined by competitors that cheat to circumvent EPA regulations. Hence our actions to ensure a level playing field among manufacturers is key both to our present and future success in protecting the public from harmful emissions.

I hope through this report we can provide a window into our ongoing efforts to protect the public from harmful emissions while ensuring a level playing field among the regulated industries.

Executive Summary

ES.1 Overview

This is the fifth in a series of vehicle and engine compliance reports issued by the U.S. Environmental Protection Agency's (EPA) Office of Transportation and Air Quality (EPA OTAQ).[3] These reports offer a reference to the data that the EPA OTAQ Compliance Division collects in implementing emissions regulations for vehicles, engines, and other motorized equipment.

This report presents compliance data for vehicle and engine model years 2014 through 2017, and data related to testing, defects, and recalls in calendar years 2014 through 2017, for a variety of sectors encompassing highway and nonroad engines and vehicles. These include, for example, light-duty vehicles (i.e., passenger cars and passenger trucks), highway motorcycles, highway heavy-duty engines and trucks such as tractor-trailers and buses, nonroad engines such as construction and agricultural equipment, marine craft of all sizes, and locomotives.

ES.2 EPA OTAQ's Compliance Activities Ensure that Clean Air Benefits of EPA's Regulations Are Maximized

Air quality in the U.S. has improved over the years, as regulations and technologies have affected emissions from all pollution sectors. However, there are areas across the country where air quality does not meet the National Ambient Air Quality Standards, and in many of these areas, mobile sources are the dominant contributor to emissions. EPA OTAQ's compliance program is key to ensuring that regulations for vehicles, engines, and other motorized equipment achieve the result of clean air.

ES.2.1 Air Quality Has Improved Overall

As described in EPA's report, *Our Nation's Air: Status and Trends Through 2017*, nationally, concentrations of air pollutants have dropped significantly since 1990.[4] Concentrations of pollutants refer to the amount of a pollutant per volume of air, as measured at an air quality monitor:

- Carbon monoxide (CO) 8-hour average, concentrations down 77%;
- Lead 3-month average, down 80%;
- Nitrogen dioxide (NO_2) annual average, down 56%;
- Nitrogen dioxide (NO_2) 1-hour average, down 50%;
- Ozone 8-hour average, down 22%;
- Particulate matter $\leq$ 10 microns (PM_{10}) 24-hour average, down 34%;
- Particulate matter $\leq$ 2.5 microns ($PM_{2.5}$) annual average, down 41%;
- $PM_{2.5}$ 24-hour average, down 40%;
- Sulfur dioxide (SO_2) 1-hour average, down 88%; and
- Numerous air toxics have declined with percentages varying by pollutant.

[3] EPA's previous vehicle and engine compliance reports can be found on EPA's website at www.epa.gov/vehicle-and-engine-certification/compliance-activity-reports-vehicles-and-engines.

[4] Found on EPA's website at: www.epa.gov/air-trends.

Decreases in pollutant concentrations measured at air quality monitors indicate that EPA's air pollution control programs are contributing to improved air quality.

Decreases in emissions estimates over time are also an indicator of the overall effectiveness of EPA's air pollution control programs. Annual emissions estimates describe the total amount of a pollutant that is emitted or released over the course of a year from all sources, such as power plants, industrial facilities, highway vehicles, nonroad vehicles, and local area sources.

According to *Our Nation's Air*, between 1970 and 2017, the U.S. economy continued to grow, the number of vehicle miles travelled in the U.S. continued to grow, and population and energy use also increased, as seen in Figure ES-1. During the same time period, total emissions of six common air pollutants dropped by 73 percent.[5,6]

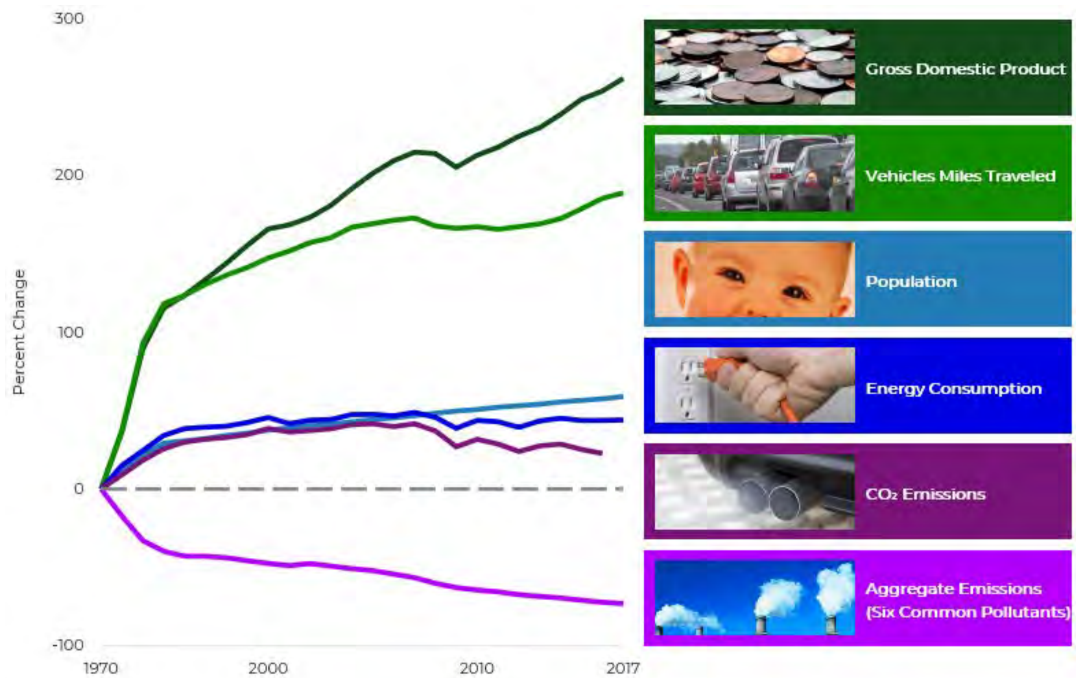

Figure ES-1: Comparison of Growth Areas and Declining Emissions, 1970 - 2017

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[5] The six pollutants included are: carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter of diameter less than or equal to 10 microns, and less than or equal to 2.5 microns (PM_{10} and $PM_{2.5}$), volatile organic compounds (VOC), sulfur dioxide (SO_2), and ammonia (NH_3).

[6] Note that vehicle emissions of carbon dioxide and other greenhouse gases have increased during this period and are the fastest-growing source of greenhouse gas emissions in the United States. The first EPA regulations controlling carbon dioxide as a pollutant took effect with 2012 model year cars. For more information about light-duty vehicle greenhouse gas data, please see *The 2018 EPA Automotive Trends Report,* available on EPA's website at: www.epa.gov/automotive-trends. For more information about all greenhouse gas sources, see EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2017*, available on EPA's website at: www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2017.

ES.2.2 Air Quality Does Not Meet the National Ambient Air Quality Standards in Many Areas Across the Country, and Mobile Sources Are a Significant Contributor

While emissions of pollutants have been declining, there are still millions of people across the country breathing pollution at levels above the National Ambient Air Quality Standards.[7] Based on the 2014 National Emissions Inventory, mobile sources are significant contributors to total emissions, accounting for more than half of the NOx and CO emissions nationwide (NOx is necessary for ozone, more commonly known as smog, formation). Furthermore, mobile sources are the dominant emissions sources in many individual urban areas. In addition, mobile sources contribute to higher localized levels of pollutants near roads and transportation facilities. EPA estimated that in 2009, more than 45 million people in the United States lived, worked, or attended school within 300 feet of a major road, airport, or railroad. Individually and in combination, many of the pollutants found near roadways have been associated with adverse health effects.[8] Highway and nonroad vehicles and engines are used by people as they go about their daily lives – at work, at home, in transit, and in recreation.

Mobile sources, which include highway vehicles and nonroad vehicles and equipment, are the dominant emissions sources in many individual urban areas.

These facts emphasize the importance of EPA's transportation-related air quality programs.

ES.2.3 EPA's Compliance Activities Are Necessary to Ensure Regulations Deliver Clean Air

EPA derives authority to regulate vehicles, fuels, and engines through a variety of environmental statutes enacted by Congress. The Clean Air Act, as well as the Energy Policy and Conservation Act, the Energy Policy Act, and Energy Independence and Security Act give EPA the authority to regulate nearly all engines and vehicles that emit pollutants into the environment. These statutes also give EPA the authority to regulate the fuels that power these mobile sources, and the responsibility for emissions compliance oversight that extends from initial product design to performance on the road and in the field.

EPA's compliance activities confirm that vehicle and engine manufacturers are satisfying their regulatory obligations.

All mobile source sectors contribute to the national inventory of emissions, and EPA OTAQ's compliance programs cover these different sectors, as described in this report. Compliance programs play an essential role in achieving the benefits of statutes and regulations. EPA OTAQ oversees a comprehensive set of compliance activities to confirm that vehicle and engine

[7] See www.epa.gov/airquality/greenbook/popexp.html. EPA sets National Ambient Air Quality Standards for the pollutants ozone, carbon monoxide (CO), particulate matter of diameter less than or equal to 10 microns (PM_{10}), particulate matter of diameter less than or equal to 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), lead, and SO_2. Ozone is not directly emitted, but forms in the atmosphere from volatile organic compounds (VOCs) and nitrogen oxides (NOx). For more information, see EPA's website at www.epa.gov/criteria-air-pollutants.

[8] More information is available at: www.epa.gov/air-research/near-roadway-air-pollution-and-health-frequent-questions

manufacturers and fuel producers and distributors are satisfying their regulatory obligations. Under EPA's Tier 2 and Tier 3 programs, for example, light-duty vehicles, including SUVs and other light-duty trucks, must meet a fleet average standard. Compliance data show that manufacturers are meeting their regulatory targets: in model year 2017, 99 percent of the vehicle test groups were certified to Tier 2 Bin 5 or better (see Sections 2.5.1 and 3.9 for more information). Light-duty vehicle manufacturers are achieving better emissions control than the standards by compliance margins of more than 50 percent, for pollutants NOx, non-methane organic gases (NMOG), and CO.

The data we collect, and present in this report, provide the foundation of our compliance assessments.

ES.3 EPA's Compliance Activities Are Diverse and Tailored to Different Industries

The industries included in this report differ significantly, in terms of numbers of manufacturers, complexity of the vehicles and engines they build, and the emissions standards and regulatory requirements on those products. Some sectors are more consolidated than others. For example, there are a larger number of highway motorcycle manufacturers (more than 100) obtaining certificates for fewer than 300 engine families each year, compared to the light-duty vehicle sector, where 36 vehicle manufacturers obtained certificates for more than 500 unique exhaust test group/evaporative families. The small spark ignition engine sector, which includes products such as lawn and garden equipment for residential use, has the largest number of engine families, as 900 or more were certified in each of these model years.

EPA's compliance activities also vary and are tailored to the differences in these industries.

ES.3.1 Defect and Recall Reporting

One example is defect and recall reporting. Manufacturers in all regulated sectors are required to report emission-related defects to EPA. An emission-related defect is a defect in design, materials or workmanship in a device, system or assembly, as described in the approved application for certification. EPA regulations generally establish minimum numbers of confirmed defects that trigger defect information reporting requirements. An emission-related defect can lead to a recall, but this does not happen in every case because some defects in emission-related parts do not increase emissions. Under the Clean Air Act, if EPA determines that a substantial number of vehicles or engines in a category or class do not meet emission standards in actual use, even though they are properly maintained and used, EPA can require the manufacturer to recall and fix the affected vehicles and engines.

Recall programs protect air quality by holding manufacturers responsible for fixing defects in their products at no cost to consumers.

Over calendar years 2014 – 2017, the defect and recall programs have affected millions of vehicles and engines currently in use. Table ES-1 shows recall reports and affected vehicles or engines by sector. A vehicle or engine may be subject to multiple recalls, and therefore the same vehicle or engine may be included more than once in the "Affected Vehicles" count.

Table ES-1: Recall Reports and Affected Vehicles/Engines by Regulated Sector, 2014 - 2017

Regulated Sector	2014		2015		2016		2017	
	Recalls	Affected Vehicles	Recalls	Affected Vehicles	Recalls	Affected Vehicles	Recalls	Affected Vehicles
Light-Duty Vehicles	44	9,006,273	64	4,191,581	65	5,969,283	86	4,937,955
Highway Motorcycles	0	0	2	1,050	3	23,931	2	8,179
Heavy-Duty Highway Engines	12	149,392	6	338,453	9	755,553	6	41,752
Nonroad Spark Ignition Engines	2	21,502	0	0	3	9,362	3	4,171
Recreational Vehicles	2	20,016	1	244	1	800	5	90,551

As seen in Table ES-1, the number of defects and recalls reported light-duty vehicles is greater than any other industry sector. Because of the factors that make the light-duty sector unique, defect and recall reporting are critical components of compliance for this sector. Light-duty emission standards are the most stringent of any sector and light-duty vehicles have the most sophisticated and complex emission control systems, including on-board diagnostic systems, that are integrated with other computer-controlled systems within a vehicle. Given this greater complexity, there is a greater opportunity for defects to occur. In addition, the light-duty vehicle sector has existing infrastructure, in the form of dealerships, that facilitates conveying information about defects and recalls to consumers, as well as implementing recalls and servicing vehicles. For these reasons, defect and recall reporting are critical light-duty compliance tools.

ES.3.2 Compliance Audits

For other sectors, such as heavy-duty highway engines, nonroad spark ignition engines, recreational vehicles, and highway motorcycles, compliance audits conducted in the field play a greater role in how EPA assesses compliance. For these industry sectors, an essential part of EPA OTAQ's compliance programs is the ability to inspect products and emission measurement processes in the field to validate that the regulated sectors comply with applicable emission standards. EPA OTAQ has a variety of field inspections tools that serve to validate the different facets of compliance, and because manufacturing occurs across the globe, EPA's compliance audits do as well.

From calendar years 2014 to 2017, EPA OTAQ conducted 91 compliance audits across a variety of regulated sectors in North America, Europe, and Asia, as shown on the maps below. In its audits, EPA found issues such as problematic emissions measurement software, noncompliant calibration and testing practices, missing records, use of test fuel that did not meet specifications, and others.

Of these compliance audits, 16 were Selective Enforcement Audits (SEAs). For SEAs, a formal pass/fail determination is made at the end of the audit, based on the emission test results of the sampled products. In the period from 2014-2017, EPA suspended one SEA that began in 2013 and the manufacturer agreed to recall its products voluntarily. There were no failed audits among the 16 SEAs conducted from 2014-2017; however, there were testing and laboratory issues that manufacturers were required to correct.

EPA's world-wide compliance audits promote a level playing field among manufacturers.

Locations of compliance audits are marked with a pin on the maps in Figures ES-2 through ES-4 below. A yellow or red shadow under a pin indicates multiple audits in that area. The darker the shadow, the greater the number of audits in that location. For example, in Southern California, 14 audits occurred in the 2014 – 2017 timeframe.

EPA will continue to use its diverse and targeted compliance tools as statutes and regulations provide, to use its resources appropriately and efficiently to assess compliance of manufacturers in all industry sectors.

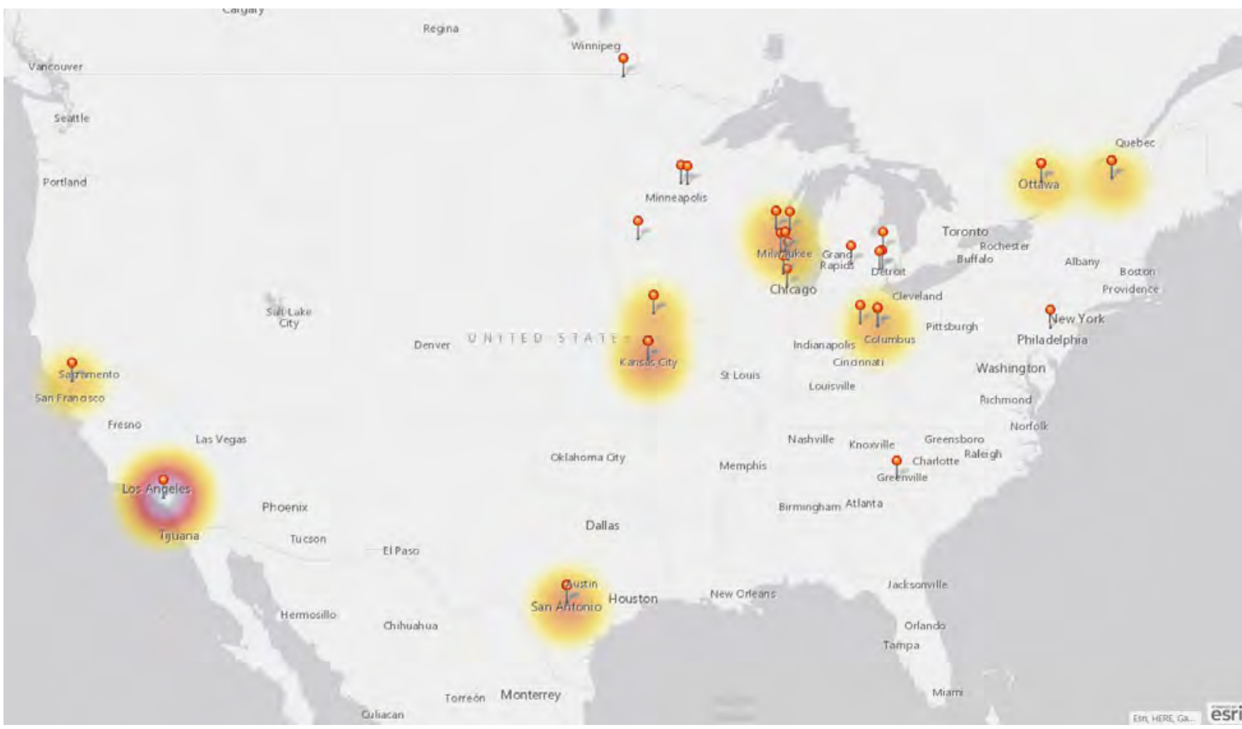

Figure ES-2: EPA OTAQ Compliance Audit Locations in North America, 2014 -2017

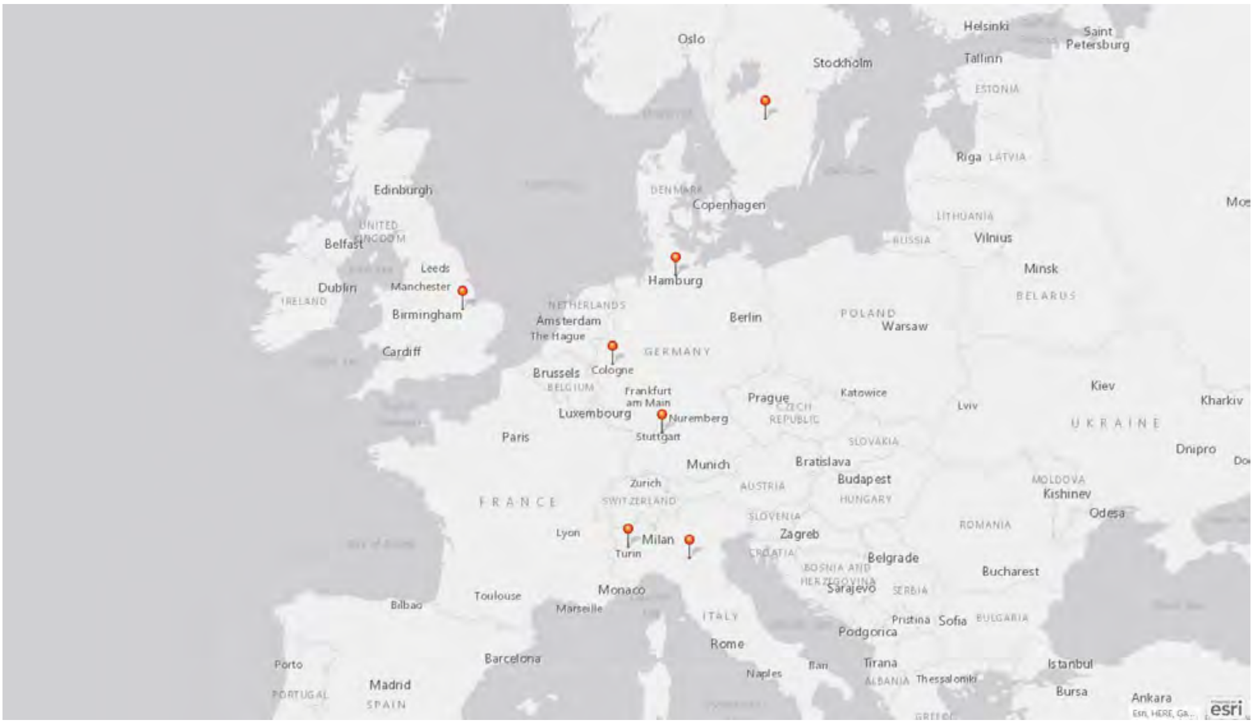

Figure ES-3: EPA OTAQ Compliance Audit Locations in Europe, 2014 - 2017

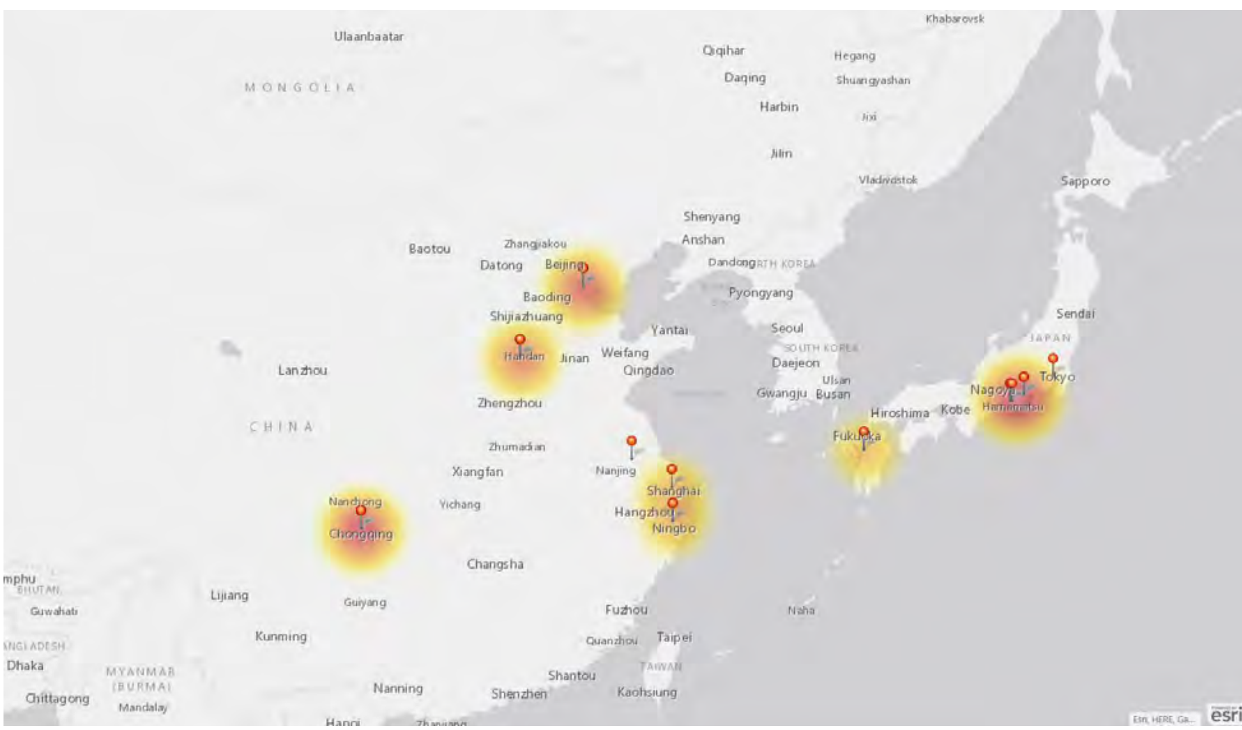

Figure ES-4: EPA OTAQ Compliance Audit Locations in Asia, 2014 - 2017

ES.4 EPA Continuously Considers Ways to Improve Compliance and Oversight Programs as Industries Grow and Technologies Change

As described throughout this report, EPA employs a rigorous, multi-layer process to test and certify new vehicle models before they can be sold, and for testing vehicles and engines that are in production and on the road. As technologies evolve and circumstances change, EPA continuously considers ways to improve compliance and oversight programs. Over the past 45 years, EPA's oversight and testing program has developed new tools and new techniques to adapt to technology advances, so that we achieve the Agency's mission of protecting public health and the environment. EPA OTAQ intends to continue to adapt its compliance oversight to be both efficient and unpredictable.

This compliance report covers model years 2014-2017 as well as compliance actions taken in calendar years 2014-2017. During this time, EPA OTAQ learned that Volkswagen equipped their model year 2009 – 2016 diesel passenger vehicles with software that enabled cars to pass emissions tests, but exceed pollution standards during normal vehicle operation. See Section 2.6 of this report for more information. The Volkswagen defeat device case highlights the need for EPA's active and visible presence in monitoring compliance with emissions standards.

Reinforcing this need is the ever-growing number and diversity of vehicles, engines, and products developed by industry that must receive a Certificate of Conformity. The Clean Air Act requires each vehicle and engine to have a Certificate of Conformity, which is a license to produce and sell products for one model year consistent with the vehicle description and any terms of the certificate. The number of certificates that EPA issues continues to grow. The total number of certificates EPA issued in model years 1995, 2000, and 2007 - 2017 is shown in Figure ES-5. The dashed line in the figure denotes a change in the x-axis (beginning with model year 2007, information is yearly). For model year 2017, EPA issued close to 5000 certificates. In comparison, for model year 1995, EPA issued 810.

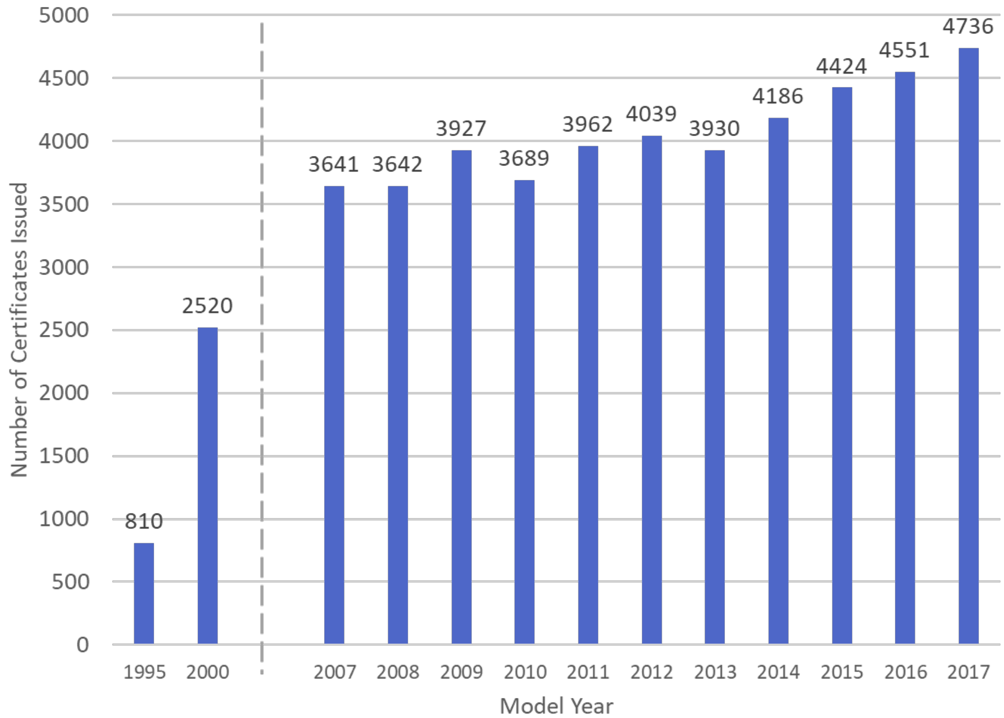

Figure ES-5: Total Number of Certificates Issued in Model Years Since 1995

Numbers of certificates in some sectors have remained relatively stable, but there have been substantial changes in many sectors. For example, certificates for the category of "forklifts, generators, and compressors" has increased more than five times. Also, new categories of certificates have been added to EPA's list, for example, evaporative components for nonroad spark ignition engines, and heavy-duty tractors and vocational vehicles.

EPA OTAQ recognizes the need to adapt and change compliance programs to become less predictable. In September 2015, we announced that we would be keeping manufacturer vehicles longer and that our testing would include additional evaluations not disclosed to manufacturers. Since that time, EPA OTAQ has screened more than 300 vehicles using nonstandard tests and have taken action as appropriate when the testing identified potential issues. EPA applies a "3 x 3" approach to vehicle testing, in which we test cars at three times in their lifecycle: preproduction, production, and in-use, using three test methods: standard laboratory test procedures, undisclosed laboratory procedures, and testing on the road.

EPA OTAQ has also improved the systems we use to collect and verify data from manufacturers. Disparate systems of data collection had evolved for the various vehicle and engine sectors, but as of 2015, EPA OTAQ consolidated them into one umbrella system, called "Engine and Vehicles – Compliance Information System," or EV-CIS. This comprehensive data management system facilitates issuance of certificates of conformity and allows vehicle and engine manufacturers to submit data efficiently and securely, while also allowing EPA to share emissions data with a broad range of partners and stakeholders. EV-CIS includes built-in validation of manufacturer and EPA data, thus helping to prevent data entry errors and even to identify potential noncompliant products.

EPA remains committed to developing compliance tools, tests, and methods that are unpredictable and that employ efficiencies to keep pace with the ever changing and growing industry sectors. Compliance is vital to ensure that Americans continue to breathe clean air and have confidence that the products manufactured for sale in the U.S. meet emission control standards.

1. Introduction

1.1 Organization of this Report

This is the fifth in a series of vehicle and engine compliance reports issued by the U.S. Environmental Protection Agency's (EPA) Office of Transportation and Air Quality (EPA OTAQ). These reports offer a convenient reference to the data that EPA OTAQ collects in implementing emissions regulations for vehicles, engines, and other motorized equipment.

This report provides compliance data for vehicle and engine model years 2014 through 2017, and data related to testing, defects, and recalls in calendar years 2014 through 2017 for a variety of sectors encompassing highway and nonroad engines and vehicles. These include light-duty vehicles (i.e., passenger cars and passenger trucks), highway motorcycles, highway heavy-duty engines and trucks such as tractor-trailers and buses, nonroad engines such as construction and agricultural equipment, marine craft of all sizes, and locomotives.

The report is organized as follows:

- Section 1, Introduction. This section provides the context for EPA's compliance programs, including the statutory authority for these programs, the regulations that apply, and recent air quality trends.

- Section 2, Overview of Compliance Programs and Processes. This section describes generally the programs and processes EPA employs to ensure that vehicles and engines comply with emissions standards over their full lifecycle.

- Sections 3 - 8: Compliance Data by Sector. These sections provide compliance data, production volumes for the U.S., and other information, organized by industry sector:
    - Section 3: Light-Duty Vehicles
    - Section 4: Highway Motorcycles
    - Section 5: Heavy-Duty Highway Engines
    - Section 6: Nonroad Compression Ignition Engines
    - Section 7: Nonroad Spark Ignition Engines
    - Section 8: Recreational Vehicles

  Table 1-1 provides examples of the types of vehicles and engines included in each sector.

- Section 9: Alternative Fuels and Alternative Fuel Conversion Systems. This section provides details about alternative fuel use among the different industry sectors, and information about alternative fuel conversion systems.

Table 1-1: Industry Sectors and Examples

Industry Sector	Examples	Key
Light-Duty Vehicles	Passenger cars, vans, SUVs, small trucks	
Highway Motorcycles	On-highway motorcycles, cruisers, choppers, scooters, touring bikes, mopeds, street bikes	
Heavy-Duty Highway Engines	Tractor-trailers (semi-trucks), buses, delivery and work trucks	
Nonroad Compression Ignition Engines (Nonroad CI)	Construction and agricultural equipment, such as tractors, generators, construction and road-work equipment, welders	
	Marine diesel boats and ships, oceangoing vessels	
	Locomotives	
Nonroad Spark Ignition Engines (Nonroad SI)	Small SI: lawnmowers, string trimmers, chain saws, small compressors, pumps, snow blowers	
	Marine SI: inboard and outboard motorboats, jet-skis	
	Large SI: forklifts, large compressors, generators	
	Evaporative components: fuel lines, fuel tanks	
Recreational Vehicles	All-terrain vehicles (ATVs), utility vehicles (UTVs), sand cars, dune buggies	
	Off-highway motorcycles	
	Snowmobiles	

This report does not cover transportation fuel quality/compliance programs or vehicle/engine fuel economy and greenhouse gas emissions compliance data. More information on these programs, as well as other EPA references, can be found on EPA's website, as listed in Table 1-2.

Table 1-2: EPA References

Information	EPA Website Address
Fuel compliance information, including EPA analyses of data	www.epa.gov/fuels-registration-reporting-and-compliance-help
Gasoline standards	www.epa.gov/gasoline-standards
Diesel fuel standards	www.epa.gov/diesel-fuel-standards
Light-duty vehicle carbon dioxide and fuel economy trends	www.epa.gov/fuel-economy-trends/explore-co2-and-fuel-economy-trends-data
EPA's online Emission Standards Reference Guide (comprehensive list of EPA mobile source emission standards)	www.epa.gov/otaq/standards/index.htm
Comprehensive list of regulations for emissions from vehicles and engines	www.epa.gov/regulations-emissions-vehicles-and-engines
Previous vehicle and engine compliance reports	www.epa.gov/vehicle-and-engine-certification/compliance-activity-reports-vehicles-and-engines

1.2 Statutory Authority

EPA derives authority to regulate vehicles, fuels, and engines through a variety of environmental statutes enacted by Congress. Table 1-3 outlines the primary environmental statutes that give EPA the authority to develop and implement its mobile source clean air programs.

Table 1-3: Environmental Statutes

Statute	Authority
Clean Air Act (CAA)	Emission standards for highway & nonroad vehicles and their fuels
Energy Policy and Conservation Act (EPCA)	Fuel economy information programs for consumers, including vehicle fuel economy labels
Energy Policy Act (EPAct) Energy Independence and Security Act (EISA)	Annual volume standards for renewable fuel content

These statutes give EPA the authority to regulate nearly all engines and vehicles that emit pollutants into the environment, authority to regulate the fuels that power these mobile sources, and responsibility for emissions compliance oversight that extends from initial product design to performance on the road and in the field.

1.3 Scope of EPA Vehicle, Engine, and Equipment Regulations

Compliance programs play an essential role in achieving the benefits of statutes and regulations. EPA oversees a comprehensive set of compliance activities to ensure that vehicle and engine manufacturers and fuel producers and distributors satisfy their regulatory obligations.

Compliance programs play an essential role in ensuring the public receives the benefits of clean air.

EPA has been regulating motor vehicle emissions since being established as a federal agency in 1970. Table 1-4 lists vehicle and engine regulations that apply to model years 2004 and later. This table is meant to be an overview of the regulations that currently apply to the various sectors covered in this report, but it does not include every regulation. For a comprehensive list of EPA vehicle and engine emission standards, refer to EPA's online Emission Standards Reference Guide, available at www.epa.gov/otaq/standards/index.htm, and see the comprehensive list of regulations for emissions from vehicles and engines at www.epa.gov/regulations-emissions-vehicles-and-engines.

As Table 1-4 illustrates, over time, EPA has added regulations to previously unregulated mobile source sectors and has improved regulations in other sectors to strengthen their efficacy.

Table 1-4: Vehicle and Engine Regulations and Implementation Dates

Affected Industry Sector/Category	Program/Rulemaking Description	Effective Model Year[9]
Light-Duty Vehicles	Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards Phase 2 – Established emission standards for greenhouse gases including carbon dioxide, methane, and nitrous oxide Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards Phase 1 – First mobile source emission standards for greenhouse gases including carbon dioxide, methane, and nitrous oxide	2017 - 2025 2012-2016
	Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards – Established new vehicle emission standards and further lowered the sulfur content of gasoline Tier 2 Motor Vehicle Emission and Fuel Standards – Treated vehicles and fuels as a system by concurrently regulating gasoline sulfur content to enable use of vehicle aftertreatment technology that would significantly reduce exhaust emissions	2017 2004
	Revisions and Additions to Motor Vehicle Fuel Economy Label – Redesigned label to provide the public with information on vehicles' fuel economy, energy use, fuel costs, and environmental impacts, allowing comparisons between conventional and advanced technology vehicles such as electric vehicles and plug-in hybrid electric vehicles. Revisions to Motor Vehicle Fuel Economy Labeling – Revised the method for determining fuel economy label values to better represent typical driving patterns and more accurately estimate actual consumer fuel economy	2013 2008
	Clean Alternative Fuel Vehicle and Engine Conversions – Provided additional compliance options for manufacturers of clean alternative fuel conversion systems for highway vehicles and engines	All[10]
	Mobile Source Air Toxics – Set standards to lower gasoline benzene content, reduce cold temperature exhaust emissions,	2010

[9] Effective model year refers to the first year of a new program where only one year is noted. Many programs are phased in over multiple model years.

[10] Although this regulation took effect with its promulgation in 2011, it relates to clean alternative fuel conversion systems that can apply to any model year that is subject to any emission standard.

	and reduce evaporation and permeation from portable fuel containers Mobile Source Air Toxics – First regulation identifying compounds that should be considered mobile source air toxics and required refiners beginning in 2002 to maintain their average 1998-2000 gasoline toxic emission performance levels	2002
Highway Motorcycles	Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
	Highway Motorcycle Permeation Emissions – Established new evaporative/permeation standards for fuel tank(s) and lines	2008
	Highway Motorcycle Exhaust Emissions – Established emissions standards for exhaust and evaporative emissions for motorcycles, updating standards that were more than 20 years old. Included previously unregulated motorcycles with engines of <50 cc (scooters and mopeds)	2010 and 2006[11]
Heavy-Duty Highway Engines and Vehicles	Heavy-Duty GHG and Fuel Efficiency Standards Phase 2 – Established vehicle and engine performance standards for model years 2021-2027 for semi-trucks, large pickup trucks, vans, and all types and sizes of buses and work trucks; and model years 2018-2027 for certain trailers Heavy-Duty GHG Standards – Established the first emission standards for greenhouse gas pollutants from heavy-duty engines and vehicles for model years 2014 -2018	2021 2018 2014
	Standard for diesel fluid systems – Established minimum maintenance intervals for replenishment of diesel exhaust fluid with the use of selective catalytic reduction technologies	2014
	Nonconformance Penalties for On-Highway Heavy-Duty Diesel Engines – Established fines for manufacturers that are not meeting standards	2012
	Onboard Diagnostic (OBD) Systems – New OBD requirement for engines over 14,000 pounds; revisions to OBD for engines under 14,000 pounds Light Heavy-Duty OBD – Established OBD monitoring requirements for heavy-duty chassis certified vehicles, and for engines certified for use in heavy-duty vehicles between 8,500 and 14,000 pounds gross vehicle weight rating (GVWR)	2010 2004
	Heavy-Duty Highway Rule – Established more stringent exhaust emission standards for heavy-duty vehicles and engines; required Ultra Low Sulfur Diesel (ULSD) fuel (15 ppm sulfur maximum)	2007

[11] New highway motorcycle standards applied in 2006; more stringent standards applied to Class III motorcycles (engine size ≥280 cc) in 2010.

Nonroad Compression Ignition Engines & Equipment	Construction & Agricultural	Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		Tier 4 Nonroad Diesel Rule – Established more stringent emissions standards for all engines greater than 19 kilowatts (25 hp) and lowered nonroad diesel fuel sulfur to 15 ppm maximum Tier 3/Interim Tier 4 – Established more stringent emission standards for engines between 37 and 560 kilowatts (50 and 750 hp)	2010 2006
	Marine Diesel Engines	Standards for New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder – Established two additional tiers of NOx standards for Category 3 marine diesel engines, taking effect in 2011 and 2016; established HC and CO standards; and established limit on sulfur in marine fuel in the Emission Control Area (2012 for 1.0% and 2015 for 0.1%)	2016 2011 2015 2012
		Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		Tier 3 and Tier 4 Emission Standards for Marine Diesel Engines – Established more stringent emission standards for newly built and remanufactured Category 1 and 2 marine diesel engines Commercial: Tier 4 2014-2017 Commercial and Recreational: Tier 3 2009-2014	 2014 2009
	Locomotives	Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		Tier 3 and Tier 4 Emission Standards for Locomotive Diesel Engines – Established more stringent emission standards for newly built and remanufactured engines Tier 3 Tier 4	 2012 2015
Nonroad Spark Ignition Engines and Equipment	Small Spark Ignition Engines (Small SI)	Control of Emissions from Nonroad Spark Ignition Engines and Equipment – Established more stringent exhaust emission standards for Class I (model year 2012) and Class II (model year 2011) engines below 19 kilowatts and fuel permeation standards for all engines below 19 kilowatts	2012 2011
	Marine Spark Ignition Engines (Marine SI)	Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		Control of Emissions from Nonroad Spark Ignition Engines and Equipment – Established first federal exhaust emission standards for sterndrive and inboard Marine SI engines and increased the stringency of exhaust emission standards for outboard and personal watercraft engines. Established new evaporative emission standards for all Marine SI engines	2010

	Large Spark Ignition Engines (Large SI)	Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		New Emissions Standards for Large SI Engines – Established new exhaust and evaporative emission standards, diagnostic capability and portable emission testing provisions Tier 2 Tier 1	 2007 2004
Recreational Vehicles		Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		New permeation standards for fuel components	2008
		New Exhaust Emission Standards for Recreational Vehicles – Snowmobiles, Tier 3 Off-highway motorcycles, ATVs and UTVs	 2012 2006
Aircraft[12]		Greenhouse Gas Reporting Program – Required reporting of greenhouse gas emissions from all sectors of the economy	2011
		NOx Emission Standards for Aircraft Gas Turbine Engines – Established new NOx emission standards for aircraft, engines consistent with international standards (Committee on Aviation Environmental Protection, or CAEP) New Type standards: CAEP/8: 2014 CAEP/6: 2012 End of grandfather clause for engines in production before the start of new standards: CAEP/6: 2013 Control of Air Pollution from Aircraft and Aircraft Engines; Emission Standards and Test Procedures – Established more stringent NOx exhaust emission standards for aircraft engines	2014 2013 2012 2005

In addition to regulating vehicles and engines, EPA regulates motor vehicle fuels, including gasoline, diesel, and renewable fuels such as ethanol and biodiesel. Refer to Table 1-2 for EPA resources.

EPA also regulates portable fuel containers, as noted in Table 1-4. (This industry is not covered by a specific section in this report.) EPA began validation test work on various manufacturers' portable fuel container emission families, and that work is continuing. The industry consistently sells approximately 20 million containers per year.

[12] The Federal Aviation Administration has primary oversight responsibility for aircraft emissions compliance. A general overview can be found on the web at: www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/Primer_Jan2015.pdf.

1.4 Air Quality Trends and the Contribution of Mobile Sources to Air Pollution

This section presents information about air pollution trends for context and perspective. This information comes from EPA's report, *Our Nation's Air: Status and Trends Through 2017*, and from the National Emissions Inventory for the year 2014.

1.4.1 Air Quality Has Improved

The concentration of a pollutant is the amount of that pollutant per volume of air, measured over a specific averaging time at an air quality monitor. As described in *Our Nation's Air: Status and Trends Through 2017*, nationally, concentrations of criteria and hazardous air pollutants have dropped significantly since 1990, for example:

- Carbon monoxide (CO) 8-hour average, concentrations down 77%;
- Lead 3-month average, down 80%;
- Nitrogen dioxide (NO_2) annual average, down 56%;
- Nitrogen dioxide (NO_2) 1-hour average, down 50%;
- Ozone 8-hour average, down 22%;
- Particulate matter $\leq$ 10 microns (PM_{10}) 24-hour average, down 34%;
- Particulate matter $\leq$ 2.5 microns ($PM_{2.5}$) annual average, down 41%;
- $PM_{2.5}$ 24-hour average, down 40%;
- Sulfur dioxide (SO_2) 1-hour average, down 88%; and
- Numerous air toxics have declined with percentages varying by pollutant. [13]

Decreases in pollutant concentrations measured at air quality monitors indicate that EPA's air pollution control programs are contributing to improved air quality.

Decreases in emissions estimates over time are also an indicator of the overall effectiveness of EPA's air pollution control programs. Annual emissions estimates describe the total amount of a pollutant that is emitted or released over the course of a year from all sources, such as power plants, industrial facilities, highway vehicles, nonroad vehicles, and local area sources. According to *Our Nation's Air*, between 1970 and 2017, the U.S. economy continued to grow, the number of vehicle miles travelled in the U.S. continued to grow, and population and energy use also increased, as seen in Figure 1-1. During the same time period, total emissions of six common air pollutants dropped by 73 percent.[14] However, the graph also shows that between 1970 and 2017, CO_2 emissions – for which there are no ambient air quality standards - increased 15 percent.

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[13] *Our Nation's Air*, found on EPA's website at: www.epa.gov/air-trends. "Criteria" air pollutants are those for which EPA sets national ambient air quality standards.

[14] The six pollutants included are CO, nitrogen oxides (NO_x), PM_{10} and $PM_{2.5}$, volatile organic compounds (VOC), SO_2, and ammonia (NH_3).

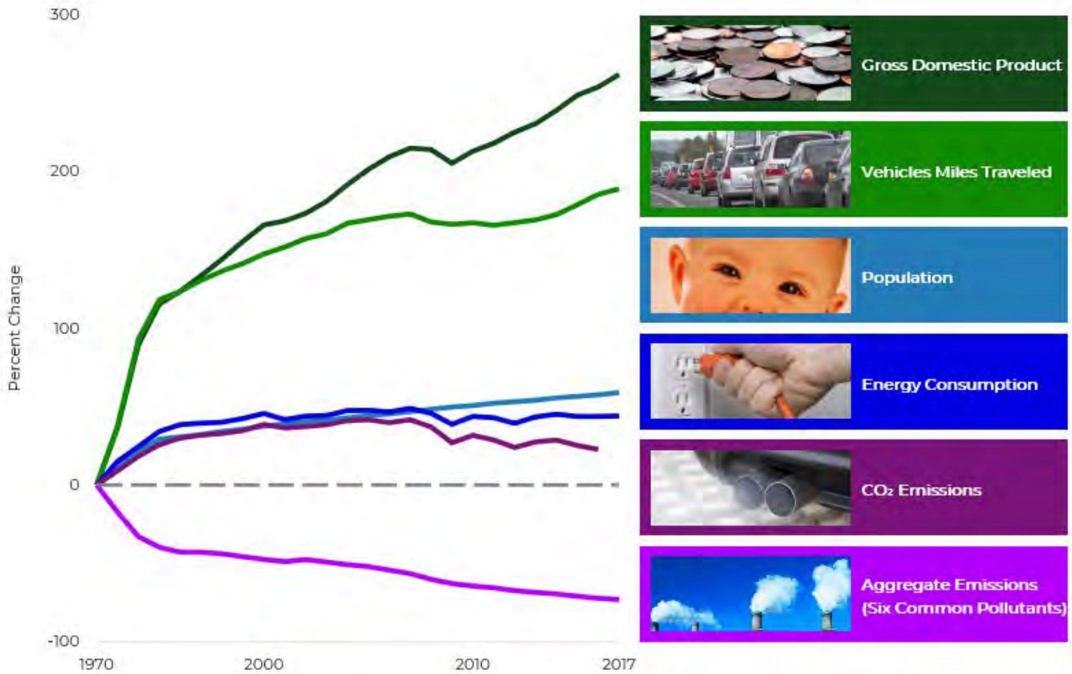

Figure 1-1: Comparison of Growth Areas and Declining Emissions, 1970-2017[15]

While emissions of pollutants declined over this period, there are still areas of the country where concentrations of air pollutants do not meet the National Ambient Air Quality Standards.[16]

1.4.2 National Emissions Inventory

EPA's estimates of national emissions also provide context for EPA's air pollution control programs. The National Emissions Inventory (NEI) is a comprehensive national inventory of emissions of both criteria and hazardous air toxic pollutants from 60 different emissions sectors, developed on a three-year cycle.[17]

The NEI data for 2014, the most recent year available, show that mobile sources account for about 7% of the emissions of both $PM_{2.5}$ and VOCs, and more than half of the NOx and CO emissions nationwide.

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[15] *Our Nation's Air*, found on EPA's website at: www.epa.gov/air-trends.

[16] EPA sets National Ambient Air Quality Standards for the pollutants ozone, carbon monoxide (CO), particulate matter of diameter less than or equal to 10 microns (PM_{10}), particulate matter of diameter less than or equal to 2.5 microns ($PM_{2.5}$), nitrogen dioxide (NO_2), lead, and SO_2. Ozone is not directly emitted, but forms in the atmosphere from volatile organic compounds (VOCs) and nitrogen oxides (NOx). For more information, see EPA's website at www.epa.gov/criteria-air-pollutants. For more information about areas not meeting National Ambient Air Quality Standards, see www.epa.gov/green-book.

[17] This information is based primarily upon data provided by state, local, and tribal air agencies for sources in their jurisdictions, and supplemented by data developed by EPA. The latest NEI available is for the year 2014. Information about the National Emissions Inventory can be found on EPA's website at: www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei.

Figure 1-2 shows the contribution of the various types of mobile sources to the mobile source part of the emissions inventory for these four pollutants. The pie charts are divided into the following categories:

- “Onroad” includes all vehicles built to operate on roadways, such as passenger cars and trucks, heavy-duty trucks, and motorcycles;[18]
- “Nonroad” includes vehicles and equipment used for construction and mining, agriculture, recreation, industry, lawn and garden, and logging;
- “Marine” refers to commercial marine vessels only; “Locomotive” and “Aircraft” are the other mobile sources represented.

[18] In this report, these sources are referred to as “highway” vehicles and engines.

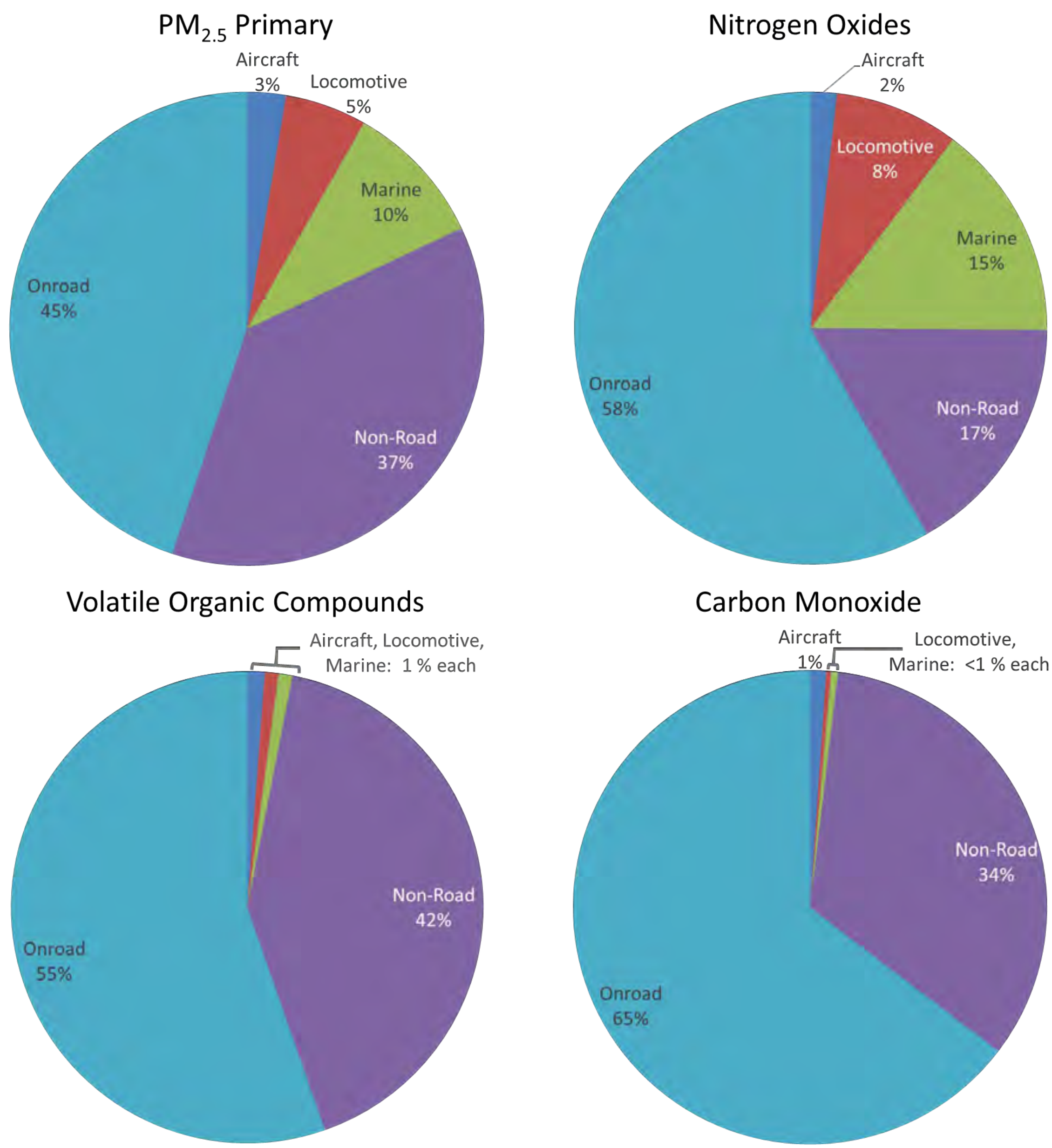

Figure 1-2: U.S. Mobile Source Emissions by Sector, 2014

In all four cases, the "Onroad" sector makes up the single largest percentage of the mobile source emission pie, followed by the "Nonroad" sector. "Marine," (i.e., commercial marine vessels), "Locomotive," and "Aircraft" make up the remainder. Mobile sources are significant contributors to total national emissions and are the dominant emissions sources in many individual urban areas. In addition, mobile sources contribute to higher localized levels of pollutants near roads and transportation facilities.

Mobile sources, which include highway vehicles and nonroad vehicles and equipment, are the dominant emissions sources in many individual urban areas.

EPA estimated that in 2009, more than 45 million people in the United States lived, worked, or attended school within 300 feet of a major road, airport, or railroad. Individually and in combination, many of the pollutants found near roadways have been associated with adverse health effects. [19] Highway and nonroad vehicles and engines are used by people as they go about their daily lives – at work, at home, in transit, and in recreation.

These facts emphasize the importance of EPA's transportation-related air quality programs. All mobile source sectors contribute to the national inventory of emissions. EPA OTAQ's compliance programs cover all these sectors, as described in the next sections of this report.

[19] More information is available at: www.epa.gov/air-research/near-roadway-air-pollution-and-health-frequent-questions

2. Overview of Compliance Programs and Processes

2.1 Background

EPA emissions regulations have a variety of testing and reporting obligations that enable EPA OTAQ to monitor compliance. The programs may apply to vehicles and engines before they are produced (preproduction), during production, and after they are in customer service (postproduction). EPA has the authority and flexibility to choose compliance strategies that best fit an industry sector at any given time. Factors that influence the use of a particular compliance approach include the regulatory requirements affecting a given industry sector, the technology being used to meet the emission standards, industry-specific production processes and cycles, and sector or manufacturer size.

However, another factor influencing EPA OTAQ's compliance approach emerged in the time period covered by this report. In 2015, Volkswagen admitted to equipping U.S. diesel passenger cars dating back to the 2009 model year with software designed to circumvent the emissions control system, sacrificing pollution control for other features important to the company. The deceit involved software that detected when vehicles were undergoing emissions testing and directed full activation of emission controls only during the test. During normal vehicle operation, the software switched off emission controls, allowing the cars to emit nitrogen oxides (NOx) at levels up to 40 times the standard.[20] This type of software is known as a "defeat device" because it defeats the purpose of the vehicles' emissions control systems.

In January 2016, the Department of Justice filed a complaint on behalf of EPA in federal court, alleging that Volkswagen violated the Clean Air Act. Since that time, the company has settled the lawsuit, agreeing to pay billions of dollars to repair or buy back affected vehicles, mitigate excess air pollution, and invest in electric vehicle infrastructure. Volkswagen also pleaded guilty to criminal action on the part of individuals. Volkswagen has paid $4.3 billion in civil and criminal penalties.

EPA is continually adapting and changing compliance programs to become less predictable.

EPA OTAQ is continuously evaluating how to assess and improve manufacturer compliance throughout the life of the vehicles and engines produced. As a result of the 2015 experience with Volkswagen, we recognized the need to again adapt and change our compliance programs to become less predictable. In September of 2015, we announced to manufacturers that our testing would include additional evaluations designed to detect potential defeat devices.

Given that vehicle and engine manufacturing occurs worldwide, EPA sends teams to manufacturing locations abroad, to test vehicles and engines coming off the assembly line. EPA also partners with other federal agencies, such as U.S. Customs and Border Protection, to leverage their activities to inspect vehicles and engines at the point these products enter the U.S.

EPA's mobile source compliance processes seek to ensure that the vehicles and engines are fully compliant with emissions standard throughout their full useful life, so EPA's testing programs and other

[20] More information can be found on EPA's website, at www.epa.gov/vw.

requirements are designed to cover the lifespan of vehicles and engines. Generally, EPA's mobile source compliance programs and activities can be divided into three periods:

- **Preproduction** activities include certification testing and reporting and other compliance processes conducted before vehicles and engines are produced.

  Production activities include audits and other compliance testing conducted on vehicles and engines coming off the production line, but before they enter customer service.

- **Postproduction or in-use** activities include in-use testing and reporting and other compliance processes conducted after vehicles and engines enter customer service.

Although compliance activities for the various mobile source sectors may differ in timing, they generally follow similar protocols. Figure 2-1 illustrates the compliance timeline for light-duty vehicles. As shown in the figure, there are compliance actions that occur preproduction, during production, and in-use at specific mileage points that represent the light-duty vehicle period of useful life.

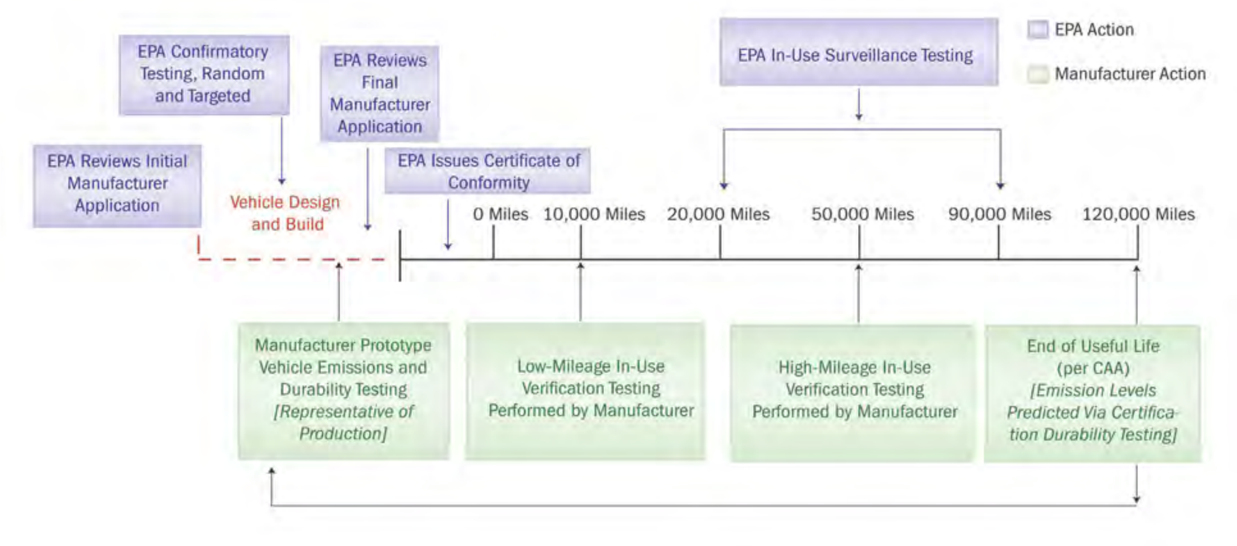

Figure 2-1: Compliance Schedule for Light-Duty Vehicles

Figure 2-2 shows a similar timeline for heavy-duty highway vehicles and nonroad engines. Note these vehicles and engines have a "useful life" defined in regulations, appropriate for the intended service class. For example, based on the regulations, useful life for heavy-duty highway engines is up to 435,000 miles, and for marine compression ignition engines it is up to 20,000 hours.[21]

[21] Note that the figure's End of Useful Life text is an example. End of Useful Life depends on engine type.

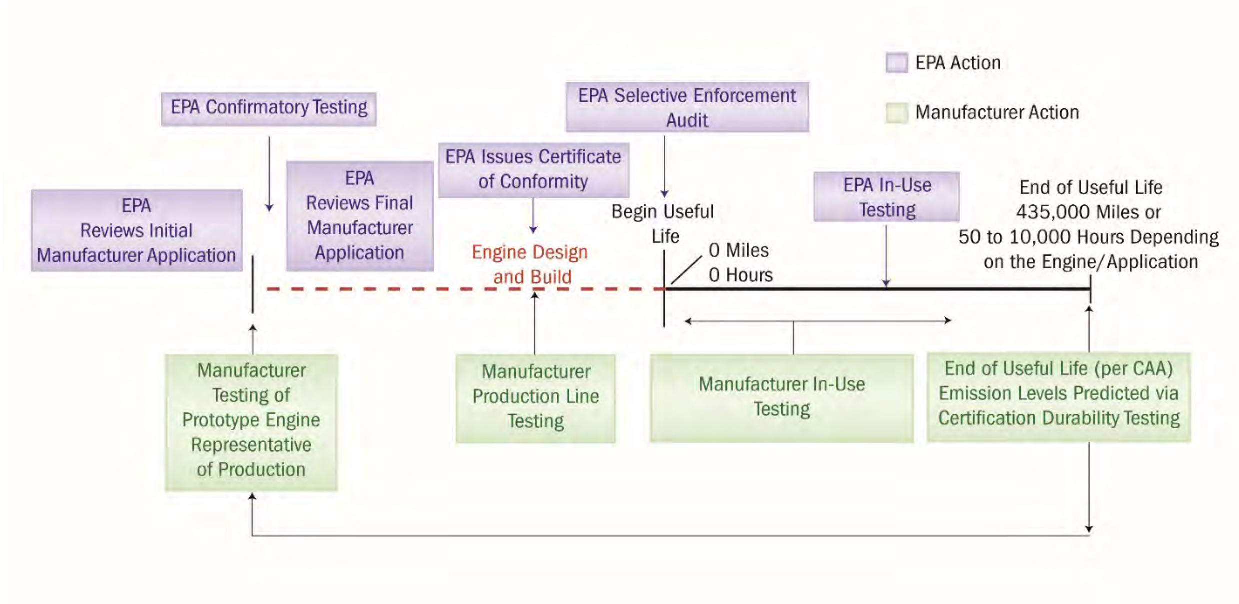

Figure 2-2: Compliance Schedule for Certain Heavy-Duty Highway and Nonroad Engines

2.1.1 Compliance Flexibility

EPA regulations typically give manufacturers some flexibility about how they will achieve emissions compliance. Examples include emissions standard phase-ins, averaging, banking and trading (ABT) programs and several types of exemptions. This regulatory flexibility enables manufacturers to align their business model with emissions requirements and sometimes allow manufacturers to earn credit for introducing new technologies early. At the same time, some regulatory flexibilities introduce challenges to compliance oversight because vehicles and engines subject to one regulation and set of standards may legally certify to different emissions levels. This report includes discussion of flexibility provisions and presents data showing how manufacturers are using them.

2.2 Preproduction Programs: Certificates of Conformity

Section 206 of the Clean Air Act requires all engines and vehicles to be covered by a Certificate of Conformity before they can enter commerce in the U.S. A Certificate of Conformity is a license to produce and sell products for one model year consistent with the vehicle description and any terms of the certificate. Every class of engines and vehicles introduced must have a Certificate of Conformity, and these certificates are generally issued to a group of vehicles or engines having similar design and emission characteristics. For light-duty vehicles, certificates are issued for each unique combination of exhaust test group and evaporative family.[22] For heavy-duty vehicles and nonroad equipment subject to engine standards, the unit of certification is called an engine family. Test groups and engine families may include multiple models. Conversely, different versions within a given model may be included in different engine families or test groups.

[22] An exhaust test group is a group of vehicle models with similar engines, drive trains, and emission control systems. It represents a group of vehicles or engines that have similar design and emission characteristics.

2.2.1 Application for Certification

The certification process begins when a manufacturer submits an application for certification to EPA. Applications cover an exhaust test group or engine family that represents a group of vehicles or engines having similar design and emission characteristics. EPA requires manufacturers to provide detailed information in the certification application to show that the vehicles or engines meet all the applicable emissions requirements, and to describe the vehicles or engines to be covered by the Certificate of Conformity. The certificate is a license to produce and sell the vehicle and covers only those vehicles or engines specifically described in the application. The list below generally describes the information and data that manufacturers must submit to begin the application process:

- A description of each test group/engine family, including the basic engine design and list of distinguishable configurations to be included in the test group/engine family;
- The production volumes for the U.S. of each configuration in the test group or engine family;
- A description of the test engine representing the test group or engine family;
- An explanation of how the emission control system operates;
- A description of the test procedures and equipment used to test the engine;
- The intended useful life of the family and emission deterioration characteristics over this useful life;
- Durability grouping (i.e., groups of vehicles/engines with similar emission deterioration and emission component durability);
- Durability test procedures;
- A description of vehicles used to demonstrate tailpipe emissions and emission control component durability;
- List of all test results, official certification levels, and the applicable emission standards for each vehicle/engine tested;
- Evaporative and On-Board Recovery Vapor Refueling (ORVR) system information (light-duty only);
- Information on emission control diagnostic systems (i.e., On-Board Diagnostics for applicable sectors);
- Manufacturer representative and official company contact information.

At the end of the application process, manufacturers must attest to a statement that the information in the application is accurate and complete.

2.2.2 Certificates Issued for Model Years 2014 – 2017

Table 2-1 shows the number of certificates that EPA issued in model years 2014 – 2017.[23]

[23] Certificates for portable fuel containers are not shown in this table. These certificates are unique in that they are valid for five years, rather than one. There were 12 valid certificates held by manufacturers in 2014; 19 in 2015; 21 in 2016, and 23 in 2017.

Table 2-1: Number of Certificates of Conformity, Model Years 2014 – 2017

Industry Sector	Category	MY 2014	MY 2015	MY 2016	MY 2017
Light-Duty Vehicles	Passenger cars and trucks	536	559	574	599
	Alternative fuel conversions[24]	147	131	204	195
Highway Motorcycles	On-highway motorcycles	289	289	293	299
Heavy-Duty Highway Engines	Compression ignition (diesel)	30	32	34	41
	Spark ignition (mostly gasoline)	10	14	12	15
	Tractors and vocational vehicles	66	97	103	126
	Alternative fuel conversions	31	31	25	22
	Evaporative emissions systems	10	13	12	18
Nonroad Compression Ignition Engines	Diesel powered equipment, such as tractors, generators, construction equipment, forklifts, welders	432	456	489	491
	Diesel boats and ships	148	177	172	193
	Oceangoing vessels per International Maritime Organization requirements	23	33	36	30
	Locomotives	108	121	146	151
Nonroad Spark Ignition Engines	Small SI: Small nonroad gasoline powered equipment, such as lawnmowers, string trimmers, chain saws, small compressors, pumps, utility vehicles < 25 mph, snow blowers, floor cleaners	900	956	944	972
	Marine SI: Gasoline boats and personal watercraft	169	189	172	178
	Large SI: Large nonroad gasoline powered equipment, such as forklifts, compressors, generators, and stationary equipment	194	208	210	226
	Evaporative components (mostly intended for small nonroad gasoline and marine gasoline equipment)	815	831	843	866
Recreational Vehicles	All-terrain vehicles/utility vehicles	197	205	206	232
	Off-highway motorcycles	49	53	47	49
	Snowmobiles	32	29	29	33
Total		**4186**	**4424**	**4551**	**4736**

[24] Conversion systems modify vehicles and engines so that they can run on different fuels than the ones for which they were originally designed. For more information, see EPA's website at: www.epa.gov/vehicle-and-engine-certification/vehicle-and-engine-alternative-fuel-conversions.

2.2.3 Increase in Certificates Issued

By requiring certificates for all vehicles and engines, EPA ensures that manufacturers in a sector meet the same requirements.

While it is typical for the number of certificates to fluctuate from year to year, the overall trend has been one of growth, as shown by the increasing number of certificates issued each model year from 2014 through 2017 in Table 2-1. This is a longer-term trend: for model year 1995, EPA issued a total of 810 Certificates of Conformity across all sectors; for model year 2000, EPA issued 2,520 certificates; for model year 2007, it was 3,641.[25] The total number of certificates EPA issued in model years 1995, 2000, and 2007 – 2017 is shown in Figure 2-3.[26] The dashed vertical line in the figure denotes a change in the x-axis scale (beginning with model year 2007, information is yearly).

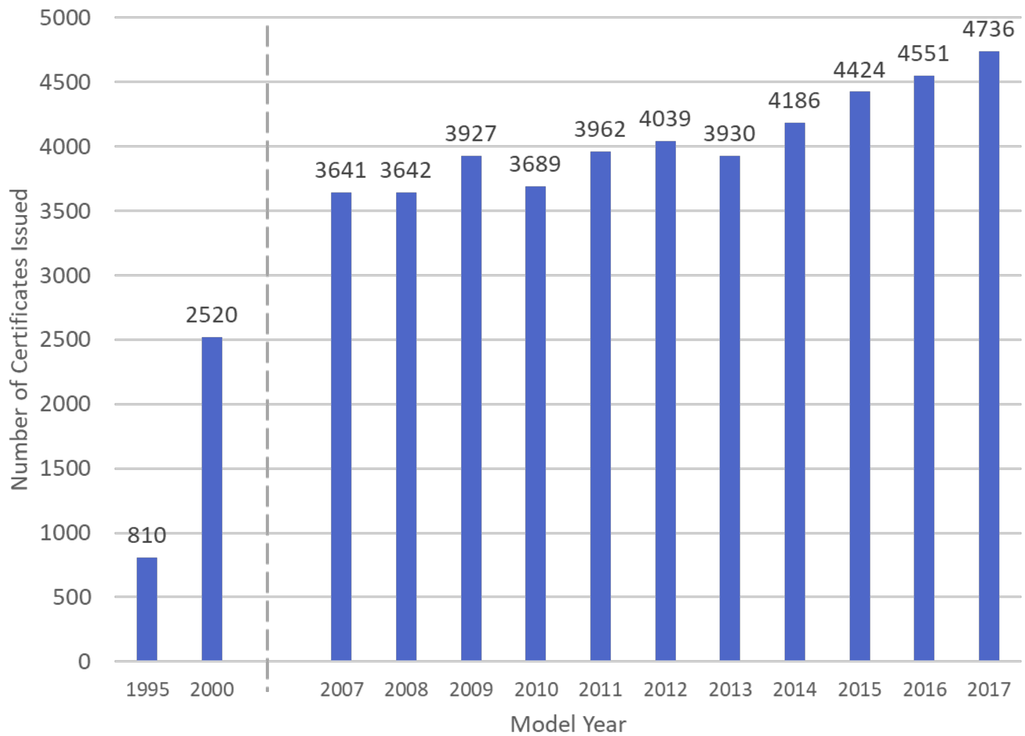

Figure 2-3: Total Number of Certificates Issued in Model Years Since 1995

The later sections of this report cover production volume for the U.S. of the various vehicle and engine types over model years 2014 – 2017. Regardless of how production volumes for the U.S. have changed, the variety of vehicles, engines, and components that EPA certifies continues to increase.

[25] The number of certificates for model years 2000 and 2007 come from the "2008 Progress Report, Vehicle and Engine Compliance Activities," EPA-420-R-10-022, which updated the total number of certificates for model year 2007. All of EPA's previous compliance reports can be found on EPA's website at: www.epa.gov/vehicle-and-engine-certification/compliance-activity-reports-vehicles-and-engines. The number of certificates in model year 1995 has not been included in a previous compliance report.

[26] This figure does not include certificates for portable fuel containers.

From model year 2007 to 2017, the number of certificates EPA has issued has increased from 3,641 to 4,736, an increase of 30%. Table 2-2 shows the number of model year 2007 certificates compared to the number of model year 2017 certificates by category, along with the difference and percent change from model year 2007. This table uses the category names from the 2007 and 2008 compliance activity reports; new categories since that time are in italics. These years are just a snapshot; not shown is the fluctuation in numbers of certificates for each category during the years in between.

Table 2-2: Comparison of Certificates Issued for Model Years 2007 and 2017

Industry Sector	Category Name	MY 2007	MY 2017	Change	Percent Change
Light-Duty Vehicles	Cars & Light Trucks	518	590	72	14%
	Light-Duty Vehicle Independent Commercial Importers	22	9	-13	-59%
	Light-Duty Alternative Fuel Conversions	--	195	195	
Highway Motorcycles	Motorcycles	418	299	-119	-28%
Heavy-Duty Highway Vehicles and Engines	Semi trucks and buses (diesel)	58	42	-16	-28%
	Semi trucks and buses (gasoline)	38	36	-2	-5%
	Heavy-Duty Alternative Fuel Conversions	--	0		
	Heavy-Duty Tractors and Vocational Vehicles	--	126		
	Heavy-Duty Engine Evaporatives	19	18	-1	-5%
Nonroad Compression Ignition Engines	Diesel Boats and Ships	117	193	76	65%
	Oceangoing vessels	31	30	-1	-3%
	Locomotives	60	151	91	152%
	Agricultural and Construction Equipment	676	491	-185	-27%
Nonroad Spark Ignition Engines	Lawn and Garden Equipment	1084	972	-112	-10%
	Gasoline Boats and Personal Watercraft	112	178	66	59%
	Forklifts, Generators, and Compressors	34	226	192	565%
	Nonroad Spark Ignition Evaporative Components	--	866	866	
Recreational Vehicles	All-Terrain Vehicles	309	232	-77	-25%
	Off-highway Motorcycles	106	49	-57	-54%
	Snowmobiles	37	33	-4	-11%
Total		**3639**	**4736**	**1097**	**30%**

As seen in the table, some sectors have remained relatively stable, such as oceangoing vessels, heavy-duty gasoline trucks and buses, and snowmobiles; some sectors show general increases over time such as light-duty vehicles; and in some sectors, there have been substantial changes. For example, the category of "forklifts, generators, and compressors" has increased more than five times. Also, since model year 2007, some new categories of certificates have been added to EPA's list:

- alternative fuel conversions, for both light-duty and heavy-duty vehicles (a new category as a result of a 2011 rulemaking for aftermarket system providers and installers);
- evaporative components for nonroad spark ignition engines (a 2008 regulation established new evaporative emissions standards); and
- heavy-duty tractors and vocational vehicles (a new category created in 2011 heavy-duty greenhouse gas rule; these were previously not regulated as complete vehicles).

2.2.4 EPA's Improved Data Collection System

EPA's "Engines and Vehicles – Compliance Information System," or EV-CIS, is a comprehensive system used to collect and verify data from manufacturers, which facilitates the issuance of Certificates of Conformity. As of 2015, the disparate systems of data collection that had evolved for the various vehicle and engine sectors were consolidated into this one umbrella system. EV-CIS allows vehicle and engine manufacturers to submit required data efficiently and securely, while also allowing EPA to share nonconfidential data with government partners such as the National Highway Traffic Safety Administration, as well as with other stakeholders.

EPA's EV-CIS data system includes built-in validation of manufacturer data, preventing errors. EV-CIS is an example of EPA's use of LEAN principles to achieve our mission more effectively.

EV-CIS covers a broad range of mobile source industries. It includes modules for 14 industries, each with its own unique regulatory requirements, as well as modules for implementing light-duty and heavy-duty greenhouse gas programs. The system captures more than 11,000 data elements submitted by manufacturers. The modular approach enables changes when EPA OTAQ needs to integrate new or revised rules into the system.

EV-CIS is not just an internal EPA improvement. The system includes built-in validation of certain manufacturer data, thus preventing errors in data entry and improving the process for everyone. EV-CIS is an example of EPA's use of LEAN principles to create efficient and effective systems, and EPA remains committed to continuous improvement.

2.2.5 Confirmatory Certification Testing

Manufacturers conduct the initial testing to support an application for a Certificate of Conformity and report the results to EPA. Subsequent certification testing, called confirmatory testing, occurs after an application has been submitted. Confirmatory tests are performed by either the manufacturer or by EPA and serve to validate the manufacturer's initial emissions or fuel economy test results.

2.3 Production Programs

The objective of compliance activities that occur during production is to confirm that vehicles and engines coming off production lines match specifications set forth in the Certificate of Conformity. In other words, production programs are designed to verify that manufacturers are producing the same vehicle or engine that they certified based on a preproduction prototype. Some mobile source regulations call for routine production line testing. EPA may also audit production vehicles and engines without prior notice, using selective enforcement audits. While EPA uses a variety of compliance tools as appropriate for specific industry sectors, the goal is the same across sectors: to ensure that vehicles and engines sold in the U.S. meet the emission standards.

2.3.1 Compliance Audits

An essential part of EPA OTAQ's compliance programs is the ability to inspect products and emission measurement processes in the field to validate that the regulated sectors comply with applicable emission standards. Assessing compliance in a comprehensive manner includes:

- Ensuring that products perform according to applicable emission standards;
- Ensuring that assembly processes result in products that are faithful to the Certificate of Conformity;
- Ensuring that emission measurements for submission to EPA conform to applicable standards and procedures;
- Ensuring that submitted records and reports are accurate, timely, and conform to regulatory requirements.

EPA OTAQ has a variety of field inspection tools that serve to validate the different facets of compliance described above, and because manufacturing occurs across the globe, EPA's compliance audits do as well. Compliance audits in the field are a useful tool for certain industry sectors. They are used less frequently in the light-duty vehicle industry, because other approaches are available to ensure that vehicles produced are meeting regulations. For example, both EPA and manufacturers implement confirmatory testing for light-duty vehicles, which involves testing pre-production vehicles and engines. Furthermore, both EPA and light-duty vehicle manufacturers conduct in-use compliance testing to monitor in-use vehicle emissions. However, in other sectors such as heavy-duty highway engines, nonroad spark ignition engines, recreational vehicles, and highway motorcycles, compliance audits conducted in the field play a greater role and are an important way for EPA to assess compliance.

Field inspection tools include the following:

- Records Inspection – An inspection to determine whether the records and reports comply with requirements of the Clean Air Act and associated regulations;
- Emission Laboratory Audit – An inspection to determine whether the equipment, calibration processes, and test procedures conform to applicable regulations, to ensure that the results reported to EPA are accurate and valid;

- Test Monitoring – An inspection where EPA personnel observe testing conducted under existing EPA programs such as Production Line Testing or In-Use Test Orders;
- Assembly Line Audit – An inspection to assess whether the assembly procedures will reliably result in a product that is materially the same as that for which a Certificate of Conformity was granted, that the product is properly labeled, and that the ultimate purchaser is provided with emission warranty terms and information on how to properly maintain and use the product;
- Selective Enforcement Audit (SEA) Test Orders – The most formal type of field audit where products are randomly selected, secured, and tested, according to a regulatory methodology and under EPA supervision. Manufacturers are required to test the products according to a test order to demonstrate that the product represented at the time of certification in fact conforms with applicable standards at the time of production. SEAs usually include other field inspection processes, such as records inspections and test lab audits.

The results of a compliance audit generally include feedback to a manufacturer on how to fully comply with regulatory requirements, including those that pertain to laboratory equipment standards, test procedures, records management, and reporting compliance.

EPA's world-wide compliance audits promote a level playing field among manufacturers.

From calendar years 2014 to 2017, EPA OTAQ's Compliance Division conducted 91 compliance audits across a variety of regulated sectors. The number of compliance audits done in each year is shown in Table 2-3.

Table 2-3: Number of EPA OTAQ Compliance Audits, 2014 – 2017

Type of Compliance Audit	2014	2015	2016	2017
Field Audits/Inspections	29	20	11	15
Selective Enforcement Audits (SEAs)	2	2	4	8
Total	31	22	15	23

EPA conducted compliance audits manufacturers on several continents, including North America, Europe, and Asia, as shown on the maps below. In its compliance audits, EPA found issues such as problematic emissions measurement software, noncompliant calibration and testing practices, missing records, use of test fuel that did not meet specifications, and others. Left uncorrected, these issues could result in EPA not accepting manufacturer's certification data. Thus manufacturers must correct these issues to obtain certificates for their products.

Of these 91 compliance audits, 16 were Selective Enforcement Audits (SEAs). For SEAs, a formal pass/fail determination is made at the end of the audit, based on the emission test results of the sampled products. In the period from 2014-2017, EPA suspended one SEA that began in 2013 and the manufacturer agreed to recall its products voluntarily. There were no failed audits among the 16 SEAs conducted from 2014-2017; however, there were testing and laboratory issues that manufacturers were required to correct.

The Agency exercises discretion when selecting families for compliance audits in the field, based on factors such as whether test results or other information suggest that emissions from a given family or industry sector are likely to exceed a standard or Family Emission Limit, production volume for the U.S., contribution to the inventory, and other compliance program data, such as the results of in-use testing. In addition to these factors, EPA incorporates a random selection component.

Locations of compliance audits are marked with a pin on the maps in Figures 2-4 through 2-6 below. A yellow or red shadow under a pin indicates multiple audits in that area. The darker the shadow, the greater the number of audits in that location. For example, in Southern California, 14 audits occurred in the 2014 – 2017 timeframe.

EPA's compliance presence promotes a level playing field across manufacturers and industries, and maximizes likelihood that the full measure of benefits that regulatory programs are expected to generate are in fact delivered to the public. EPA will continue to use compliance audits, including SEAs, to assess compliance wherever manufacturing occurs.

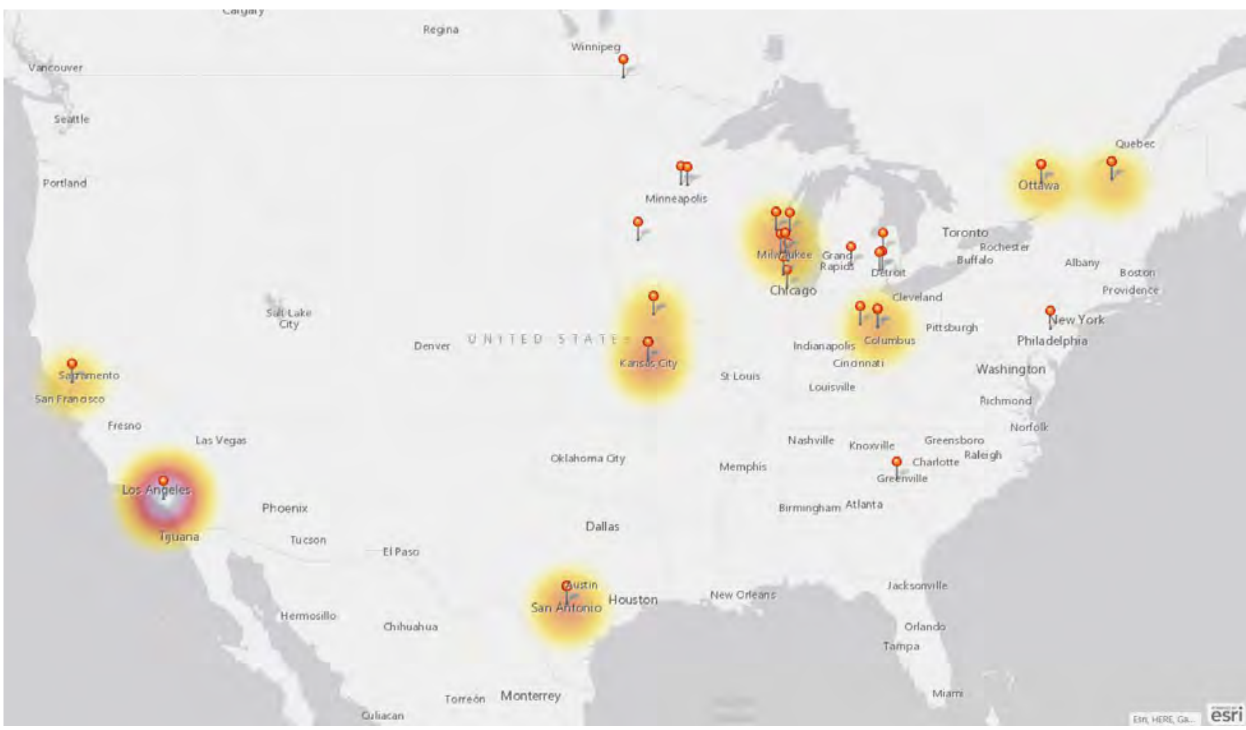

Figure 2-4: EPA OTAQ Compliance Audit Locations in North America, 2014 – 2017

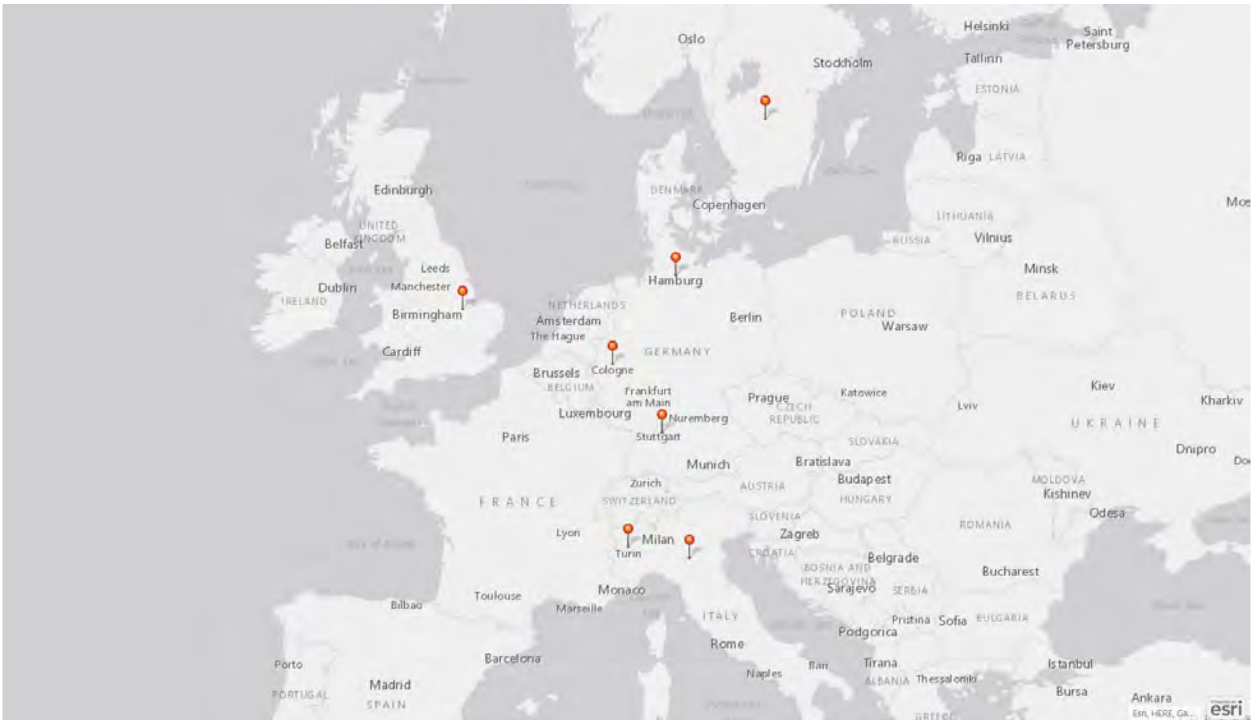

Figure 2-5: EPA OTAQ Compliance Audit Locations in Europe, 2014 – 2017

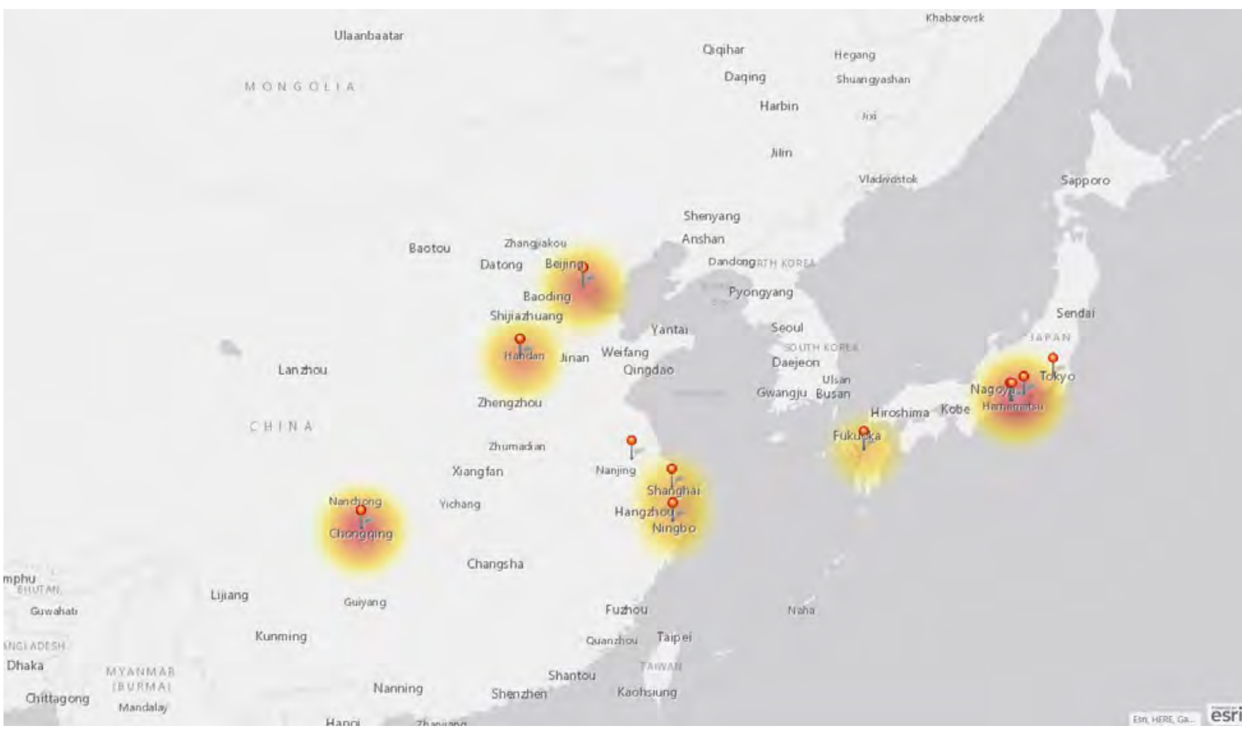

Figure 2-6: EPA OTAQ Compliance Audit Locations in Asia, 2014 – 2017

2.4 Postproduction Programs

2.4.1 In-Use Compliance Programs

In-use compliance programs track emissions performance of production vehicles and engines after they enter customer service. In-use testing programs are conducted by both EPA and manufacturers. (See Section 3.6, In-Use Compliance Testing.)

2.4.2 Defect Reporting Programs

Manufacturers are required to report emission-related defects to EPA. An emission-related defect is a defect in design, materials or workmanship in a device, system or assembly, as described in the approved application for certification. Manufacturers must include defects even if they do not increase emission levels. EPA regulations generally establish minimum numbers of confirmed defects that trigger defect reporting requirements. An emission-related defect can lead to a recall, but this does not happen in every case because some defects in emission-related parts do not increase emissions.

The next sections of this document cover defect reporting for the years 2014-2017. This information is summarized in Table 2-4 below.

Table 2-4: Defect Reports by Regulated Sector, 2014 -2017

Regulated Sector	2014	2015	2016	2017
Light-Duty Vehicles	199	273	228	284
Highway Motorcycles	0	3	4	5
Heavy-Duty Highway Vehicles and Engines	22	29	27	31
Nonroad Spark Ignition Engines	9	2	4	4
Recreational Vehicles	1	2	4	9

2.4.3 Recall Programs

An emissions recall entails action by a manufacturer to repair, adjust, or modify customer-owned vehicles to remedy an emission-related problem. The purpose of an emissions recall is to prevent excessive pollution from vehicles or engines that are already in customer service.

Vehicle and engine manufacturers are required to design and build their products to meet emission standards for the useful life of the vehicle or engine specified by law. Under Section 207(c)(1) of the Clean Air Act, if EPA determines that a substantial number of vehicles or engines in a category or class do not meet emission standards in actual use, even though they are properly maintained and used, EPA can require the manufacturer to recall and fix the affected vehicles and engines. EPA may use a variety of data sources, including EPA and manufacturer test results, to determine whether a recall is necessary. When an emissions recall occurs, the manufacturer must notify vehicle owners and provide instructions about how to have the vehicle repaired. Most recalls are initiated voluntarily by manufacturers once potential noncompliance is discovered; however, EPA also has the authority to order the manufacturer to recall and fix noncompliant vehicles or engines if the manufacturer declines to implement a voluntary recall.

Recall programs protect air quality by holding manufacturers responsible to fix defects in their products at no cost to consumers.

The next sections of this document cover recalls by sector for the years 2014-2017. This information is summarized in Table 2-5.

Table 2-5: Recall Reports and Affected Vehicles/Engines by Regulated Sector, 2014 – 2017

Regulated Sector	2014		2015		2016		2017	
	Recalls	Affected Vehicles	Recalls	Affected Vehicles	Recalls	Affected Vehicles	Recalls	Affected Vehicles
Light-Duty Vehicles	44	9,006,273	64	4,191,581	65	5,969,283	86	4,937,955
Highway Motorcycles	0	0	2	1,050	3	23,931	2	8,179
Heavy-Duty Highway Vehicles and Engines	12	149,392	6	338,453	9	755,553	6	41,752
Nonroad Spark Ignition Engines	2	21,502	0	0	3	9,362	3	4,171
Recreational Vehicles	2	20,016	1	244	1	800	5	90,551

The number of defects and recalls reported light-duty vehicles is greater than any other industry sector, because this industry differs from the others in terms of requirements, complexity of systems, and infrastructure of the industry. The light-duty sector has been regulated since the 1970s and the emission standards are the most stringent of any sector. As described earlier, light-duty manufacturers must conduct in-use testing, which allows them to identify defects issues in production, and EPA also conducts this type of testing. In addition, light-duty vehicles have the most sophisticated and complex emission control systems, including on-board diagnostic systems, that are integrated with other computer-controlled systems within a vehicle. Given this greater complexity, there is a greater opportunity for defects to occur. Finally, the light-duty vehicle sector has existing infrastructure, in the form of dealerships, that facilitates conveying information about defects and recalls to consumers, as well as implementing recalls and servicing vehicles. In other sectors, warranty tracking systems are not as developed, and many smaller certificate holders lack appropriate infrastructure for robust reporting. Therefore, defect and recall programs play a greater role in the light-duty industry, and as discussed in Section 2.3.1; compliance audits play a more important role in other industry sectors.

2.5 Regulatory Flexibility Programs

EPA builds flexibility into its emissions regulations to increase compliance efficiency, decrease costs, and encourage manufacturers to introduce new technologies.

2.5.1 Average Banking and Trading Programs

Average Banking and Trading (ABT) provisions allow manufacturers to meet an overall fleet average standard instead of an individual vehicle or engine standard. Manufacturers can use the ABT provisions by certifying some vehicles and engines at levels below the emission standard, thus generating positive credits that can be used to offset vehicles and engines with emissions above the standard. Compliance is determined by calculating the manufacturer's fleet-wide average of each exhaust test group's production or sales volume and emission level. The reconciliation generally occurs on an annual basis. The flexibility to meet fleet average emission standards by ABT credits can facilitate earlier introduction of clean technology into the market.

2.5.2 Transition Program for Equipment Manufacturers

The Transition Program for Equipment Manufacturers (TPEM) applies to land-based nonroad compression ignition (diesel) engines. A relatively small number of engine designs can be used in thousands of different products. When new emission standards take effect and engines are redesigned to achieve the required emission reductions, equipment powered by those engines may also need to be redesigned. The TPEM program recognizes this potential challenge by providing manufacturers a transition period. During the transition period, manufacturers may continue to use a limited number of engines meeting the previous standards while they update their product designs to accommodate redesigned engines that meet the new standards.

2.5.3 Small Volume Manufacturers

The regulations also allow for flexibility for "small-volume manufacturers" of vehicles, engines, and equipment in meeting some of the compliance requirements. For example, a small-volume manufacturer may use optional procedures to demonstrate compliance with general standards and specific emission requirements. The definition of small-volume manufacturer varies by sector, and is based on factors such as the number of units sold, the number of employees the manufacturer has, and the manufacturer's revenue in either the current or a baseline year. Table 2-6 below provides examples of these thresholds for the various sectors. The descriptions in this table are brief summaries of EPA regulations; please refer to the regulations themselves for the legal definitions.

Table 2-6: Small-Volume Manufacturer Thresholds

Industry Sector / Regulation	Regulation	Small-Volume Manufacturer Threshold
Light-Duty Vehicles	40 CFR 86.1838-01	5000 units with respect to the compliance with Tier 3 standards, and 15,000 units for all other requirements, or a manufacturer that qualifies as a small business under the Small Business Administration regulations.
Highway Motorcycles	40 CFR 86.410-2006	< 500 employees and producing < 3000 motorcycles per year for the U.S.
Heavy-Duty Highway Vehicles and Engines	40 CFR 1036.801 and 1037.801	HD on-highway engine/vehicle manufacturer: defined by limits on the total number of employees (< 1000 for engine manufacturers, < 1,500 for vehicle manufacturers) and total revenue.
Nonroad Compression Ignition Engines (Nonroad CI)	40 CFR 1039.801	Construction and agricultural equipment: ≤ 2500 units produced for the U.S. and ≤ 1000 employees.
	40 CFR 1042.901	Marine diesel boats and ships, oceangoing vessels: annual worldwide production of < 1,000 internal combustion engines of Category 1 and 2 (marine and nonmarine). Manufacturers of Category 3 engines are not small volume manufacturers.
	40 CFR 1033.901	Locomotives: ≤ 1,000 employees.
Nonroad Spark Ignition Engines (Nonroad SI)	40 CFR 1054.801	Small SI (lawnmowers, string trimmers, chain saws, small compressors, pumps, snow blowers): • Handheld engines/equipment: ≤ 25,000 units produced for the U.S. per year; • Non-handheld engines: ≤ 10,000 units produced for the U.S. per year; • Non-handheld equipment: ≤ 5000 units produced for the U.S. per year.
	40 CFR 1045.801	Marine SI (inboard and outboard motorboats, jet-skis) • Engines: ≤ 250 employees; • Vessels: ≤ 500 employees.
	40 CFR 1048.801	Large SI (forklifts, large compressors, generators): ≤ 2000 units produced for the U.S. per year or with < 200 employees.
Recreational Vehicles	40 CFR 1051.801	All-terrain vehicles (ATVs) and off-highway motorcycles: ≤ 5000 off-highway motorcycles and ATVs per year produced for the U.S.
	40 CFR 1051.801	Snowmobiles: U.S. production of ≤ 300.

2.5.4 Exemption Programs

Some vehicles and engines imported into the United States are eligible for an exemption from federal emission requirements. For example, vehicles belonging to military personnel or nonresidents may be eligible for exemption, and vehicles imported for testing or display may also be exempt. Depending on the type of exemption, importers must request written EPA approval in advance. EPA works with the U.S. Customs and Border Protection to ensure that proper approvals have been issued before vehicles and engines may enter the United States. An exemption may cover multiple vehicles and/or engines.

Table 2-7 below shows the number of import exemptions for the categories of light-duty vehicles, heavy-duty vehicles and nonroad engines and equipment, highway motorcycles, and recreational vehicles in the years 2014 – 2017, by exemption type. Note that this information is generally limited to those exemptions requiring EPA approval.

Table 2-7: Import Exemptions by Type, Calendar Years 2014 – 2017

Import Exemption Type	2014	2015	2016	2017
Returning Military Service Personnel	634	599	616	544
Non Resident	579	724	701	688
Repair/Alteration	124	164	160	194
Testing	238	205	309	408
Display	45	57	68	62
Racing	349	343	474	484
Competition	94	138	152	162
Total	**2063**	**2230**	**2480**	**2542**

Figure 2-7 displays this same information in a bar chart.[27]

[27] "Military" in this figure refers to exemptions for returning military service personnel.

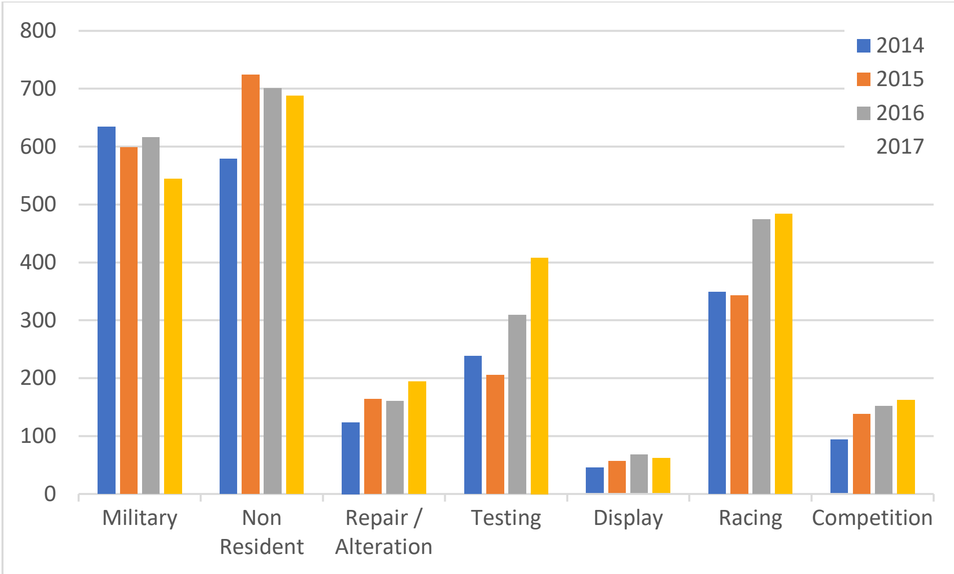

Figure 2-7: Import Exemptions by Type, 2014-2017

In calendar years 2014 through 2017, EPA issued a total of 9,315 import exemptions: 6,328 for light-duty vehicles, 787 for heavy-duty and nonroad engines or equipment, and 2,200 for highway motorcycles and recreational vehicles (ATVs, off-highway motorcycles, and snowmobiles). Figure 2-8 illustrates import exemptions by sector, and shows that more than two thirds of the total import exemptions were for light-duty vehicles in these years. About a quarter were either for motorcycles or recreational vehicles. Heavy-duty and nonroad engines and equipment comprised the remainder.

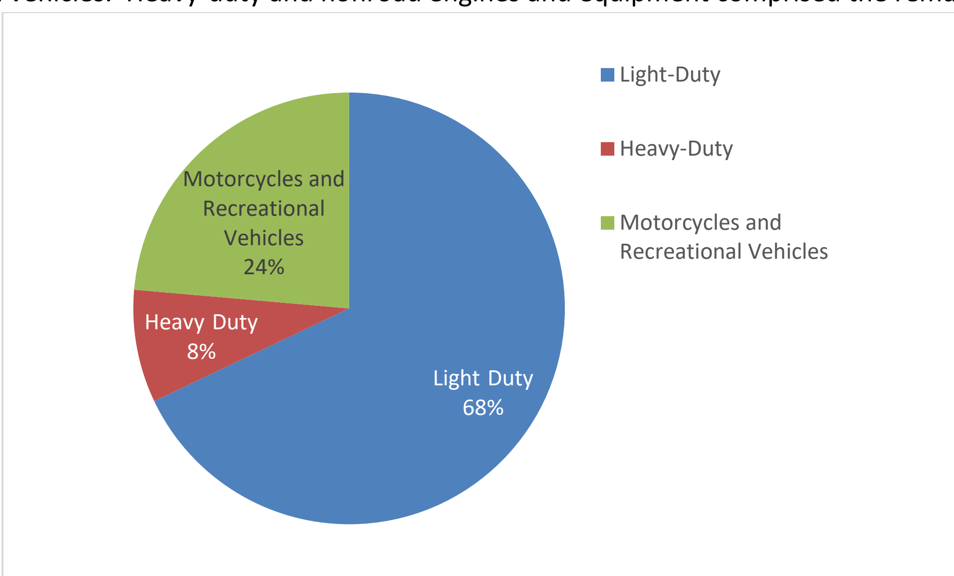

Figure 2-8: Import Exemptions by Sector, Combined for Years 2014 – 2017

2.6 Enhanced Compliance Oversight as a Result of Volkswagen Clean Air Act Violations

As this compliance report covers model years 2014-2017 as well as compliance actions taken in calendar years 2014-2017, it would not be complete without mention of Volkswagen diesel vehicle Clean Air Act violations. Volkswagen, Audi, and Porsche (collectively, "Volkswagen" in this section), equipped their model year 2009 – 2016 diesel passenger vehicles with software that enabled cars to pass emissions tests, but exceed pollution standards during normal vehicle operation.

EPA has since resolved a civil enforcement case against Volkswagen, subject to three partial settlements. These settlements resolve allegations that Volkswagen violated the Clean Air Act by the sale of approximately 590,000 model year 2009 to 2016 diesel motor vehicles equipped with "defeat devices" in the form of computer software designed to cheat on federal emissions tests. The major excess pollutant at issue in this case is NOx, which causes serious health concerns. Volkswagen has also pleaded guilty to criminal felony counts and has paid $4.3 billion in civil and criminal penalties.[28]

Volkswagen installed software on certain diesel vehicles that is designed to detect when the vehicle is undergoing emissions testing and turns full emissions controls on only during the test. The effectiveness of emissions control devices is reduced during all normal driving. This results in cars that meet emissions standards in the laboratory or testing station, but during normal operation, emit NOx at levels up to 40 times the standard. This software is a "defeat device" that is prohibited under the Clean Air Act.[29] Affected vehicles included both 2.0 liter and 3.0 liter diesel light duty vehicles, as shown in Table 2-8.

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[28] For additional information, see EPA's website at: www.epa.gov/vw and www.epa.gov/enforcement/volkswagen-clean-air-act-civil-settlement

[29] Section 203(a)(3)(b) of the Clean Air Act, 42 U.S.C. Sec. 7522(a)(3)(b), prohibits the manufacture, selling, or installation of any device that intentionally circumvents EPA emission standards by bypassing, defeating, or rendering inoperative a required element of the vehicle's emissions control system.

Table 2-8: Volkswagen Light-Duty Diesel Vehicles and Model Years Affected by the Defeat Device

Vehicle Model	Model Years
2.0 Liter Diesel	
Jetta	2009 – 2015
Jetta Sportwagen	2009 – 2014
Beetle	2013 – 2015
Beetle Convertible	2013 – 2015
Audi A3	2010 – 2015
Golf	2010 – 2015
Golf Sportwagen	2015
Passat	2012 – 2015
3.0 Liter Diesel	
Volkswagen Touareg	2009 – 2016
Porsche Cayenne	2013 – 2016
Audi A6 Quattro	2014 – 2016
Audi A6 Quattro	2014 – 2016
Audi A8	2014 – 2016
Audi A8L	2014 – 2016
Audi Q5	2014 – 2016
Audi A7	2009 – 2016

The Volkswagen defeat device case highlights the need for EPA's active and visible presence in monitoring compliance with emissions standards. As described throughout Section 2 of this report, EPA employs a rigorous, multi-layer process to test and certify new vehicle models before they can be sold, and for testing vehicles that are in production and on the road. As technologies evolve and circumstances change, EPA continuously considers ways to improve compliance and oversight programs. Over the past 45 years, EPA's oversight and testing program has developed new tools and new techniques to adapt to technology advances, to achieve the agency's mission of protecting public health and the environment.

EPA continuously develops new compliance tools and techniques to achieve the Agency's mission: protecting public health and the environment.

EPA's testing and oversight includes standard and non-standard laboratory testing using dynamometers and on-road testing in real-world conditions. Both are necessary as part of an active robust program. This provides a multi-layered oversight approach focused on:

- Testing both pre-production prototypes and production vehicles on the dynamometer, which provides accurate, reliable and repeatable measurements that can be used to compare against the standard, and across vehicle types;
- On-road testing using portable emissions measurement systems (PEMS) that measure emissions during real world driving situations;

- Laboratory audits ensuring that manufacturer, contract, and other test labs conform to testing protocols and data quality standards, so the data EPA gets from these sources meet standards and that results can be compared among labs; and
- Holding manufacturers accountable for their actions through rigorous enforcement of the Clean Air Act, which provides a strong deterrence against cheating and helps maintain a level playing field for the vast majority of automakers that comply with laws and regulations fairly.

A strong oversight and compliance program is critical to ensure that the clean air standards that EPA OTAQ sets for vehicles to protect public health actually result in the emissions reductions anticipated. EPA OTAQ will continue to adapt and improve — as we have before — to ensure we deliver on the Agency's mission.

3. Light-Duty Vehicles

Light-duty vehicles include passenger vehicles such as cars, vans, SUVs, and light trucks. This sector has been subject to increasingly stringent emissions and fuel economy standards since the 1970s. The most recent emissions standards in effect are the Tier 3 vehicle and fuel standards, which EPA adopted in 2014 and which took effect in 2017. The Tier 3 standards reduce NOx, VOC, $PM_{2.5}$, and air toxics.

3.1 Certification

EPA issued more than 500 certificates to light-duty vehicle original equipment manufacturers (OEMs) for each model year 2014 through 2017, almost reaching 600 in model year 2017. EPA also issued between 131 and 195 certificates for alternative fuel conversions systems for these model years, as shown below in Table 3-1. More information about these systems is found in Section 9.1 of this document.

Table 3-1: Light-Duty Vehicle Sector Certificates of Conformity, Model Years 2014 -2017

Category	MY 2014	MY 2015	MY 2016	MY 2017
Passenger cars and trucks	536	559	574	599
Alternative fuel conversions[30]	147	131	204	195

There were 36 manufacturers (OEMs) that received light-duty vehicle certificates for one or more of these model years. For light-duty vehicles, certificates are issued for each unique combination of test group and evaporative family. Figure 3-1 shows the number of certified light-duty vehicle test groups for model year 2014-2017 by manufacturer. A test group can include multiple models, and in some cases a test group includes both car and truck models. The manufacturers with a smaller number of test groups in each of these figures are grouped together as “Other,” (21 manufacturers).[31]

[30] Conversion systems modify vehicles and engines so that they can run on different fuels than the ones for which they were originally designed. For more information, see EPA’s website at: www.epa.gov/vehicle-and-engine-certification/vehicle-and-engine-alternative-fuel-conversions.

[31] Some of these manufacturers did not certify vehicles in every model year.

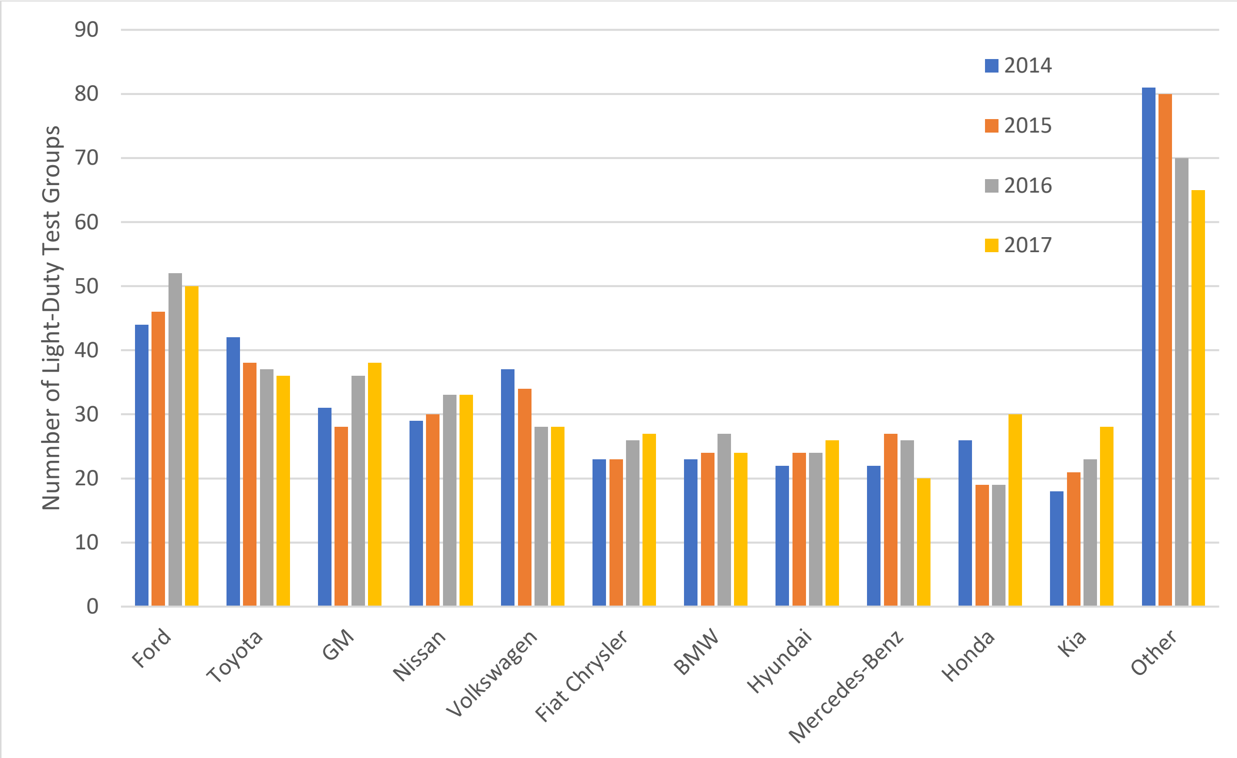

Figure 3-1: Light-Duty Vehicle Test Groups by Manufacturer, Model Year 2014-2017

3.2 Production Volume

The total production volume of model year 2014 -2017 cars and light-duty trucks for the U.S. is presented in Table 3-2 and Figure 3-2 below. As seen in both the table and the figure, the annual production volume of cars has remained around 9 million over this timeframe, while production of trucks has been steadily increasing and is approaching the production volume of cars.[32]

Table 3-2: Light-Duty Vehicle Production Volume of Cars and Trucks for the U.S., Model Years 2014 - 2017

Vehicle Type	MY 2014	MY 2015	MY 2016	MY 2017
Car	9,209,352	9,602,428	9,002,444	8,939,040
Truck	6,304,986	7,138,461	7,277,467	8,072,414
Total Light-Duty	15,514,338	16,740,889	16,279,911	17,011,454

[32] These broad categories of car and light-duty truck can be further disaggregated into vehicle types of sedan/wagon, car SUV, truck SUV, pickup truck, and minivan/van. The first two types, sedan/wagon and car SUV comprise "cars;" the remaining are considered light-duty trucks. Car SUVs are generally smaller two-wheel drive vehicles, while truck SUVs are larger or four-wheel drive vehicles. Further information about market share of these vehicle types can be found in EPA's latest *Automotive Trends Report*, found on EPA's website at: www.epa.gov/automotive-trends

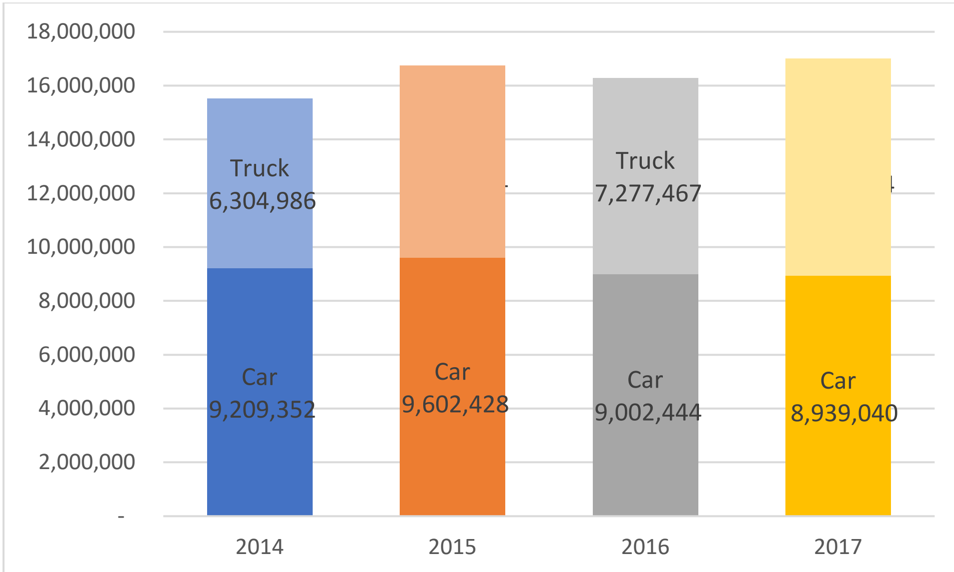

Figure 3-2: Light-Duty Vehicle Production Volume for the U.S., Model Year 2014 - 2017

Figure 3-3 presents the number of model year 2014-2017 cars produced for sale in the U.S. by manufacturer. Manufacturers with smaller production volumes in these figures are grouped together as "Other" (19 manufacturers).

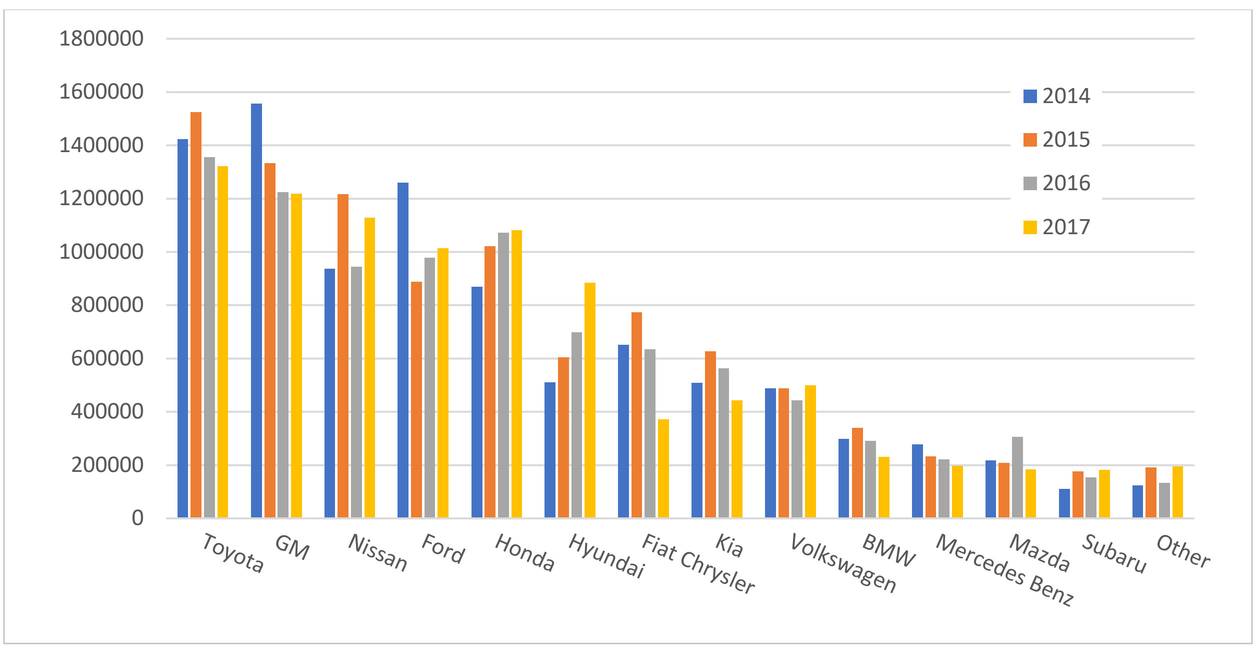

Figure 3-3: Car Production Volume by Manufacturer, Model Years 2014-2017

A comparison of Figure 3-1 and Figure 3-3 shows that the manufacturer that certifies the largest number of car test groups does not necessarily produce the most cars. Light-duty truck production volumes are shown in Figure 3-4, and again, the manufacturer that certifies the largest number of light-duty truck test groups is not necessarily producing the most light-duty trucks. (In this figure, "Other" includes 15 manufacturers.)

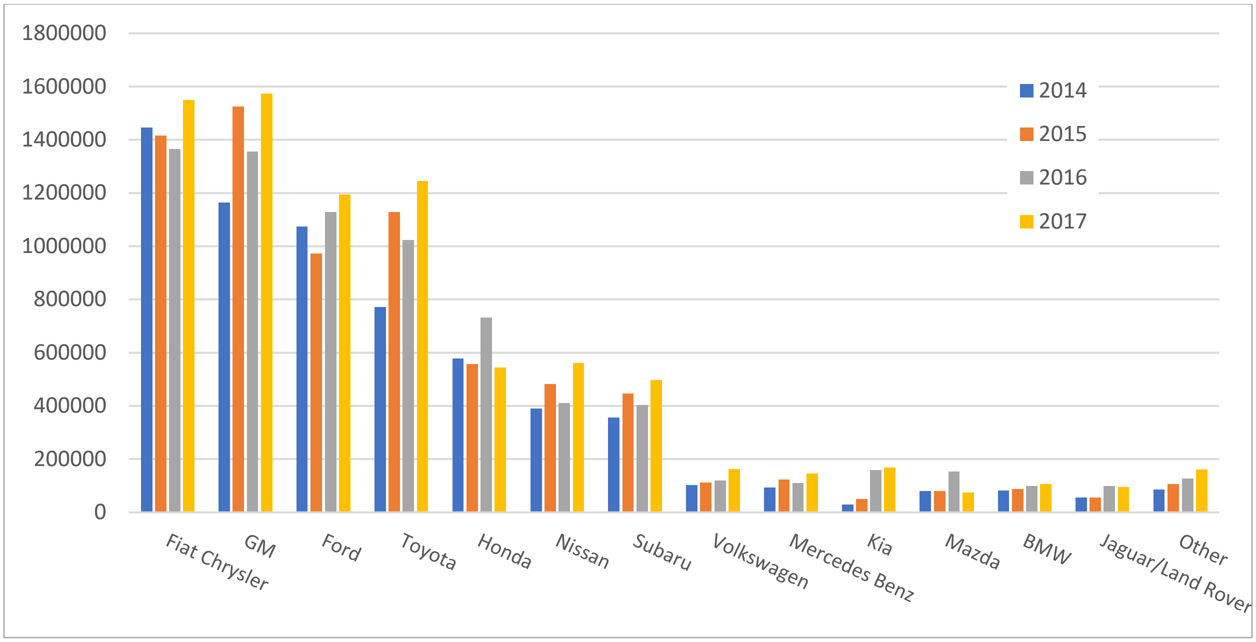

Figure 3-4: Light-Duty Truck Production Volume by Manufacturer, Model Years 2014 - 2017

In contrast to Figure 3-3 and Figure 3-4, which show production volumes for cars and light-duty trucks separately, Figure 3-5 shows the combined production volume of cars and light-duty trucks by manufacturer for just one model year, 2017. Again, manufacturers with smaller production volumes in these figures are grouped together as "Other."

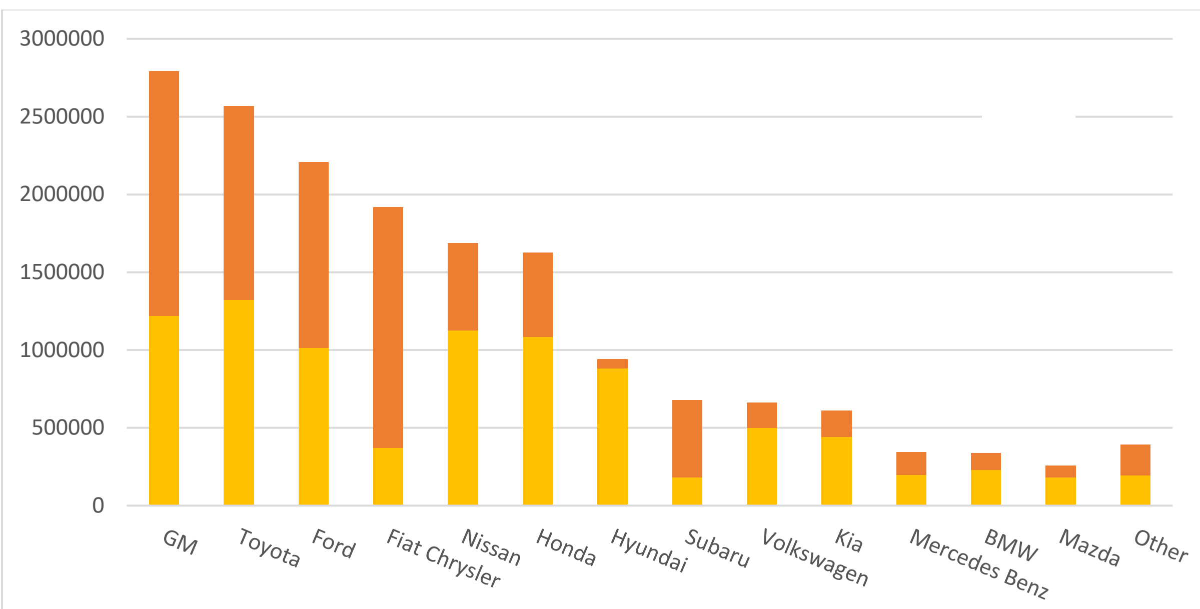

Figure 3-5: Overall Light-Duty Vehicle Production Volume by Manufacturer, Model Year 2017

3.3 Confirmatory Testing

EPA and manufacturers test pre-production vehicles (i.e., prior to their introduction into commerce) to confirm initial manufacturer emission test results. The confirmatory test results become the official certification test results, whether the confirmatory testing is performed by the manufacturer or by EPA. When a vehicle fails a confirmatory test, the manufacturer is allowed one retest to confirm or refute the failure. If the vehicle passes on retest, the retest is deemed the official certification test and the results from the retest stand as the official emission levels for that vehicle. Sometimes a confirmatory test failure can be attributed to problems that render the test vehicle unrepresentative of production vehicles. In those situations, the manufacturer corrects the problem in the test vehicle and retests. In other cases, failures over the confirmatory test reflect actual engineering problems. These types of failures usually result in manufacturer action to change the vehicle calibration and update the certification application accordingly, resulting in a quantifiable emissions reduction for the vehicles that are ultimately produced. Regardless of whether a confirmatory test failure is due to problems with the test vehicle or problems with the calibration, the manufacturer must correct problems and the vehicle must pass confirmatory testing before EPA will issue a certificate.

3.4 Fuel Economy Testing

EPA and manufacturers perform confirmatory testing for both emissions and fuel economy validation. Fuel economy test results are the source for information that appears on new vehicle fuel economy labels and that EPA and the U.S. Department of Transportation's National Highway Safety Administration (NHTSA) use to assess compliance with corporate average fuel economy (CAFE) and GHG standards.

The national program for greenhouse gas emissions (GHG) and fuel economy standards for light-duty vehicles was developed jointly by EPA and NHTSA. The greenhouse gas and fuel economy standards apply to passenger cars, light-duty trucks and medium-duty passenger vehicles, and were established in two phases:

- Phase 1, covering model years 2012 through 2016; and
- Phase 2, covering model years 2017-2025.

EPA continues to work with manufacturers to implement these regulations. As part of the 2012 rulemaking establishing the 2017-2025 standards, EPA made a regulatory commitment to conduct a "midterm evaluation" of the longer-term standards for model years 2022-2025. Following conclusion of the mid-term evaluation, on August 24, 2018 NHTSA and EPA proposed to amend the Corporate Average Fuel Economy (CAFE) and greenhouse gas emissions standards for passenger cars and light trucks and establish new standards, covering model years 2021 through 2026. The public comment period for this proposal closed on October 23, 2018.[33]

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[33] For additional information, please see EPA's website at: www.epa.gov/regulations-emissions-vehicles-and-engines/safer-and-affordable-fuel-efficient-vehicles-proposed.

EPA reports fuel economy test data in an annual Automotive Trends Report, which includes both laboratory test value results and results adjusted for real-world driving conditions. [34] The Automotive Trends Report also includes a section on manufacturer GHG compliance for model years through 2017.

3.5 Durability Testing

The Clean Air Act requires that EPA emission standards apply for the full useful life of the vehicle. Since emissions may degrade as vehicles age and accrue miles, manufacturers must perform durability testing prior to certification to demonstrate that a vehicle will remain compliant for its full useful life, despite any deterioration that may occur over time or distance. EPA regulations establish processes by which manufacturers may demonstrate durability using standard or custom methods. Manufacturers that use their own durability aging procedures must provide EPA with an "equivalency factor" that enables comparison between the proprietary method and EPA's published, standard method. This allows a third party that relies on the EPA method to replicate the manufacturer's method.

EPA has a variety of compliance tools and tests for light-duty vehicles, covering pre-production, production, and post-production time periods.

3.6 In-Use Compliance Testing

Both EPA and manufacturers conduct testing to monitor in-use vehicle emissions. EPA conducts in-use vehicle surveillance testing at the National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan. The purpose of the EPA surveillance program is to assess emissions performance a few years after vehicles enter the fleet. EPA typically recruits two- or three-year-old vehicles from volunteers in southeast Michigan. EPA selects vehicles for surveillance both randomly and based on consideration of certification data, manufacturer in-use verification data, vehicle production volume, new technology, and public complaints and inquiries. Generally, EPA tests three vehicles per class. A class is a vehicle model or group of similar models from a given manufacturer. If any of the initial vehicles within a class fails a test, EPA recruits additional vehicles from that class for follow-up testing to determine whether an emissions problem is likely to exist and is not an artifact of the small sample size (or even a single defective vehicle).

EPA also conducts an in-use confirmatory testing program for vehicle classes that merit closer scrutiny. These classes may be identified through failures in either EPA in-use surveillance or manufacturer in-use testing programs.

Table 3-3 shows the vehicle classes selected for EPA surveillance testing in calendar years 2014 – 2017, by model year, manufacturer, and model, as well as the vehicles selected for confirmatory testing in this timeframe. Note that some of the classes selected include more than one model, and where that is the case, all the models are listed in the third column of this table.

[34] See EPA's website at: www.epa.gov/automotive-trends.

Table 3-3: Vehicle Classes Tested in EPA's In-Use Testing Program, Calendar Years 2014-2017

Model Year	Manufacturer	Model
Surveillance Vehicles		
2008	General Motors	GMC Canyon, Chevrolet Colorado
	General Motors	Saturn Outlook, Buick Enclave, GMC Acadia
	General Motors	Pontiac G6, Chevy Malibu, Saturn Aura
2009	Ford	F150
2010	Ford	Escape
	General Motors	Chevrolet Equinox
	Toyota	Matrix, Scion xB
2011	Ford	Escape
	Ford	F150 FFV
	General Motors	Buick Lucerne, Chevy Impala
	Hyundai	Tucson
	Mitsubishi	Outlander
2012	Audi	A5, A5 Quattro
	BMW	528i
	Chrysler	Fiat 500
	Chrysler	200, Dodge Avenger
	Chrysler	Dodge Grand Caravan
	Ford	Fiesta
	Ford	Mustang
	Ford	Focus
	Ford	F250 Diesel
	Ford	Focus
	General Motors	Buick Lacrosse, Chevy Impala
	General Motors	GMC Yukon/Sierra, Chevrolet Silverado/Tahoe
	General Motors	Chevrolet Cruze
	Honda	CRV
	Hyundai	Sonata
	Kia	Forte
	Kia	Sorento
	Kia	Soul
	Mazda	Mazda5
	Mazda	Mazda3
	Mercedes Benz	C 250, SLK 250
	Mitsubishi	Outlander
	Nissan	Altima, Rogue
	Nissan	Infinity G37, M37
	Nissan	Versa
	Subaru	Forester, Impreza

Model Year	Manufacturer	Model
	Toyota	Scion XB
	Toyota	Camry
	Toyota	Tacoma
	Volkswagen	Beetle, Golf, Jetta, Passat
	Volvo	S60
2013	Audi	A6 Quattro, A6
	BMW	X5
	Chrysler	Dodge Challenger
	Chrysler	Dodge Dart
	Chrysler	Dodge Ram
	Chrysler	300, Dodge Charger
	Ford	Escape
	Ford	F150
	Ford	Fusion Hybrid, C-Max Hybrid
	Ford	Transit Connect
	General Motors	Cadillac ATS
	General Motors	Chevrolet Equinox
	General Motors	Chevrolet Silverado
	General Motors	Chevrolet Malibu
	Honda	Accord
	Honda	Fit
	Hyundai	Elantra
	Kia	Optima
	Land Rover	Evoque
	Mazda	Mazda3
	Mercedes Benz	GLK350
	Mitsubishi	Outlander
	Porsche	Cayenne
	Subaru Fuji	Forester, Outlook
	Subaru Fuji	Scion FR-S, Subaru BRZ
	Toyota	Corolla
	Toyota	Prius C
	Toyota	Venza, Lexus RX 350
	Volkswagen	Beetle, Golf, Jetta, Passat, Sportwagen
2014	Audi	A4/A5 Quattro
	BMW	Mini Cooper, Countryman, x3, x83
	Chrysler	Dodge Dart, Fiat 500
	Chrysler	Dodge Ram 1500
	Chrysler	Dodge Durango, Jeep Grand Cherokee
	Chrysler	Jeep Compass, Jeep Patriot
	Ford	Flex

Model Year	Manufacturer	Model
	Ford	Fusion
	General Motors	Buick Encore, Chevrolet Traverse, GMC Enclave
	General Motors	Chevrolet Captiva/Equinox, GMC Terrain
	General Motors	Chevrolet Cruze/Malibu
	General Motors	Chevrolet Silverado
	Honda	Civic
	Honda	CRV
	Honda	Odyssey
	Hyundai	Santa Fe, Santa Fe Sport
	Hyundai	Sonata
	Jaguar/Land Rover	Range Rover FFV
	Kia	Sorento
	Kia	Soul
	Mazda	Mazda 6
	Mitsubishi	Mirage
	Nissan	Frontier
	Nissan	Murano
	Toyota	Camry
	Toyota	4 Runner
	Volvo	S60
	Volkswagen	Tiguan
2015	BMW	328i
	FCA	Chrysler Town & Country
	FCA	Dodge Durango, Jeep Grand Cherokee
	FCA	Chrysler 200
	Ford	Focus FFV
	Ford	Fusion, Lincoln MKZ Hybrid
	Ford	F150
	General Motors	Buick LaCrosse, Chevrolet Impala/Cruze
	General Motors	Chevrolet Silverado
	Honda	Accord
	Honda	Acura TLX
	Hyundai	Elantra
	KIA	Sorrento
	Mazda	CX5, CR-5
	Mitsubishi	Outlander, Outlander Sport
	Nissan	Sentra
	Nissan	Versa
	Subaru	Outback
	Toyota	Avalon, Camry, Rav4; Lexus ES350
	Toyota	Sequoia, Tundra

Model Year	Manufacturer	Model
	Volkswagen	Jetta
	Volvo	S60
Confirmatory Vehicles		
2008	General Motors	Cadillac Escalade, GMC Yukon
2009	General Motors	Chevrolet Equinox, Pontiac Torrent
2011	General Motors	Chevrolet Cruze
2012	Honda	Pilot
2013	Chrysler	Chrysler 300, Dodge Challenger, Dodge Charger
2013	Chrysler	Dodge Ram

In addition to its own in-use testing, EPA uses data from the mandatory manufacturer run In-Use Verification Program (IUVP) to monitor in-use light-duty vehicle emissions performance. Manufacturers recruit IUVP vehicles from private citizens across the United States. The vehicles are minimally screened for safety and tampering. The IUVP tests are required at low mileage (between 10,000 and 50,000 miles) and high mileage (greater than 50,000 miles). Manufacturers must complete low mileage IUVP testing one year after the end of production and complete high mileage IUVP testing five years after the end of production, and must report their IUVP data to EPA on a pre-determined schedule. Figure 3-6 shows a sample IUVP test schedule for a model year 2017 vehicle.

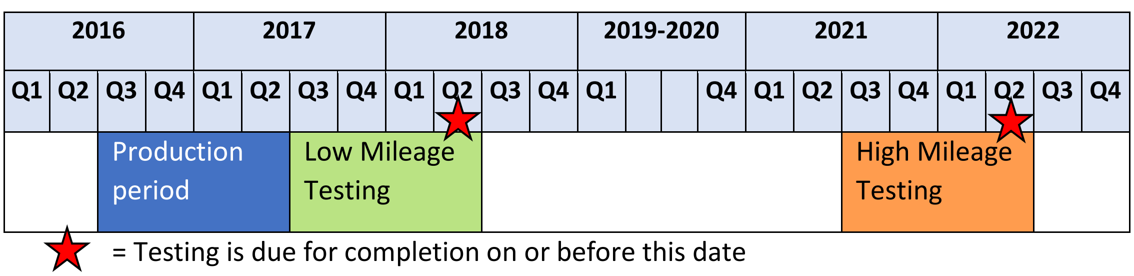

Figure 3-6: Example Timeline for IUVP Testing Process, Model Year 2017 Vehicle

If any manufacturer's failure rates for a particular test group surpass the threshold established in the regulations, that manufacturer must automatically conduct an In-Use Confirmatory Test Program (IUCP) on the test group that has failed. Depending on the results of the IUCP testing, manufacturers might need to recall or implement other remedies for the failing test groups.

IUVP yields significant information about how light-duty vehicles perform in use. The data allow EPA to work with manufacturers to identify potential design issues for future model years and target vehicles that might need additional attention. Table 3-4 shows the total number of vehicles tested in each test procedure and their corresponding failure rates by vehicle model year for all IUVP testing conducted and reported through March 2018. The test types include the Federal Test Procedure (FTP), US06 Cycle, the 2-day evaporative emissions test, and the onboard refueling vapor recovery (ORVR) test.[35]

Table 3-4: Light-Duty In-Use Verification Test Volumes and Failure Rates, Calendar Years 2014-2017

Model Year	FTP		US06		2-Day Evap		ORVR	
	Vehicles Tested	Percent Fail	Vehicles Tested	Percent Fail	Vehicles Tested	Percent Fail	Vehicles Tested	Percent Fail
High-Mileage Testing								
2008	1185	8.9%	833	1.1%	157	5.1%	158	5.7%
2009	1103	11.0%	809	1.2%	168	3.6%	164	5.5%
2010	1043	11.3%	759	1.2%	161	4.3%	160	3.1%
2011	1015	12.2%	756	1.1%	160	6.3%	157	7.6%
2012	1025	12.4%	764	0.5%	162	3.7%	170	10.6%
2013	520	12.1%	413	0.7%	79	7.6%	75	10.7%
2014	14	21.4%	13	0.0%	4	0.0%	3	0.0%
Low-Mileage Testing								
2008	647	4.3%	558	0.2%	155	1.3%	153	5.9%
2009	529	3.8%	479	0.4%	132	6.1%	130	6.9%
2010	613	3.4%	545	0.0%	164	1.8%	163	3.1%
2011	606	3.0%	539	0.9%	172	2.9%	170	7.1%
2012	665	3.9%	586	0.3%	182	2.7%	178	10.1%
2013	634	3.8%	575	0.2%	186	7.0%	181	4.4%
2014	649	3.9%	593	0.2%	177	1.7%	182	0.0%
2015	623	4.0%	560	0.2%	178	3.4%	174	0.0%
2016	509	4.5%	476	0.4%	118	1.7%	115	0.0%
2017	13	15.4%	13	0.0%	3	0.0%	3	0.0%

Figure 3-7 shows the light-duty in-use test information from Table 3-4 in terms of passes and fails by each type of test. Overall, the test results from this program show that the majority of the in-use fleet continues to comply with the emission standards.

[35] ORVR is a vehicle emission control system that captures fuel vapors from the vehicle gas tank during refueling. This requirement was phased in from 1998-2006.

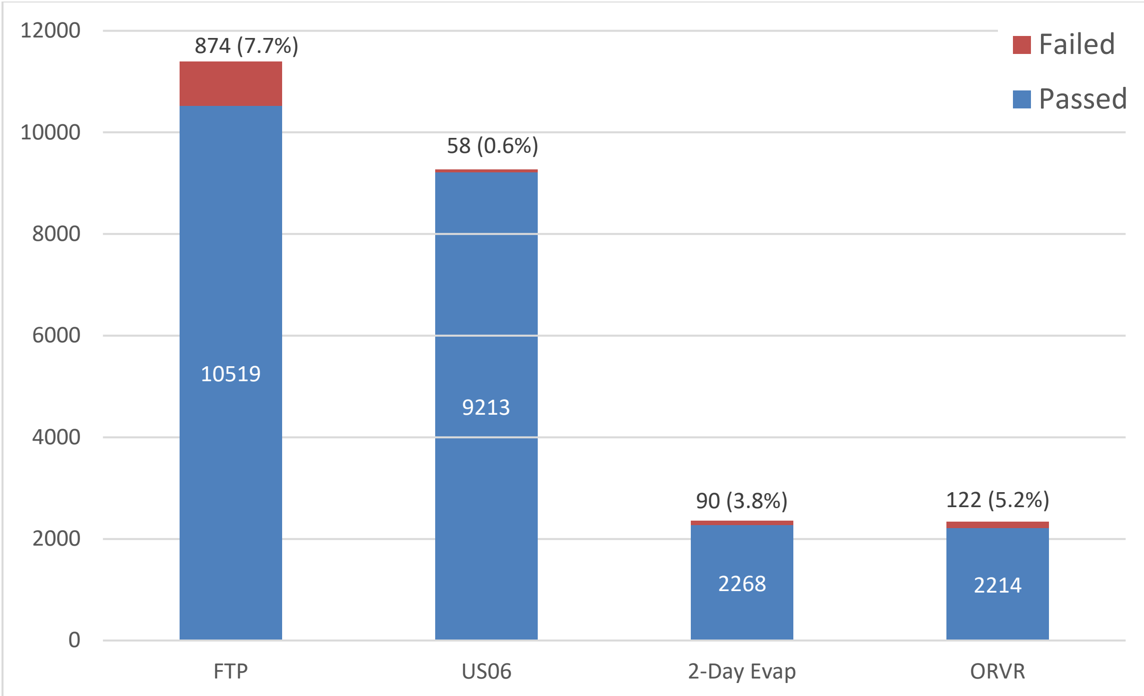

Figure 3-7: In-Use Vehicle Testing by Test, Calendar Years 2014-2017

When IUVP testing identifies potential emissions concerns, EPA and manufacturers work together to implement solutions which may involve voluntary manufacturer action to fix the problem, or, if necessary, an EPA-ordered emissions recall.

In-use testing is an important aspect of EPA's light-duty vehicle compliance program, identifying emissions concerns and resolving them.

3.7 Defect Reporting

Light-duty vehicle manufacturers are required to notify EPA when they learn of emission-related defects in 25 or more vehicles of the same class (e.g., exhaust test group) and category (e.g., manufacturer and model year). Table 3-5 presents the number of defect reports by manufacturer in calendar years 2014 – 2017, and the number of vehicles affected by these defects over the same period of time. Defects reported in this timeframe potentially affected more than 156 million vehicles. A single defect incidence may affect multiple model years of a given vehicle.

Table 3-5: Light-Duty Vehicle Defect Reports by Manufacturer, Calendar Years 2014-2017

Mfr Name	Reports in CY2014		Reports in CY2015		Reports in CY2016		Reports in CY2017	
	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles
Audi	23	889,046	10	145,333	15	285,243	14	635,500
Lamborghini	0	--	1	477	1	729	0	--
Bentley	1	2,208	1	2,903	1	2,184	1	5,355
BMW	14	527,811	33	1,379,393	23	486,492	0	--
Cummins	0	--	0	--	1	564	5	220,740
Fiat Chrysler	21	7,406,614	21	5,109,347	24	1,303,265	36	5,489,460
Ford	16	1,593,480	9	485,503	13	4,436,046	19	3,294,467
FPT Industrial	0	--	9	78,856	0	--	0	--
General Motors	22	3,257,424	34	11,329,891	33	8,790,279	31	15,547,581
Honda	11	5,552,262	19	4,242,279	16	4,337,396	13	2,762,605
Hyundai	19	842,867	15	1,546,059	19	4,518,898	13	3,183,332
Isuzu	0	--	2	2,671	0	--	0	--
Jaguar/Land Rover	2	156,580	8	507,022	7	93,599	2	180,079
Kia	6	2,999,319	16	1,409,239	17	1,938,378	20	2,322,588
Maserati	0	--	1	12,990	1	36,478	0	--
Mazda	8	820,242	5	904,185	3	60,531	1	453,477
Mercedes Benz	12	170,973	10	300,550	8	687,495	28	1,709,613
Mitsubishi	0	--	0	--	5	184,740	0	--
Nissan	7	530,971	10	905,776	11	1,594,905	13	1,792,533
Porsche	12	140,643	12	407,602	4	39,925	29	873,295
Rolls Royce	1	760	0	--	0	--	0	--
Subaru	9	132,699	5	1,036,228	5	77,283	6	1,600,351
Suzuki	0	--	1	19,249	0	--	0	--
Toyota	0	--	32	16,581,936	3	54,700	28	12,083,125
Volkswagen	12	879,214	17	1,095,065	15	634,936	22	611,030
Volvo	3	31,897	2	42,134	3	53,720	3	168,434
Total:	**199**	**25,935,010**	**273**	**47,544,688**	**228**	**29,617,786**	**284**	**52,933,565**

Figure 3-8 below presents the information in Table 3-5 graphically.

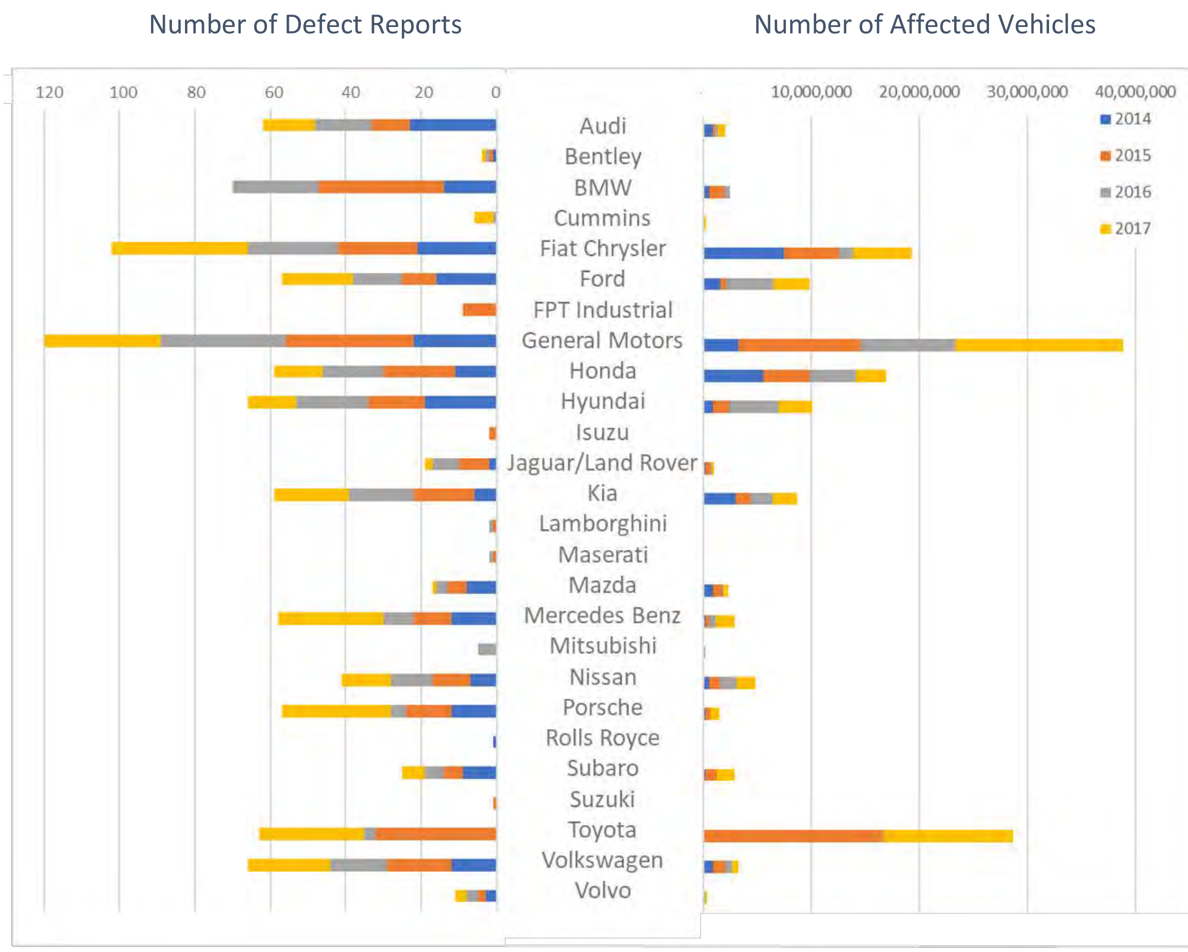

Figure 3-8: Number of Defect Reports (left) and Affected Vehicles (right) by Manufacturer, Calendar Years 2014-2017

Table 3-6 shows the number of defects by defect category, for all the vehicles coved by defect reports in calendar years 2014 – 2017. (The totals for this table are the same as the totals in Table 3-5.)

Table 3-6: Light-Duty Vehicle Defect Reports by Problem Category, Calendar Years 2014-2017

Problem Categories	Reports in CY2014		Reports in CY2015		Reports in CY2016		Reports in CY2017	
	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles
Air Inlet/Intake System	5	166,354	5	3,556,267	11	1,986,706	11	1,479,446
Catalyst/Aftertreatment Component/System (non-diesel engine)	11	597,403	1	5,468	5	2,357,444	9	1,406,740
Computer Related (Other than OBD)	27	4,950,098	32	5,282,200	25	2,615,177	33	5,102,613
Crankcase Ventilation Component/System	6	172,382	11	259,553	3	4,441	5	2,624,076

Problem Categories	Reports in CY2014		Reports in CY2015		Reports in CY2016		Reports in CY2017	
	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles
Diesel Particulate Filter System	1	121,970	1	270,760	0	--	1	25,617
Electrical, Mechanical and Cooling Systems	12	647,224	45	18,399,384	23	5,321,383	41	9,863,584
Emission Control Information Label	1	367	9	56,476	7	12,016	8	162,395
Evaporative Emissions Systems	15	4,246,626	18	1,194,356	8	2,879,256	21	3,321,952
Exhaust Gas Recirculation (EGR) System	2	26,422	3	123,832	5	100,401	5	1,488,485
Exhaust System	4	296,904	11	1,744,527	8	472,293	5	91,095
Fuel Delivery Component	10	1,689,220	24	2,873,933	24	3,651,433	14	3,478,882
Fuel Delivery System	3	199,635	1	68,839	4	75,445	3	3,355,819
Fuel Tank Component	7	473,847	10	2,133,046	16	419,294	17	1,868,261
Hybrid Vehicle Component/ System	1	85,284	4	474,103	2	2,194	12	216,164
Ignition Component	8	162,154	12	1,321,740	4	69,330	9	1,305,742
Monitoring/ Measuring Sensor/ System	20	2,269,856	23	2,462,767	20	2,504,320	27	2,301,515
NOx Absorber System			2	17,558	1	12,881	1	171,441
NOx Sensor	2	110,655	3	68,407	1	85,993	4	215,482
On-Board Diagnostic (OBD) System	49	8,545,394	40	6,557,661	38	5,772,343	40	4,358,322
On-Board Refueling and Vapor Recovery (ORVR) System	1	19,533	1	80,300	0	--	1	1,148,375
Oxygen Sensor	7	838,022	8	447,608	8	202,739	4	6,750,211
Secondary Air System	0	--	0	--	2	13,883	6	2,142,815
Selective Catalytic Reduction System	5	142,694	5	112,334	9	455,466	5	37,920
Turbocharger/ Supercharger	2	172,966	4	33,569	4	603,348	2	16,613
Total	**199**	**25,935,010**	**273**	**47,544,688**	**228**	**29,617,786**	**284**	**52,933,565**

3.8 Recall Reporting

Table 3-7 shows the number of light-duty vehicle recalls by vehicle manufacturer in calendar years 2014 – 2017 and the number of vehicles affected by the recall. Because a recall usually covers a single, specific condition, a vehicle with multiple emissions problems may be subject to multiple recalls. Therefore, the number of affected vehicles in Table 3-7 and Table 3-8 could include vehicles that have been recalled more than once. Similarly, there is not a direct correlation among the number of defect reports, recalls, and the number of vehicles that are recalled. A manufacturer may identify a defect that is not significant enough to warrant a recall. On the other hand, a manufacturer could have a few major defects that evolve into major recalls affecting large portions of their product line.

Table 3-7: Light-Duty Vehicle Recalls by Manufacturer, Calendar Years 2014-2017

MFR Name	Recalls in 2014		Recalls in 2015		Recalls in 2016		Recalls in 2017	
	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles	#	Affected Vehicles
Audi	4	279,384	3	280,552	2	19,121	1	11,088
BMW	1	367	9	401,536	2	25,322	27	1,441,759
Cummins	1	127,483	1	33,677	1	135,824	1	88,419
Fiat Chrysler	6	261,266	12	697,181	11	644,218	12	653,494
Ford	6	1,143,213	11	1,095,357	6	1,673,457	9	248,183
FPT Industrial	0	--	1	10,458	1	12,930	0	--
General Motors	4	101,940	9	762,691	5	201,689	6	250,935
Honda	2	971,247	6	88,318	4	991,456	6	232,665
Hyundai	1	62,586	0	--	2	79,905	1	260,792
Jaguar/Land Rover	1	115,510	1	19,269	1	1,934	0	--
Kia	1	26,864	0	--	4	146,961	1	61,023
Lamborghini	0	--	0	--	0	--	1	729
Maserati	0	--	0	--	1	23,479	0	--
Mazda	4	150,627	2	86,064	4	315,810	1	69,447
Mercedes Benz	0	--	0	--	1	73,696	0	--
Nissan	3	79,428	3	87,076	4	329,461	4	504,376
Porsche	0	--	0	--	0	--	1	2,299
Subaru	0	--	0	--	4	148,847	0	--
Suzuki	0	--	1	19,250	0	--	0	--
Toyota	6	5,487,623	1	170,172	8	996,401	11	694,351
Volkswagen	4	198,735	4	439,980	4	148,772	4	418,395
Total	**44**	**9,006,273**	**64**	**4,191,581**	**65**	**5,969,283**	**86**	**4,937,955**

Table 3-8 lists categories of defects that were corrected by recalls in the years 2014 – 2017. The totals in this table are the same as the totals in Table 3-7. EPA established the defect categories primarily for internal tracking purposes to identify potential, industry-wide problems with a particular component or technology.

Table 3-8: Light-Duty Vehicle Recalls by Problem Category, 2014 – 2017

Problem Category	**2014**		**2015**		**2016**		**2017**	
	#	**Affected Vehicles**	**#**	**Affected Vehicles**	**#**	**Affected Vehicles**	**#**	**Affected Vehicles**
Air Inlet/Intake System	3	1,175,761	0	--	4	467,978	3	451,728
Catalyst/Aftertreatment Component/System (non-diesel engine)	3	122,251	3	183,761	0	--	4	204,999
Computer Related (Other than OBD)	8	238,358	12	1,722,786	8	1,316,777	5	501,303
Crankcase Ventilation Component/System	2	78,871	3	207,558	2	2,083	3	719,538
Diesel Particulate Filter System	0	--	1	2,573	0	--	0	--
Electrical, Mechanical and Cooling Systems	7	4,896,100	7	323,757	3	331,627	8	744,537
Emission Control Information Label	1	367	7	46,100	7	35,467	5	127,518
Evaporative Emissions Systems	0	--	4	471,062	5	552,659	5	293,324
Exhaust Gas Recirculation (EGR) System	0	--	1	99,380	3	680,458	2	415,314
Exhaust System	0	--	1	2,471	1	12,540	2	49,840
Fuel Delivery Component	3	1,020,060	5	106,579	4	581,161	10	161,407
Fuel Delivery System	0	--	6	167,158	1	191,857	2	2,725
Fuel Tank Component	2	18,767	4	85,599	7	76,566	6	26,538
Hybrid Vehicle Component/System	2	794,284	0	--	2	109,740	6	22,508
Ignition Component	0	--	0		1	29,214	3	83,246
Monitoring/Measuring Sensor/System	7	238,102	3	608,060	3	577,119	1	31,824
NOx Sensor	0	--	0		1	91,442	1	38,640
On-Board Diagnostic (OBD) System	4	263,394	7	164,737	5	584,406	12	660,124
Oxygen Sensor	0	--	0	--	1	24,100		
Secondary Air System	0	--	0	--	1	100,021	2	155,154
Selective Catalytic Reduction System	0	--	0	--	5	179,286	4	144,115
Turbocharger/Supercharger	2	159,958	0	--	1	24,782	2	103,573
Total	**44**	**9,006,273**	**64**	**4,191,581**	**65**	**5,969,283**	**86**	**4,937,955**

3.9 Averaging, Banking, and Trading (ABT) Programs

During the time period covered by this report, manufacturers certified vehicles to both EPA's Tier 3 vehicle standards, which began to take effect in 2017, and EPA's Tier 2 vehicle standards. The Tier 2 regulation marked the first time that SUVs and other light-duty trucks were subject to the same national pollution standards as cars, and this is also a feature of Tier 3 vehicle standards.[36]

The Tier 2 regulation gives manufacturers a choice of eight emission bins to which they can certify. Lower bin numbers reflect more stringent emission standards. The Tier 2 ABT program allows manufacturers to use sales-weighted averaging to certify groups of vehicles to different bin levels, as long as the fleet as a whole on average meets Bin 5 standards each year.

In Tier 3, the bins are named using their corresponding NMOG+NOx limit in mg/mi. The highest emission bin, Bin 160 (NMOG+NOx = 160 mg/mi) is equivalent to Tier 2 Bin 5. There were other important changes from Tier 2 to Tier 3, and EPA's website provides further information.

Table 3-9 shows the percentage of exhaust test groups by emission certification bin for model years 2014-2017. In model year 2017, 89% of the vehicle test groups were certified to Tier 3 instead of Tier 2; 99% of the vehicle test groups were certified to Tier 2 Bin 5 or better (again, because the highest Tier 3 bin, Bin 160, is equivalent to Tier 2 Bin 5).

Table 3-9: Percentage of Exhaust Test Groups by Certification Bin, Model Years 2014 - 2017

Standard	Bin	MY 2014	MY 2015	MY 2016	MY 2017
Tier 2	Bin 1	3%	3%	4%	0%
	Bin 2	3%	2%	1%	
	Bin 3	9%	8%	7%	0%
	Bin 4	13%	13%	14%	2%
	Bin 5	70%	71%	65%	10%
	Bin 6			0%	
	Bin 7	0%			
	Bin 8	3%	2%	1%	1%
Tier 3	Bin 0			0%	5%
	Bin 20				
	Bin 30			3%	14%
	Bin 50				0%
	Bin 70			2%	14%
	Bin 125			3%	46%
	Bin 160				9%
Total		**100%**	**100%**	**100%**	**100%**

[36] For more information, see EPA's website at: www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-smog-soot-and-other-air-pollution-passenger.

Averaging, banking, and trading programs give manufacturers flexibility in how they satisfy clean air emission standards.

Figure 3-9 through Figure 3-11 present the average certification levels for NOx, NMOG, and CO respectively for Tier 2 Bin 5 for the manufacturers with the largest production volumes (as shown in Figure 3-5). The lower the certification level is, relative to the standard (100% on the y-axis), the greater the compliance margin. In other words, a 30% compliance margin means that vehicle emissions are 30% lower than the standard whereas a 70% compliance margin means that emissions are 70% lower than the standard. Note that the y-axis for these three figures is not constant. Also note that in 2014, the label "Volkswagen" includes only Volkswagen vehicles; after 2015, "Volkswagen" is used to refer to the Volkswagen Group, which includes other brands. Several manufacturers do not have data for model year 2017; these manufacturers certified their model year 2017 vehicles to the Tier 3 standards instead of Tier 2.

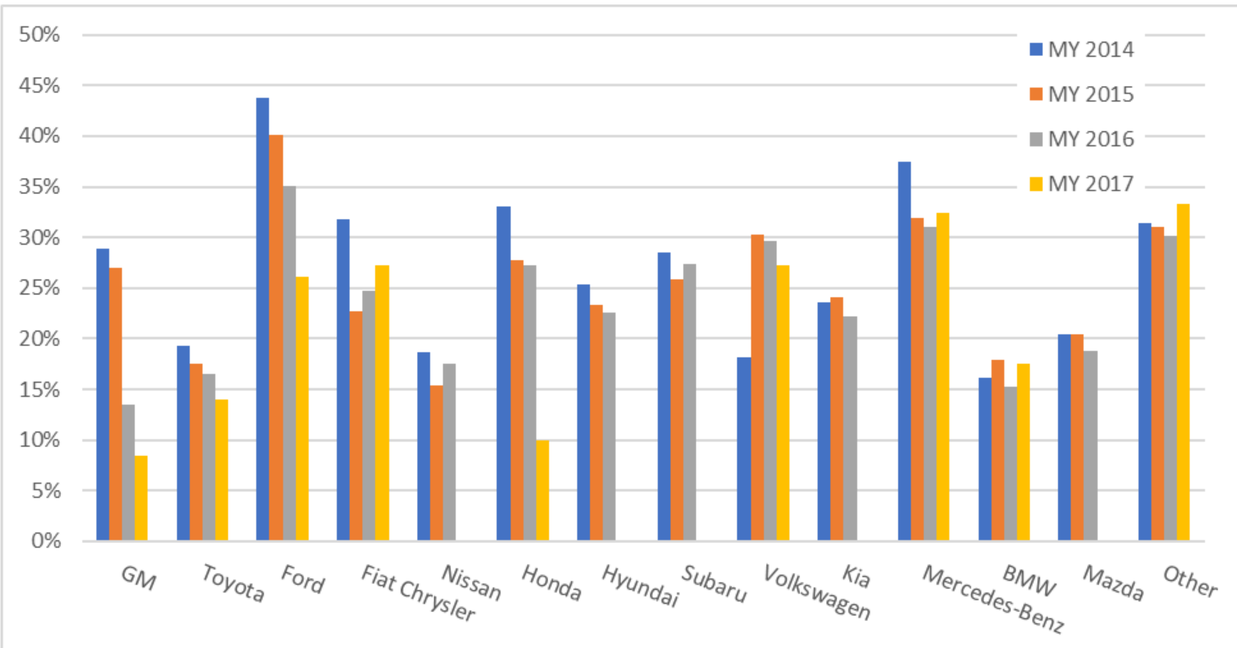

Figure 3-9: Tier 2 Bin 5 NOx Certification Levels by Manufacturer, Model Years 2014 - 2017

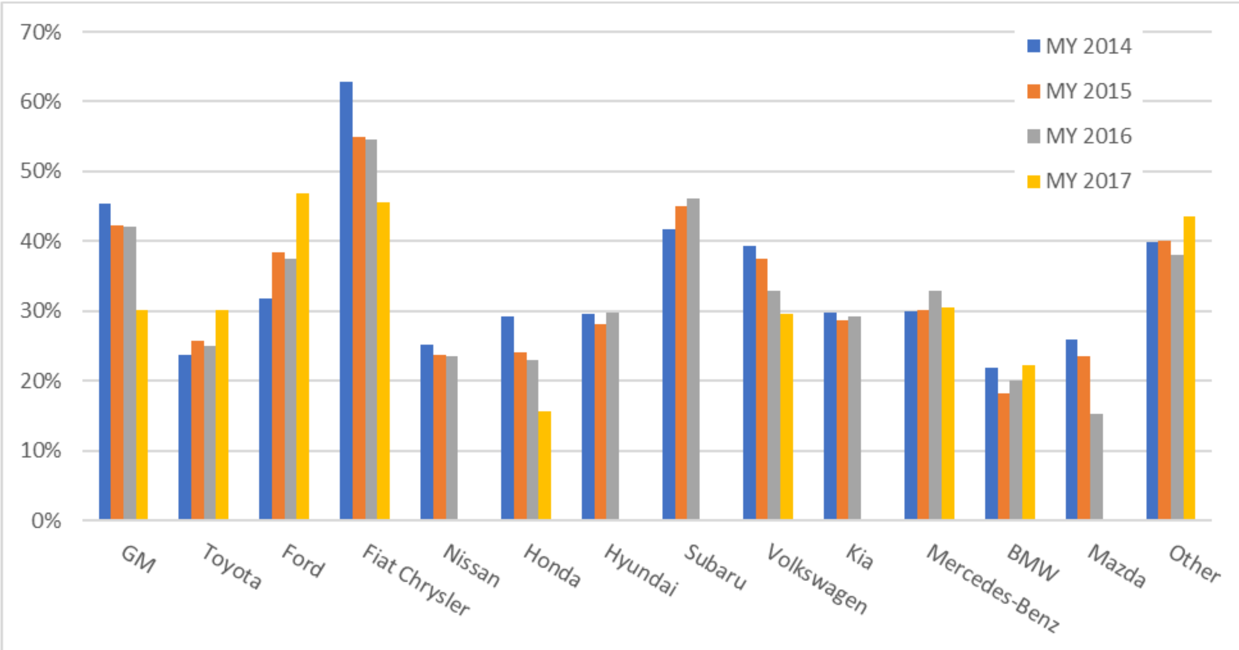

Figure 3-10: Tier 2 Bin 5 NMOG Certification Levels by Manufacturer, Model Years 2014 - 2017

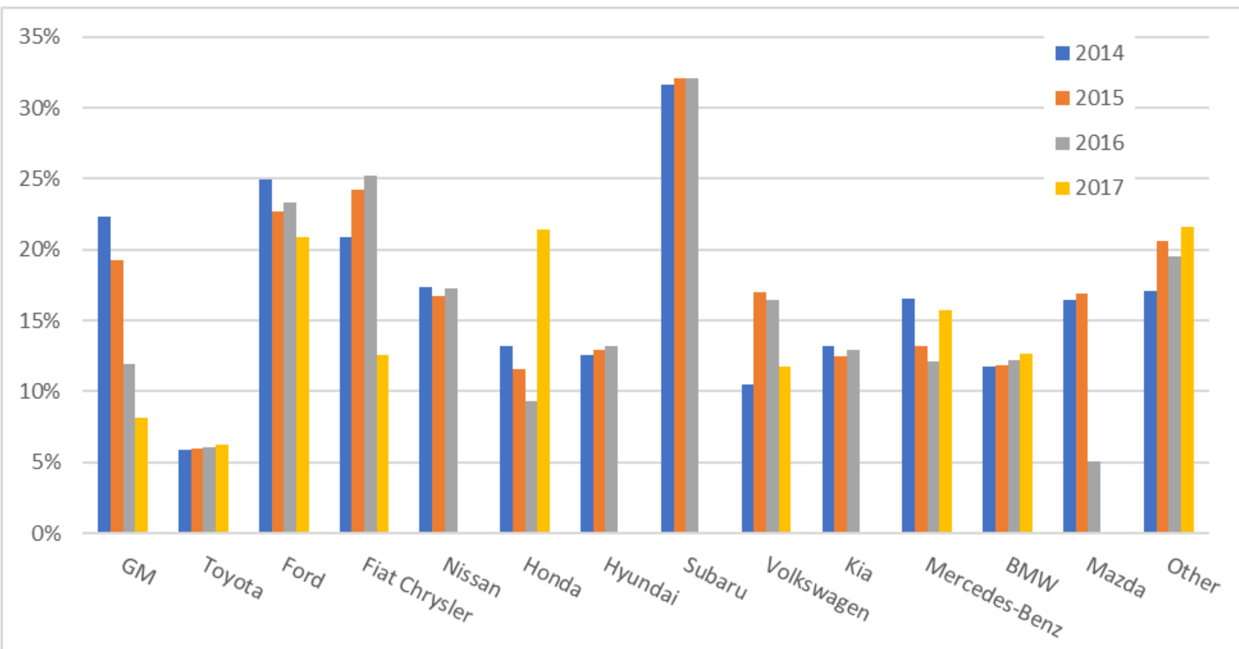

Figure 3-11: Tier 2 Bin 5 CO Certification Levels by Manufacturer, Model Years 2014 -2017

4. Highway Motorcycles

4.1 Certification

Highway and off-highway motorcycles are subject to different regulations and emission standards. This section covers highway motorcycles; off-highway motorcycles are covered in Section 8, Recreational Vehicles.

Table 4-1 presents the number of certified highway motorcycle engine families, which is equivalent to the number of certificates EPA issued, by class, for model years 2014 - 2017. Class refers to engine capacity, measured in terms of volume displaced by the motor in cubic centimeters (cc). The larger a motorcycle's engine capacity, the more power it has. For example, small scooters belong to Class Ia. The largest class, Class III, includes all motorcycles larger than 279 cc, the largest of which can be in the range of 2000 cc.

Table 4-1: Highway Motorcycle Engine Families by Class, Model Years 2014-2017

Highway Motorcycle Category	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Class Ia (<50cc)	40	35	30	33
Class Ib (50 - 169cc)	49	43	43	46
Class II (170 -279cc)	34	31	30	26
Class III (>279cc)	166	179	185	181
Battery Electric Motorcycles	0	1	5	13
Total	**289**	**289**	**293**	**299**

Table 4-2 presents the number of certified highway motorcycle engine families by manufacturer for model year 2014 – 2017. The totals in this table are the same as in Table 4-1. The manufacturers that certified a smaller number of engine families across these model years (including the battery electric manufacturers) are grouped together as "Other."

In every model year 2014 – 2017, there were more than 100 manufacturers. Comparing highway motorcycle and light-duty vehicle sectors, there is less consolidation in motorcycle manufacturers: a larger number of manufacturers (more than 100 in each year, compared to 36 for light-duty vehicles), certifying a smaller number of distinct families (less than 300 engine families each year, compared to more than 500 unique exhaust test group/evaporative families for light-duty vehicles).

EPA issues certificates to more than 100 different highway motorcycle manufacturers.

Table 4-2: Highway Motorcycle Engine Families by Manufacturer, Model Years 2014 - 2017

Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
American Honda Motor Co., Inc.	25	22	24	24
BMW	9	9	8	7
Ducati North America, Inc.	12	13	14	16
Harley-Davidson Motor Company	8	11	11	12
Kawasaki Motors Corp., U.S.A.	16	16	17	19
KTM North America, Inc.	6	7	8	12
KYMCO USA	10	9	8	7
MV Agusta USA, LLC	6	6	7	8
Piaggio Group Americas, Inc.	20	21	23	20
Suzuki Motor Corporation	19	21	22	21
Triumph Motorcycles America Ltd	10	11	13	15
Yamaha Motor Corporation	27	29	28	24
Other (>90 manufacturers)	121	114	110	114
Total	**289**	**289**	**293**	**299**

Table 4-3 presents the number of manufacturers that obtained these certificates by class

Table 4-3: Number of Motorcycle Manufacturers by Class, Model Years 2014 - 2017

Highway Motorcycle Category	Number of Manufacturers			
	MY 2014	MY 2015	MY 2016	MY 2017
Class Ia (<50cc)	33	28	24	25
Class Ib (50 - 169cc)	33	28	30	31
Class II (170 -279cc)	24	19	18	15
Class III(>279cc)	35	39	36	35
Battery Electric Motorcycles	0	1	4	11
Total	**125**	**115**	**112**	**117**

4.2 Production Volume

Figure 4-1 below shows the numbers of model year 2014 -2017 motorcycles produced for the U.S. In these years there was a downward trend: about 62,000 fewer model year 2017 motorcycles were sold compared to model year 2014. (Note the y-axis of this figure begins at 300,000 rather than zero.)

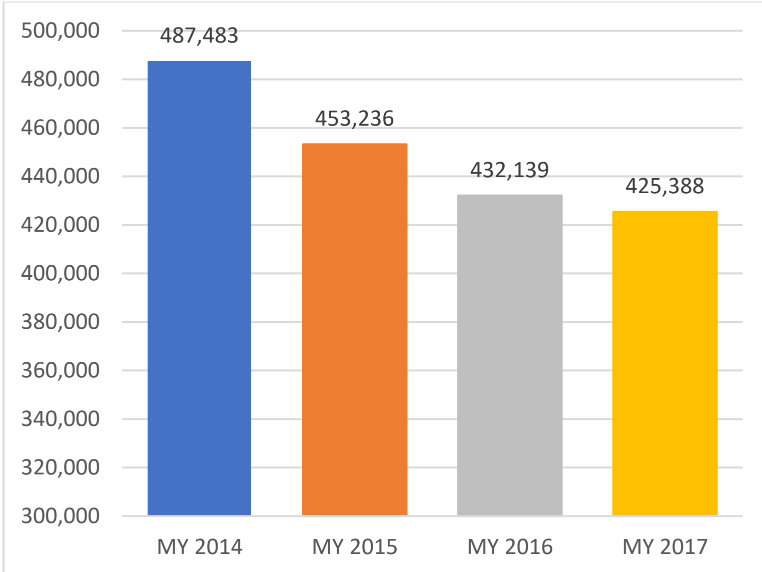

Figure 4-1: Highway Motorcycle Production Volume for the U.S., Model Years 2014 -2017

Table 4-4 and Figure 4-2 below show model year 2017 production volume – the yellow bar in Figure 4-1 – by motorcycle class. The figure shows that nearly three quarters of the model year 2017 motorcycles produced for sale in the U.S. were Class III motorcycles. Less than one percent were electric motorcycles.

Table 4-4: Highway Motorcycle Production Volume for the U.S. by Class, Model Year 2017

Highway Motorcycle Category	Production Volume	Percent of Total
Class Ia (<50cc)	53,348	13%
Class Ib (50 - 169cc)	39,439	9%
Class II (170 -279cc)	17,371	4%
Class III (>279cc)	313,929	74%
Battery Electric	1,301	<1%
Total	425,388	100%

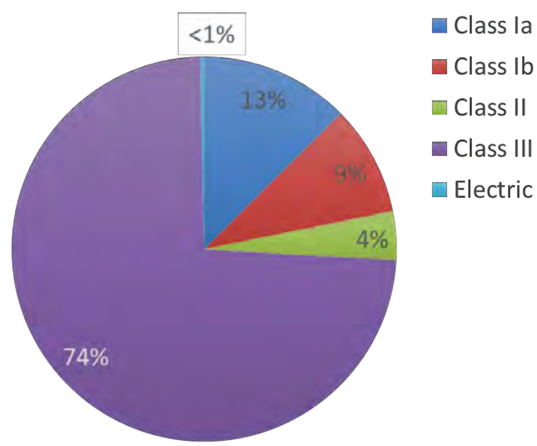

Figure 4-2: Highway Motorcycle Production Volume for the U.S. by Class, Model Year 2017

4.3 Defect Reporting

Highway motorcycle manufacturers are required to notify EPA when they learn of the existence of emission-related defects in 25 or more vehicles of the same class (e.g., engine family) and category (e.g., manufacturer, model year). Table 4-5 includes the number of defect reports for highway motorcycles in calendar years 2014 – 2017 by manufacturer, and Table 4-6 provides this information by problem category. There were no defects reported in 2014.

Table 4-5: Highway Motorcycle Defect Reports by Manufacturer, Calendar Year 2014 - 2017

Manufacturer	Number of Defect Reports in Calendar Year		
	2015	2016	2017
Harley Davidson	1	0	2
Honda	0	2	2
Suzuki	1	2	1
Victory Motorcycle/Polaris	1	0	0
Total:	**3**	**4**	**5**

Table 4-6: Highway Motorcycle Defect Reports by Problem Category, Calendar Years 2014 - 2017

Problem Category	Number of Defect Reports in Calendar Year:		
	2015	2016	2017
Electrical, Mechanical & Cooling Systems	0	2	1
Engine Emission Control Information Label	0	0	1
Catalytic Converter	1	0	0
Exhaust System	1	0	0
Fuel Delivery Component	1	2	2
Owners' Manual	0	0	1
Total:	**3**	**4**	**5**

4.4 Recall Reporting

The same three manufacturers issued recalls for highway motorcycles in calendar years 2014 – 2017. There were no recalls in calendar year 2014. Table 4-7 lists these recalls by manufacturer, and Table 4-8 lists them by problem category.

Table 4-7: Highway Motorcycle Recalls by Manufacturer, Calendar Years 2014 - 2017

Manufacturer	2015		2016		2017	
	Recalls	Affected Engines	Recalls	Affected Engines	Recalls	Affected Engines
Harley Davidson	1	31	0	--	0	--
Honda	0	--	1	17,643	1	8,059
Suzuki	1	1,019	2	6,288	1	120
Total:	**2**	**1,050**	**3**	**23,931**	**2**	**8,179**

Table 4-8: Highway Motorcycle Recalls by Problem Category, Calendar Years 2014 -2017

Problem Category	2015		2016		2017	
	Recalls	Affected Engines	Recalls	Affected Engines	Recalls	Affected Engines
Electrical, Mechanical & Cooling Systems	0	--	2	6,288	0	--
Engine Emission Control Information Label	0	--	0	--	1	120
Exhaust System	1	1,019	0	--	0	--
Fuel Delivery Component	1	31	1	17,643	0	--
Owners' Manual	0	--	0	--	1	8,059
Total:	**2**	**1,050**	**3**	**23,931**	**2**	**8,179**

5. Heavy-Duty Highway Engines

Heavy-duty highway engines are used in highway vehicles such as trucks and buses that are more than 8,500 pounds in gross vehicle weight rating (GVWR, the maximum operating weight of a vehicle as specified by the manufacturer.)

5.1 Certification

Table 5-1 below shows the number of certificates for the heavy-duty highway engine sector; it repeats a portion of Table 2-1. As shown in the table, EPA issued 147, 187, 186, and 222 heavy-duty highway certificates for model years 2014-2017, respectively. These include alternative fuel conversion and evaporative emissions systems certificates.

Table 5-1: Heavy-Duty Highway Vehicle and Engine Certificates, Model Years 2014 - 2017

Category	MY 2014	MY 2015	MY 2016	MY 2017
Compression ignition (diesel)	30	32	34	41
Spark ignition (mostly gasoline)	10	14	12	15
Tractors and vocational vehicles	66	97	103	126
Alternative fuel conversions	31	31	25	22
Evaporative emissions systems	10	13	12	18
Total	**147**	**187**	**186**	**222**

In Table 5-1, EPA distinguished certificates for alternative fuel conversions from those for compression ignition or spark ignition engines. However, this distinction is not made in Tables 5-2 through 5-5. These tables present the number of heavy-duty highway compression ignition engine families (in Tables 5-2 and 5-3), and the number of heavy-duty highway spark ignition engine families (in Tables 5-4 and 5-5), that include the alternative fuel conversions for these engine types. Thus the total number of engine families in these tables is larger than the corresponding row for the category in Table 5-1.

Table 5-2 and Table 5-3 present the number of model year 2014-2017 heavy-duty highway compression ignition (diesel) engine families certified, by service class and by manufacturer, respectively.

Table 5-2: Heavy-Duty Highway Compression Ignition Engine Families by Service Class, Model Years 2014 - 2017

Heavy-Duty Engine Service Class	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Light heavy-duty	7	5	9	7
Medium heavy-duty	8	10	11	14
Heavy heavy-duty	15	17	16	21
Urban bus	3	4	4	0
Total	**33**[37]	**36**	**40**	**42**

[37] This number does not match the number of heavy-duty highway engine certificates for compression ignition engines in Table 5-3 due to a manufacturer data entry error. This type of error is no longer possible as a result of EPA's update to the system used to enter this data.

Table 5-3: Heavy-Duty Highway Compression Ignition Engine Families by Manufacturer, Model Years 2014 - 2017

Heavy-Duty Highway Compression Ignition Engine Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Clean Air Power	0	1	0	0
Cummins Inc.	14	16	18	18
Detroit Diesel Corporation	4	4	3	4
Ford Motor Company	2	2	5	3
FPT Industrial S.p.A.	2	0	2	2
General Motors LLC	0	1	1	0
Hino Motors, Ltd	3	3	3	3
Isuzu Motors Limited	1	1	1	2
Navistar, Inc.	4	3	2	3
NGV Motori, USA, LLC	0	0		1
PACCAR Inc	1	1	2	3
Propane Fuel Technologies LLC	0	1	0	0
Volvo Powertrain North America A Division of Mack Trucks, Inc.	0	0	0	3
VPT	3	3	3	0
Total	**34**	**36**	**40**	**42**

Table 5-4 and Table 5-5 present the number of model year 2014-2017 heavy-duty highway spark ignition engine families certified, by service class and by manufacturer, respectively.

Table 5-4: Heavy-Duty Highway Spark Ignition Engine Families by Service Class, Model Years 2014-2017[38]

Heavy-Duty Engine Service Class	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Heavy-duty engines for vehicles $\leq$ 14K lbs	10	8	1	0
Heavy-duty engines for vehicles >14K lbs	26	31	27	29
Heavy-duty spark ignition engines for vehicles of all gross vehicle weight ratings	5	4	11	7
Total	**41**	**43**	**39**	**36**

[38] For MY 2014, 2015, and 2016, the number of certificates for spark ignition engines was fewer than then number of spark ignition engine families, because some vehicles between 8,500 – 14,000 lbs are chassis certified and were included in light-duty vehicle data.

Table 5-5: Heavy-Duty Highway Spark Ignition Engine Families by Manufacturer, Model Years 2014-2017

Heavy-Duty Highway Spark Ignition Engine Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
AGA Systems, LLC	0	1	1	1
Auto Gas America	4	0	0	0
BAF Technologies	2	2	0	0
Bi-Phase Technologies, LLC.	3	2	1	0
Blossman Services, Inc.	1	3	0	1
Chrysler Group LLC	1	1	1	0
CleanFuel USA Inc.	2	2	1	2
Encore TEC LLC	0	0	6	4
FCA US LLC	0	0	0	1
Ford Motor Company	5	6	2	2
General Motors LLC	3	3	1	1
Greenkraft Inc.	4	5	4	5
Icom North America LLC	2	2	0	4
IMPCO Technologies, Inc.	4	4	5	2
Landi Renzo USA Corporation	4	5	4	3
NGV Motori	2	0	0	0
OMNITEK	0	1	0	0
PARNELL USA, INC	0	0	3	0
Power Solutions International, Inc.	0	2	4	4
Powertrain Integration, LLC	0	0	0	1
Roush Industries, Inc.	2	4	3	3
Westport Dallas, Inc	0	0	2	2
Westport Power Inc.	1	0	0	0
Total	**40**	**43**	**38**	**36**

Figure 5-1 and Figure 5-2 present the number of model year 2014 – 2017 compression ignition and spark ignition engine families by each heavy-duty engine manufacturer.

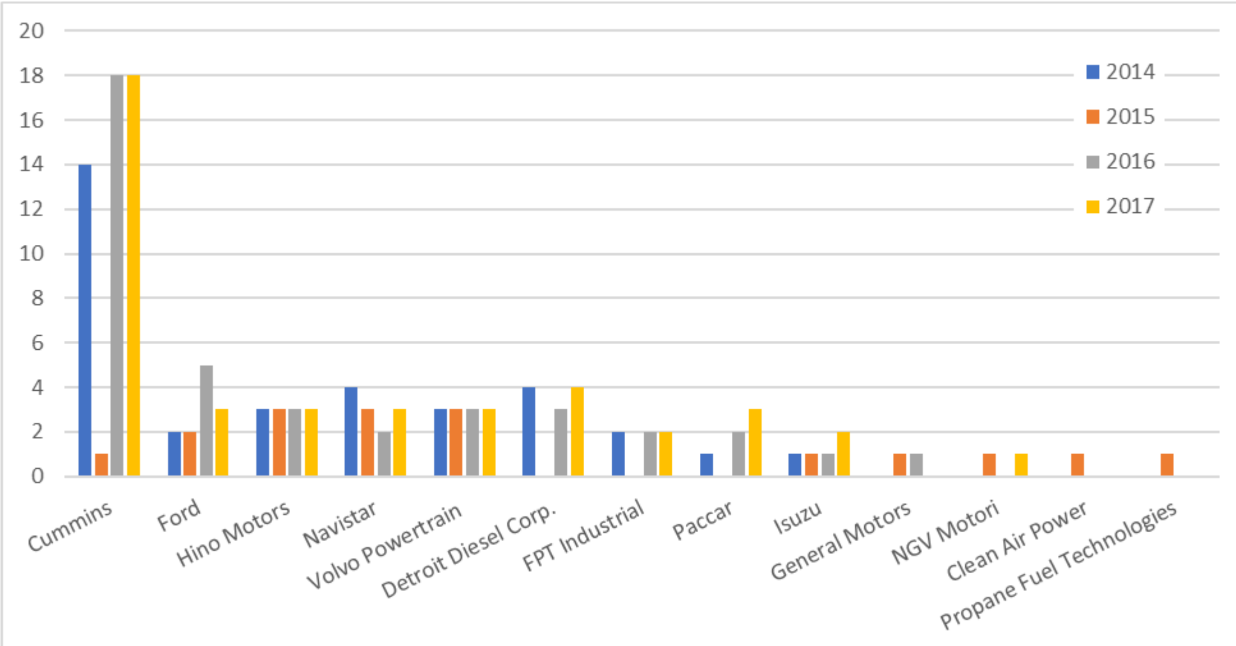

Figure 5-1: Heavy-Duty Highway Compression Ignition Engine Families by Manufacturer, Model Year 2014-2017

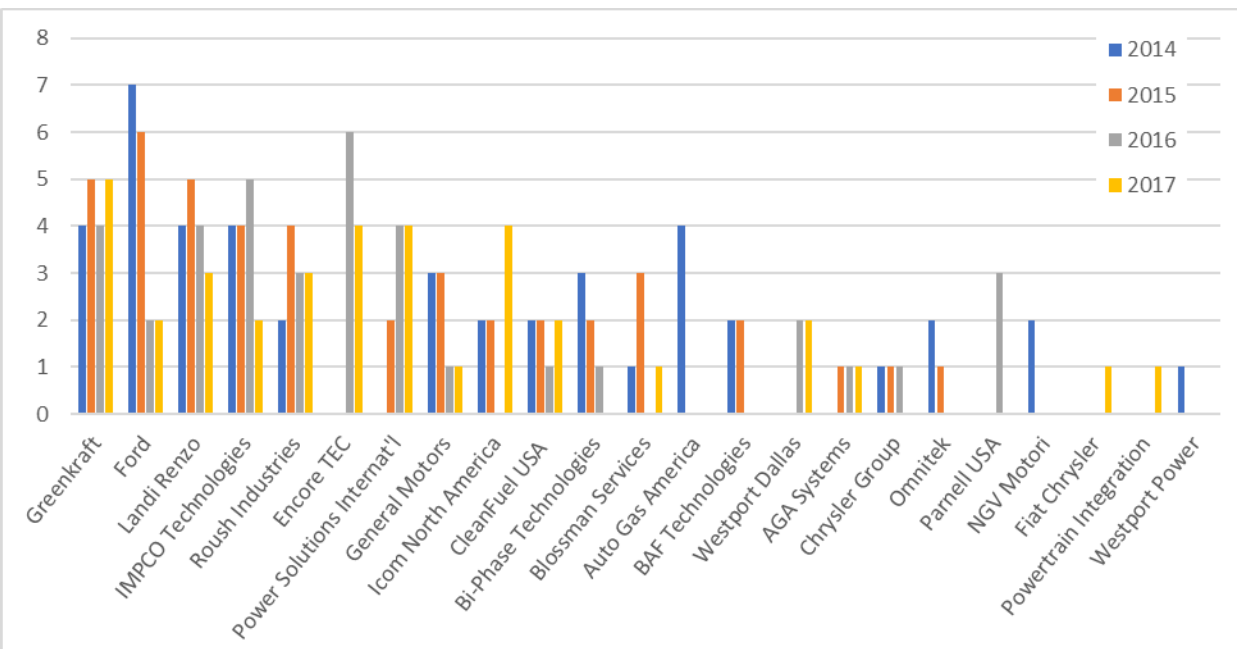

Figure 5-2: Heavy-Duty Highway Spark Ignition Engine Families by Manufacturer, Model Year 2014-2017

5.2 In-Use Compliance Testing

As is the case for light-duty vehicles, EPA relies on both internal and manufacturer testing programs to assess compliance with in-use emission standards for heavy-duty vehicles.[39] Heavy-duty in-use testing differs significantly from light-duty in-use testing. For light-duty vehicles, the test procedures used to measure emissions are the same for both certification and in-use testing. However, heavy-duty engines undergo certification testing in the laboratory, whereas in-use testing may be conducted over the road. In other words, the heavy-duty vehicle regulations do not require manufacturers to test in-use engines on a laboratory dynamometer, as they must for certification. Instead, the regulations require manufacturers to measure the percentage of time that a vehicle exceeds certain emission thresholds under real-world driving conditions using portable devices that monitor emissions of hydrocarbons, CO, NOx, and PM. Heavy-duty manufacturers use portable equipment to measure in-use emissions while a vehicle is being driven on the road in actual customer fleet applications, instead of removing the engine from the vehicle to conduct laboratory testing on an engine dynamometer.

EPA conducts surveillance testing to check heavy-duty compliance with regulations for their entire useful life.

EPA also conducts a surveillance program to assess the emissions performance of heavy-duty vehicles near the end of their useful life. The program utilizes engine dynamometer testing (where the engine is removed from the vehicle), chassis dynamometer testing on EPA's heavy-duty chassis dynamometer, and portable emissions measuring equipment. The program is currently focused on medium heavy-duty and heavy heavy-duty compression ignition engines.[40]

5.3 Defect Reporting

Table 5-6 provides the number of defect information reports that heavy-duty highway engine manufacturers submitted during calendar years 2014 – 2017. Table 5-7 shows defect information for the same years by problem category. Note that both of these tables include information about both compression ignition and spark ignition heavy-duty engines.

[39] Current regulations mandate a manufacturer-run heavy-duty in use test program for compression ignition engines. The regulations do not require manufacturer in-use testing for heavy duty spark ignition engines at this time.

[40] Definitions of medium heavy-duty and heavy heavy-duty compression ignition engines are found in the regulation at 40 CFR 1036.140.

Table 5-6: Heavy-Duty Highway Engine Defect Reports by Manufacturer, Calendar Years 2014 - 2017

Heavy-Duty Highway Engine Manufacturer	Number of Defect Reports in Calendar Year:			
	2014	2015	2016	2017
Cummins	2	4	11	11
Detroit Diesel Corporation	2	1	1	2
Ford		6	6	6
FPT Industrial		12		
Hino Motors				1
Isuzu Motors	1	1	5	1
Navistar	8			
Volvo Powertrain	9	5	4	10
Total	**22**	**29**	**27**	**31**

Table 5-7: Heavy-Duty Highway Engine Defect Reports by Problem Category, Calendar Years 2014 - 2017

Problem category	Number of Defect Reports in Calendar Year:			
	2014	2015	2016	2017
Air Inlet/Intake System		1	1	2
Catalyst/Aftertreatment Component/System (non-diesel engine)	1			1
Computer Related (Other than OBD)	1	2		1
Crankcase Ventilation Component/System		1		2
Diesel Particulate Filter System	3	1	3	3
Electrical, Mechanical and Cooling Systems				1
Emission Control Information Label		2		
Evaporative Emissions Systems	1			
Exhaust Gas Recirculation (EGR) System	1	4		1
Exhaust System		3	3	2
Fuel Delivery Component	3	1	1	
Fuel Delivery System			1	
Fuel Tank Component				1
Ignition Component			3	
Monitoring/Measuring Sensor/System	3	1	2	2
NOx Absorber System		2		
NOx Sensor	1	3	2	
On-Board Diagnostic (OBD) System	2	2	4	9
Selective Catalytic Reduction System	6	3	5	5
Turbocharger/Supercharger		3	2	1
Total	**22**	**29**	**27**	**31**

5.4 Recall Reporting

The number of recalls and the number of affected engines for each recall for the calendar years 2014 – 2017 are shown in the following two tables, first by manufacturer, and then by problem category. Note that these tables include information about both compression ignition and spark ignition heavy-duty engines.

Table 5-8: Heavy-Duty Engine Recalls by Manufacturer, 2014-2017

Manufacturer	2014		2015		2016		2017	
	#	Affected Engines	#	Affected Engines	#	Affected Engines	#	Affected Engines
Cummins	2	1,851	2	400			1	4,582
Ford			3	327,595	5	731,153	2	37,170
FPT Industrial			1	10,458	1	12,930		
Hino Motors	3	38,275			2	3,243		
Isuzu					1	8,227		
Navistar	7	109,266						
Volvo Powertrain							3	0
Total	**12**	**149,392**	**6**	**338,453**	**9**	**755,553**	**6**	**41,752**

Table 5-9: Heavy-Duty Engine Recalls by Problem Category, 2014 - 2017

Problem Category	2014		2015		2016		2017	
	#	Affected Engines	#	Affected Engines	#	Affected Engines	#	Affected Engines
Air Inlet/Intake System			1	10,458				
Catalyst/Aftertreatment Component/System (non-diesel engine)	1	176						
Computer Related (Other than OBD)	2	29,432	2	10,234	1	91,042		
Crankcase Ventilation Component/System							1	37,003
Diesel Particulate Filter System	7	111,031						
Electrical, Mechanical and Cooling Systems			1	73				
Exhaust System			1	317,361				
Fuel Delivery System					1	316		
Fuel Tank Component							1	167
Monitoring/Measuring Sensor/System					1	553,595		
On-Board Diagnostic (OBD) System	2	8,753			4	23,761	2	-
Selective Catalytic Reduction System					1	12,930	2	4,582
Turbocharger/ Supercharger			1	327	1	73,909		
Total	**12**	**149,392**	**6**	**338,453**	**9**	**755,553**	**6**	**41,752**

There were no recalls in the problem categories of Emission Control Information Label, Exhaust Gas Recirculation (EGR) System, or NOx Sensor over these calendar years.

6. Nonroad Compression Ignition Engines

EPA regulates several categories of nonroad compression ignition engines, including marine engines, locomotives, and compression ignition engines used in construction, agricultural, and other equipment.

6.1 Marine Compression Ignition Engines

Table 6-1 presents the number of certificates issued for marine engines by manufacturer. Marine engine manufacturers applying for engine certification may request an International Maritime Organization (IMO) certificate in addition to an EPA Certificate of Conformity for the same engine family.[41] The IMO program is different from EPA's program but certain jurisdictions in the U.S. require operators to display an EPA-issued IMO certificate. For the purposes of this compliance report, only one certificate for each engine family was included in the counts listed below. Manufacturers that obtained fewer than 10 certificates over these model years were grouped together as "Other."

[41] The IMO is an agency of the United Nations whose main role is to create a regulatory framework for the shipping industry for safety, security, and environmental performance, including the prevention of marine and atmospheric pollution by ships.

Table 6-1: Marine Engine EPA and IMO Certificates by Manufacturer, Model Year 2014 - 2017

Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
AB Volvo Penta	11	11	11	13
Beta Marine Ltd	4	6	7	8
Caterpillar Inc.	19	21	19	23
Cummins Inc.	17	15	14	15
Deere & Company	22	26	19	21
Electro-Motive Diesel, Inc.	11	10	11	12
FPT Industrial S.p.A.	4	4	4	7
IHI Agri-Tech Corporation			9	10
IHI Shibaura Machinery Corporation	10	9		
Ingram Barge Company	2	3	3	3
MAN Truck & Bus AG	4	4	6	4
Mercury Marine	4	2	2	2
Mitsubishi Heavy Industries Engine & Turbocharger, Ltd.		1	4	5
MTU America, Inc.	1	4	4	4
NANNI INDUSTRIES SAS	2	3	7	9
National Railway Equipment Co.		3	4	4
Northern Lights Inc	4	4	4	5
Perkins Engines Co Ltd	3	2	3	3
Scania CV AB	10	8	9	11
Transportation Systems Business Operations of General Electric Company	3	2	6	7
Wartsila Oyj	4	4	1	2
Yanmar Co., Ltd.	10	16	16	14
Other (24 manufacturers)	29	32	16	15
Total	**174**	**190**	**179**	**197**

Figure 6-1 shows the number of marine engines produced for the U.S. in model year 2014-2017.

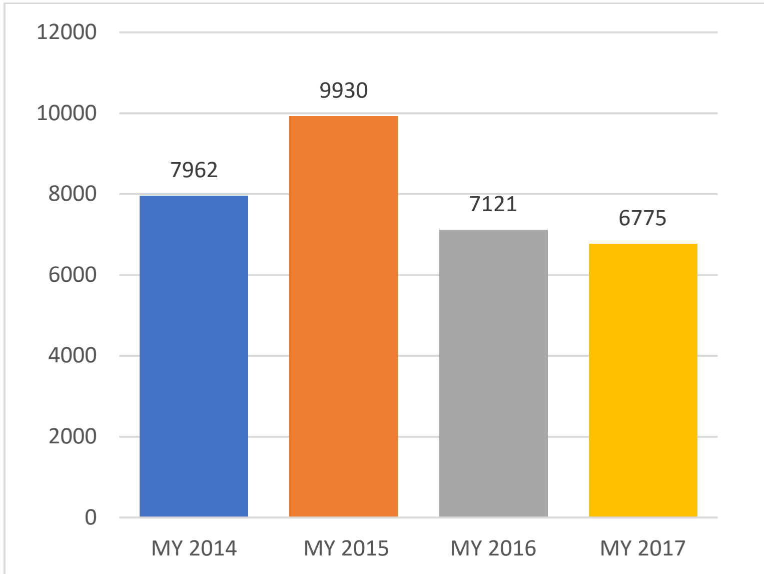

Figure 6-1: Marine Engine Production Volume for the U.S, Model Year 2014-2017

6.2 Locomotives

Some engine manufacturers who make engines for locomotives certify those engines to both nonroad compression ignition standards and to locomotive standards. Table 6-2 shows the number of certificates EPA issued for model year 2014 – 2017 locomotive engines:

Table 6-2: Locomotive Certificates by Manufacturer

Manufacturer	Number of Engine Families			
	2014	2015	2016	2017
Advanced Global Environmental	11	11	10	
Advanced Global Holdings, Inc.			5	
American Turbocharger Technologies, LLC				3
Burlington Northern Santa Fe Railway			1	2
CIT Rail		1		
Clark Industrial Power LLC				2
CSX Transportation, Inc.	9	9	9	9
Cummins Inc.	4	4	6	6
Electro-Motive Diesel, Inc.	19	19	29	34
HK Engine Components LLC	1	1	1	
Knoxville Locomotive Works				4
MotivePower Inc.	3	4	4	4
MTU America, Inc.	3	4	4	4
National Railway Equipment Co.	6	4	6	8
OceanAir Environmental, LLC	3	3	3	3
Peaker Services, Inc.	2	2	2	
Progress Rail Services	5	7	8	9
Quality Turbocharger Components LLC		1	1	1
RJ Corman Railpower LLC	1			
Thoroughbred Emissions Research, LLC	2	2	3	4
TMV Control Systems Inc.		1	1	1
Tognum America, Inc.	1			
TransPar Corporation	2	2	2	2
Transportation Systems Business Operations of General Electric Company	35	45	55	54
ZTR CONTROL SYSTEMS LLC	1	1	1	1
Total	**108**	**121**	**146**	**151**

Certificates in the locomotive industry sector include those for non-original equipment manufacturer components, new switch engines, remanufactured switch engines, new line haul engines, and remanufactured line haul engines. Figure 6-2 shows the percentage of each type of certificate in model year 2017. As seen in the figure, the majority of certificates for locomotives are for remanufactured ("reman") engines.

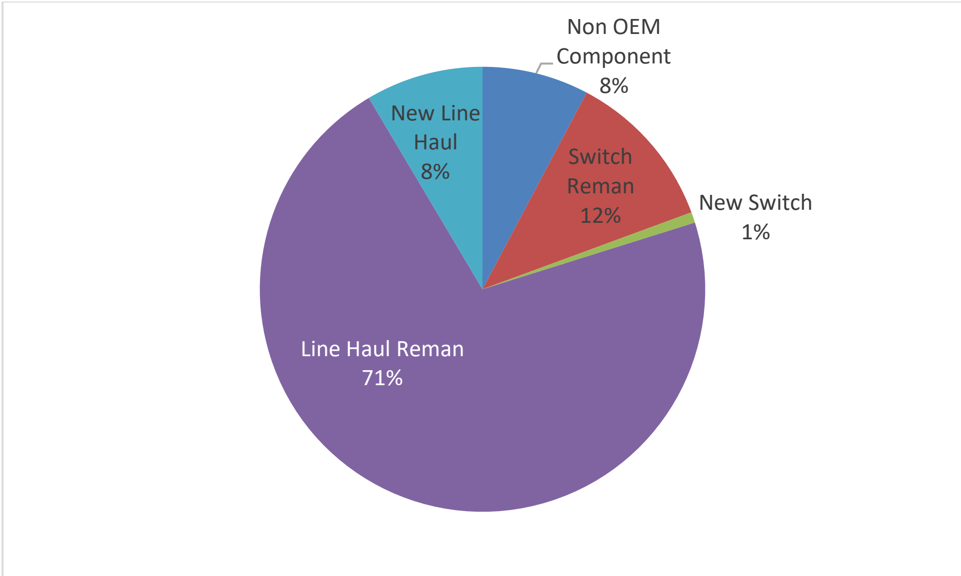

Figure 6-2: Locomotive Certificates by Type, Model Year 2017

The number of locomotive engines produced for the U.S. in model year 2014 – 2017 is shown in Figure 6-3 below.

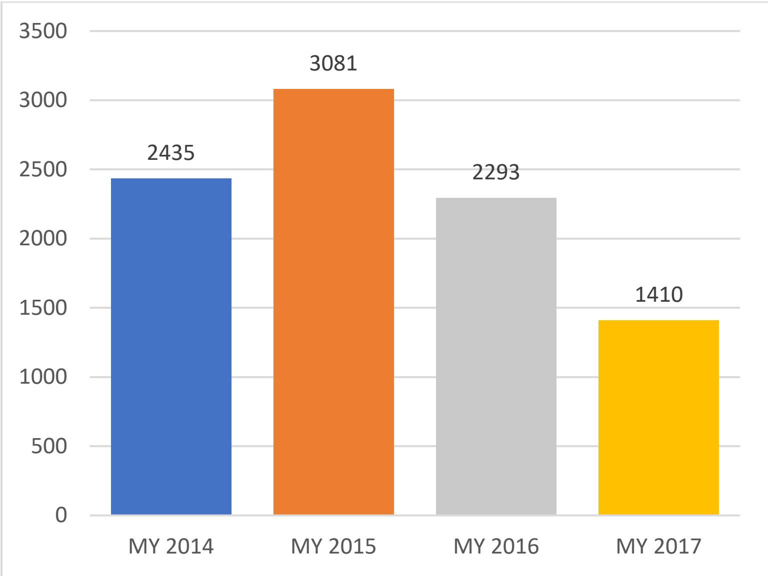

Figure 6-3: Locomotive Engine Production Volume for the U.S., Model Year 2014-2017

6.3 Construction and Agricultural Engines

This category includes nonroad compression ignition engines that are used in vehicles and equipment such as tractors, generators, construction equipment, agricultural equipment, forklifts, and welders. These engines can be certified for use in one or more service classes. Table 6-3 presents the number of certificates that were issued for model year 2014 – 2017 covering each power category.

Table 6-3: Construction and Agricultural Engine Families by Service Class, Model Years 2014 - 2017

Service Class (Power Category)	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
1 = kW<8	11	16	18	18
2 = 8<=kW<19	69	66	69	72
3 = 19<=kW<37	63	69	74	66
4 = 37<=kW<56	66	79	87	90
5 = 56<=kW<75	17	15	13	13
6 = 56<=kW<130		6	18	27
7 = 75<=kW<130	57	42	35	35
8 = 130<=kW<225	11	12	10	10
9 = 130<=kW<=560	60	79	84	84
10 = 225<=kW<450	19	17	18	18
11 = 225<=kW<=560				
12 = 450<=kW<=560	8	8	8	7
13 = 560<kW<=900	14	11	15	13
14 = 560<kW<=2237	29	25	24	23
15 = kW>560		4	5	6
16 = kW>900	7	7	9	9
17 = kW>2237	1			
Total	**432**	**456**	**487**	**491**

Table 6-4 shows the number of engine families certified by each manufacturer for the same model years. There are 41 manufacturers listed in this table, certifying one or more engine families for at least one of these model years.

Table 6-4: Construction and Agricultural Engine Families by Manufacturer, Model Years 2014 - 2017

Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
AGCO POWER INC.	6	7	7	6
CATERPILLAR	26	24	26	25
CMI	39	41	41	39
DAEDONG	4	6	8	7
DEERE	26	25	30	27
DETROIT DIESEL	2	2	2	2
DEUTZ	25	28	28	29
DOOSAN	5	6	7	8
FCA ITALY		1	2	2
FPT INDUSTRIAL S.P.	27	30	29	31
GLOBAL COMPONENT TC	1	1	2	2
HML	2	2	2	2
IAT	45	43	44	36
ISEKI	2	2	2	2
ISUZU	10	17	16	19
JCB POWER SYSTEMS	3	3	3	3
KOHLER CO.	7	10	11	10
KOMATSU LTD.	10	7	10	11
KOOP			1	1
KUBOTA	36	39	44	46
KUKJE MACHINERY	9	10	9	11
LMB	8	6	8	8
LS MTRON		4	3	4
M&M	16	15	16	29
MAN			2	2
MERCEDES-BENZ	5	6	6	6
MITSUBISHI	17	15	19	20
MOTORENFABRIK HATZ	9	13	12	9
MTU DD	8	8	8	7
NAV	1			
PERKINS	18	21	18	16
PSA PEUGEOT CITROEN	1	1	1	
SCANIA	4	4	4	4
SIMPSON & CO LIMITED	1	1	1	1
TIEM	2	2	2	2
VM MOTORI	1			
VOLKSWAGEN	1	1	1	1
VOLVO CE	3	3	3	3

Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
VPX	14	13	13	13
YANMAR	38	39	46	46
ZETOR NORTH AMERICA				1
Total	**432**	**456**	**487**	**491**

The number of construction and agricultural engines produced in the U.S. in model year 2014 – 2017 is shown in Figure 6-4 below. Note the magnitude of these production numbers is in the hundreds of thousands.

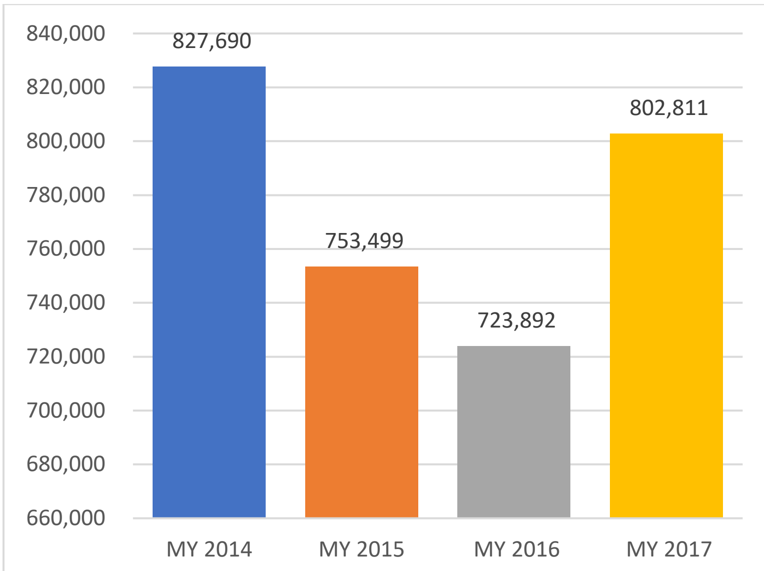

Figure 6-4: Construction and Agricultural Engine Production Volume for the U.S., Model Years 2014-2017

7. Nonroad Spark Ignition Engines

Nonroad spark ignition (Nonroad SI) engines are divided into three categories for purposes of exhaust emissions compliance:

1. Marine spark ignition (Marine SI) engines are used in marine vessels, including outboard engines, personal watercraft, and sterndrive/inboard engines.
2. Small spark ignition (Small SI) engines are generally rated below 25 horsepower (19 kW) and are used in household and commercial applications, including lawn and garden equipment, generators, and a variety of other construction, farm, and industrial equipment.
3. Large spark ignition (Large SI) engines are generally rated above 19 kW and used in forklifts, compressors, generators, and stationary equipment.

Most equipment with an Nonroad SI engine is also subject to evaporative emissions standards.

7.1 Marine Spark Ignition Engines

Marine SI engines are used in boats with outboard motors, personal watercraft, and boats with sterndrive or inboard motors. Table 7-1 shows the Marine SI engine families by manufacturer, for model year 2014 – 2017.

Table 7-1: Marine SI Engine Families by Manufacturer, Model Year 2014- 2017

Marine Spark Ignition Engine Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
American Honda Motor Co., Inc.	11	11	11	13
Bombardier Recreational Products, Inc	16	20	23	25
Briggs & Stratton Corporation	2	4	4	1
Hangzhou Hidea Power Machinery Co., Ltd.	6	6	0	6
Hangzhou Seanovo Power Machinery Co., Ltd.	0	6	0	0
Ilmor Engineering, Inc.	4	4	4	5
INDMAR PRODUCTS CO., INC	5	7	7	8
Kawasaki Motors Corp., U.S.A.	2	2	2	2
KEM Equipment, Inc.	4	6	7	7
LEHR LLC	4	5	5	4
MARINE POWER HOLDING LLC	1	2	2	4
Mercury Marine	35	37	31	27
OUTBOARDS GROUP C.V.	2	2	2	3
Pleasurecraft Marine Engine Company	4	5	5	5
Suzhou Parsun Power Machine Co., Ltd.	7	7	7	8
Suzuki Motor Corporation	11	11	10	10
Textron Specialized Vehicles	0	0	2	2
TOHATSU CORPORATION	9	10	9	10
Volvo Penta of the Americas, LLC	8	9	8	7
Yamaha Motor Corporation	28	28	29	25
Zhe Jiang Hui Yuan Power Technology Co.Ltd.	0	0	0	3
Other	10	7	4	6
Total:	**169**	**189**	**172**	**178**

Table 7-2 shows the number of each of these types of marine SI engines produced for the U.S. for model year 2017, and as Figure 7-1 illustrates, three quarters of the marine SI engines produced were outboard motors.

Table 7-2: Marine SI Engine Production Volume, Model Year 2017

Marine SI Engine Category	Production Volume	Percent of total
Outboard	287,907	75%
Personal Watercraft	66,775	17%
Sterndrive/Inboard	31,397	8%
Total Marine SI	**386,079**	**100%**

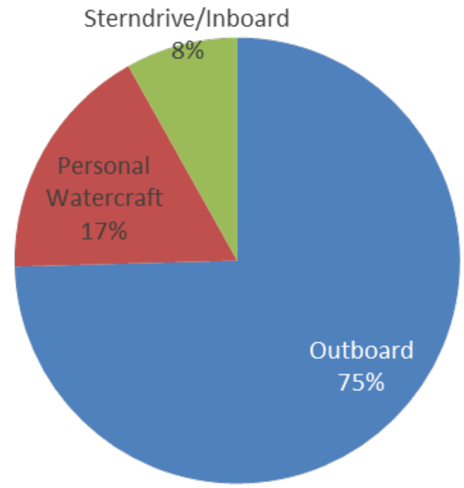

Figure 7-1: Marine SI Engine Production Percentages by Category, Model Year 2017

7.2 Small Spark Ignition Engines

There are five classes of Small SI engines. Classes are defined by whether or not the engine is used in a handheld piece of equipment and by engine displacement. Classes I and II describe engines not used in handheld equipment, and Classes III, IV, and V engines are used in handheld equipment, such as chainsaws, string trimmers, and leaf blowers.

EPA OTAQ certifies the greatest number of certificates for Small Spark Ignition engine families. This sector has more manufacturers than any other sector.

Table 7-3 presents the number of Small SI engine families that EPA certified in model year 2014-2017, by engine class. This sector has the largest number of engine families, as 900 or more were certified in each of these model years.

Table 7-3: Small SI Engine Families by Class, Model Years 2014 - 2017

Small SI Engine Class	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Class I (non-handheld)	192	214	208	210
Class II (non-handheld)	303	328	322	336
Class III (handheld)	1	1	0	0
Class IV (handheld)	253	256	254	255
Class V (handheld)	151	157	160	171
Total	**900**	**956**	**944**	**972**

Table 7-4 shows the number of Small SI Engine families certified in model years 2014 – 2017 by manufacturer. In addition to having the greatest number of engine families, this sector also has the largest number of manufacturers. A total of 146 manufacturers obtained certificates from EPA during model years 2014 – 2017 for at least one engine family in at least one of these model years.

Table 7-4: Small SI Engine Families by Manufacturer, Model Years 2014 -2017

Small SI Engine Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
American Honda Motor Co., Inc.	26	25	25	26
ANDREAS STIHL AG & Co. KG	56	55	57	54
Briggs & Stratton Corporation	39	45	45	46
Chongqing Dajiang Power Equipment CO.,LTD	16	17	20	24
Chongqing Maifeng Power Machinery Co., Ltd	6	11	11	10
Chongqing Rato Technology Co., Ltd	25	23	24	25
Chongqing Shineray Agricultural Machinery Co.,Ltd	7	10	11	12
Chongqing Zongshen General Power Machine Co., Ltd	24	25	31	31
ECHO Incorporated/Yamabiko Corporation	51	53	54	56
EMAK S.p.a.	16	17	12	18
Fuji Heavy Industries	22	22	21	16
Generac Power Systems, Inc.	17	13	11	13
Hitachi Koki USA Ltd.	15	14	12	11
Husqvarna AB	31	29	26	29
Husqvarna Outdoor Products N.A., Inc.	19	18	26	18
Husqvarna Zenoah Co., Ltd.	22	24	18	16
Jiangsu Jiangdong Group Co. Ltd.	27	32	29	31
Kawasaki Motors Corp., U.S.A.	32	36	34	35
Kohler Co.	29	36	35	41
Lifan Industry (Group) Co., Ltd.	23	22	18	18
Liquid Combustion Technology, LLC	8	9	13	13
Loncin Motor Co., Ltd.	22	27	26	32
Makita Engineering Germany GmbH	12	12	12	13
MTD Consumer Group, Inc.	14	13	11	13
Shandong Huasheng Zhongtian Machinery Group CO.,LTD.	18	19	21	20
SHANDONG YONGJIA POWER CO.,LTD	0	1	12	14
Techtronic Industries North American, Inc.	11	13	15	12
Wenling Jennfeng Industry Inc.	12	17	13	14
Wuxi Kipor Power Co., Ltd.	9	9	9	12
Yamaha Motor Corporation	14	14	13	14
Yongkang Xingguang Electrical Manufacture Co.,Ltd	13	13	13	12
Zhejiang Xingyue Industry Co.,Ltd	14	15	16	15
Zhejiang Yaofeng Power Technology Co., Ltd.	8	13	12	16
Other (> 100 manufacturers)	242	254	238	242
Total	**900**	**956**	**944**	**972**

Table 7-5 and Figure 7-2 show model year 2017 Small SI engine production volumes for the U.S. by engine class. As seen in Figure 7-2, about half of the Small SI engines produced for the U.S. are handheld categories, and about half are non-handheld categories.

Table 7-5: Small SI Engine Production Volumes, Model Year 2017

Small SI Engine Class	Production Volume	Percent of total
Non-handheld Class I	9,880,141	36%
Non-handheld Class II	4,140,248	15%
Handheld Class IV	10,881,386	40%
Handheld Class V	2,311,646	8%
Total Small SI	**27,213,421**	**100%**

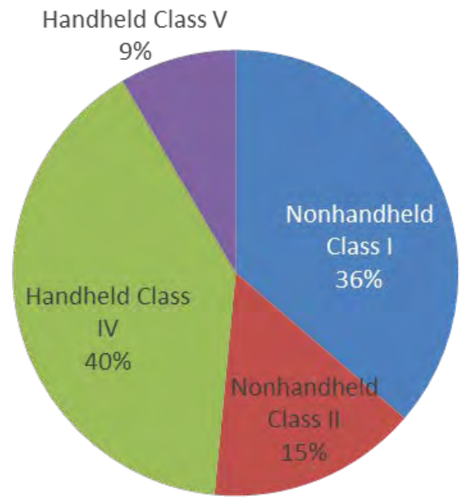

Figure 7-2: Small SI Engine Production Percentages by Engine Class, Model Year 2017

7.3 Large Spark Ignition Engines

Large SI engines include nonroad engines powered by gasoline, propane, or compressed natural gas rated over 19 kilowatts (25 horsepower). These engines are used in commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications.

Table 7-6 below shows model year 2014- 2017 Large SI engine families by manufacturer.

Table 7-6: Large SI Engine Families by Manufacturer, Model Year 2014-2017

Large Spark Ignition Engine Manufacturer	Number of Engine Families			
	2014	2015	2016	2017
Generac Power Systems, Inc.	55	54	59	64
Bucks Engines	9	9	0	0
Caterpillar Inc.	1	1	3	3
Chongqing Panda Machinery Co., Ltd.	2	3	2	2
Crown Equipment Corporation	1	1	1	2
Cummins Inc.	12	12	14	17
Deutz AG	2	5	5	5
Dresser, Inc.	1	1	1	3
ENER-G Rudox Inc.	2	3	3	2
Engine Distributors, Inc.	5	6	6	11
Global Component Technologies Corporation	3	3	3	3
Graham Ford Power Products	2	4	3	1
Guascor Power S.A.U.	5	8	8	8
IMPCO Technologies, Inc.	9	9	4	0
KEM Equipment, Inc.	15	15	15	15
Kohler Co.	4	4	6	6
Kubota Corporation	5	7	7	6
Mitsubishi Heavy Industries, Ltd.	2	2	2	2
MTU America, Inc.	3	5	5	7
Origin Engines	2	3	3	4
Power Solutions International, Inc.	21	20	23	24
Springfield Remanufacturing Corp.	5	4	4	4
Toyota Industrial Equipment Manufacturing, Inc.	2	2	2	2
Weichai America Corporation	0	2	0	3
Westport Power Inc.	1	1	2	3
Wisconsin Motors, LLC.	4	4	2	1
Woodward, Inc.	3	3	2	1
Zenith Power Products	9	10	13	11
Other (16 manufacturers)	9	7	12	18
Total:	**194**	**208**	**210**	**226**

Total production volume of model year 2017 Large SI engines for the U.S. was 242,121.

7.4 Evaporative Components

In addition to spark ignition engines themselves, EPA certifies evaporative components used with these engines, such as fuel lines and fuel tanks. Table 7-7 shows the variety of evaporative component types that EPA certifies, and the number of evaporative component families that received certificates for model years 2014 – 2017.

Table 7-7: Nonroad Spark Ignition Evaporative Component Families by Type, Model Years 2014- 2017

Component Type	Number of Evaporative Component Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Fuel Cap Permeation	14	15	16	18
Fuel Line Permeation	128	138	134	141
Fuel Tank Permeation	235	242	244	237
Large SI Diurnal	1	1	0	0
Marine SI Diurnal	30	33	32	29
Handheld Equipment Certification	68	67	74	76
Nonhandheld Equipment Certification	337	333	341	362
Vessel Certification	2	2	2	3
Total	**815**	**831**	**843**	**866**

7.5 Defect Reporting

Defect reports are for the entire category of nonroad spark ignition engines, rather than the subcategories of Marine SI, Small SI, and Large SI engines. Table 7-8 presents defect reports by manufacturer, and Table 7-9 presents them by problem category.

Table 7-8: Nonroad Spark Ignition Engine Defect Reports by Manufacturer, Calendar Year 2014 - 2017

Manufacturer	Number of Defect Reports in Calendar Year:			
	2014	2015	2016	2017
Bombardier Recreational Products	2	1	0	0
Briggs & Stratton	1	0	0	0
Cummins Power	0	0	0	1
Honda	4	0	1	0
Husqvarna AB	1	0	0	0
IMPCO Technologies	0	0	0	1
Indmar Products	0	0	0	2
Kubota Corp	0	1	0	0
Mercury/Sea Ray	1	0	0	0
Polaris	0	0	1	0
Stihl	0	0	1	0
Yamaha	0	0	1	0
Total:	**9**	**2**	**4**	**4**

Table 7-9: Nonroad Spark Ignition Engine Defect Reports by Problem Category, Calendary Year 2014 - 2017

Problem Category	Number of Defect Reports in Calendar Year:			
	2014	2015	2016	2017
Catalyst/Aftertreatment Component/System	0	0	0	1
Computer Related (other than OBD)	1	0	0	0
Electrical, Mechanical & Cooling Systems	2	1	0	0
Engine Emission Control Information Label	3	0	0	0
Fuel Delivery Component	2	1	3	1
Ignition Component	1	0	0	0
Monitoring/Measuring Sensor/System	0	0	1	1
On-Board Diagnostic (OBD) System	0	0	0	1
Total:	**9**	**2**	**4**	**4**

7.6 Recall Reporting

As in the case with defect reports, the recall reports are provided for the nonroad spark ignition engine category as a whole for calendar years 2014 - 2017. There were no recalls for this sector in 2015. Table 7-10 presents recall reports by manufacturer, and Table 7-11 presents them by problem category.

Table 7-10: Nonroad Spark Ignition Engine Recalls by Manufacturer, 2014 - 2017

Manufacturer	2014		2016		2017	
	#	Affected Engines	#	Affected Engines	#	Affected Engines
Briggs & Stratton	1	900	0	--	0	--
Honda	1	20,602	0	--	2	3,079
Indmar Products	0	--	0	--	1	1,092
Kohler	0	--	1	968	0	--
Stihl	0	--	1	5,294	0	--
Yamaha	0	--	1	3,100	0	--
Total:	**2**	**21,502**	**3**	**9,362**	**3**	**4,171**

Table 7-11: Nonroad Spark Ignition Engine Recalls by Problem Category, 2014 - 2017

Problem Category	2014		2016		2017	
	#	Affected Engines	#	Affected Engines	#	Affected Engines
Electrical, Mechanical & Cooling Systems	1	900	0	--	0	--
Fuel Delivery Component	0	--	2	8,394	2	3,079
Fuel Delivery System	0	--	1	968	0	--
Monitoring/Measuring Sensor/System	1	20,602	0	--	0	--
On-Board Diagnostic (OBD) System	0	--	0	--	1	1,092
Total:	**2**	**21,502**	**3**	**9,362**	**3**	**4,171**

8. Recreational Vehicles

Recreation vehicles include all-terrain vehicles (ATVs), utility vehicles (UTVs), sand cars, dune buggies, off-highway motorcycles, and snowmobiles. Emissions from these vehicles were not regulated until model year 2006. Each of the recreational vehicle categories is subject to an individual set of exhaust emissions standards, and all recreational vehicles became subject to the same fuel component-based permeation emission standards beginning in model year 2008.

8.1 Certification

8.1.1 All-Terrain Vehicles and Utility Vehicles

There were 85 different manufacturers that certified ATV and UTV products for model years 2014 – 2017. Table 8-1 lists the manufacturers that certified engine families over this four-year period (those certifying fewer than 10 families during the four-year period are grouped together as "Other").

Table 8-1: ATV and UTV Engine Families by Manufacturer, Model Years 2014-2017

Manufacturer	Number of ATV and UTV Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
American Honda Motor Co., Inc.	11	8	11	11
Arctic Cat	15	14	13	15
Bennche, LLC.			5	6
BMS Motorsports, Inc.	3	1	2	4
Bombardier Recreational Products, Inc	13	12	15	16
BV Powersports, LLC	4	2	2	3
CF Moto Powersports, Inc.	9	5	7	8
Deere & Company	6	4	5	5
Global Resource Development, LLC	3	3	3	2
Hisun Motors Corp., U.S.A.	8	15	18	21
Kawasaki Motors Corp., U.S.A.	5	4	4	4
KYMCO USA	12	13	12	10
LIL PICK UP INC.	4	5	3	6
Linhai Powersports USA Corporation		2	5	7
Massimo Motor Sports LLC		7	7	
Maxtrade	2	3	3	4
Polaris Industries Inc.	17	10	14	15
Ricky Power Sports, LLC		4	4	4
Suzuki Motor Corporation	6	4	4	5
Taotao USA Inc.	7	8	8	6
U-Storm Power Corporation	4	3	3	3
XY POWERSPORTS LLC	6	6		
Yamaha Motor Corporation	11	5	8	9
Other (> 60 manufacturers)	51	67	50	68
Total	**197**	**205**	**206**	**232**

8.1.2 Off-highway Motorcycles

There were 25 manufacturers that certified off-highway motorcycle engines for model years 2014 – 2017. Table 8-2 lists the manufacturers that certified at least five different emission families over this four-year period; the rest are grouped together in the category of "Other."

Table 8-2: Certificates for Off-Highway Motorcycles, Model Years 2014-2017

Off-Highway Motorcycle Manufacturer	Number of Off-Highway MC Families			
	MY 2014	MY 2015	MY 2016	MY 2017
American Honda Motor Co., Inc.	6	8	8	8
Apollo Motorsports USA, Inc.	3	3	3	3
APT Powersport and Utility Products, LLC	2	2	1	2
Baja Inc.	2	2	1	
Hisun Motors Corp., U.S.A.	1	1	1	2
Kawasaki Motors Corp., U.S.A.	3	2	2	3
KTM North America, Inc.	4	3	3	
Lianmei LLC	2	2	2	2
Maxtrade	2	2	2	2
Monster Moto, LLC	1	2	1	3
Ricky Power Sports, LLC	2	5	4	3
Suzuki Motor Corporation	1	2	2	3
Taotao USA Inc.	3	3	2	1
XMotos USA, Inc.	4	4	4	3
Yamaha Motor Corporation	6	7	7	7
Other (10 manufacturers)	7	5	4	7
Total	**49**	**53**	**47**	**49**

Emissions from recreational vehicles were first regulated with model year 2006.

8.1.3 Snowmobiles

Eight manufacturers certified snowmobile engines for model years 2014 – 2017, as shown in Table 8-3.

Table 8-3: Snowmobile Engine Families by Manufacturer, Model Years 2014 - 2017

Snowmobile Manufacturer	Number of Snowmobile Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Arctic Cat	8	7	8	9
Bombardier Recreational Products, Inc	9	8	8	8
HJR		1		
IRBIS USA LLC				1
KING DISTRIBUTION LLC	1			
Polaris Industries Inc.	7	6	6	6
Taotao USA Inc.			1	
Yamaha Motor Corporation	7	7	6	9
Total	**32**	**29**	**29**	**33**

8.1.4 Two-Stroke Engines

As shown in Table 8-4, in model years 2014 – 2017, no ATV/UTV manufacturers produced certified two-stroke engines, and only a small percentage of the certified off-highway motorcycle families were two-stroke engines. As for snowmobiles, less than half of the certified families were two-stroke engines. These data illustrate the continued technology shift to four-stroke engines, which typically have lower emissions. When the current recreation vehicle regulations were written, most ATVs sold in the U.S. and almost all snowmobiles used two-stroke engines.

Table 8-4: Percentage of Two-Stroke Engine Recreational Vehicle Families, Model Years 2014 - 2017

Recreational Vehicle Type	Percentage of Two Stroke Engine Families			
	2014	2015	2016	2017
ATV/UTV	0.0%	0.0%	0.0%	0.0%
Off-Highway Motorcycles	2.0%	1.9%	2.1%	2.0%
Snowmobiles	47%	43%	43%	45%

8.2 Production Volume

Total production of recreation vehicles for the U.S. is found in Table 8-5. There were 919,317 recreational vehicles produced for the U.S. in MY 2017. As seen in both Table 8-5 and Figure 8-1, the ATV/UTV category makes up the largest share of these vehicles.

Table 8-5: Production Volume of Certified Recreational Vehicles, Model Year 2017

Recreational Vehicle Type	Production Volume	Percent
All-Terrain Vehicle/Utility Vehicle	745,923	81%
Off-highway Motorcycle	120,006	13%
Snowmobile	53,388	6%
Total:	919,317	100%

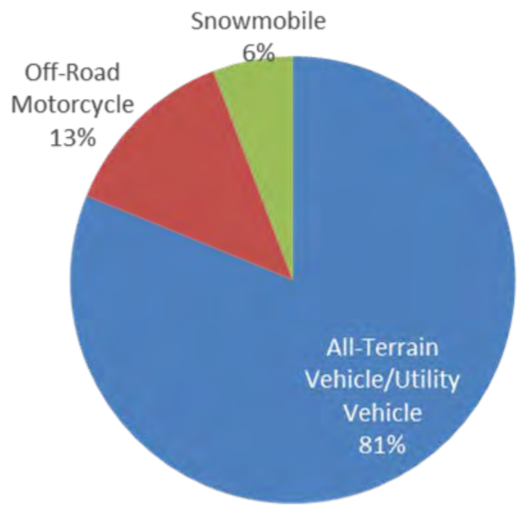

Figure 8-1: Recreational Vehicle Types, Model Year 2017

8.3 Defect Reporting

Defect reports for the entire category of recreational vehicles for calendar years 2014 – 2017 are provided by manufacture and by problem category, in Table 8-6 and Table 8-7, respectively.

Table 8-6: Recreational Vehicle Defect Reports by Manufacturer, Calendar Years 2014 - 2017

Manufacturer	Number of Defect Reports			
	2014	2015	2016	2017
Arctic Cat		0	0	1
Bombardier Recreational Products	0	1	1	3
Honda	0	1	1	1
Kawasaki	0	0	0	4
Kawasaki Motors	1	0	0	0
Polaris	0	0	1	0
Yamaha	0	0	1	0
Total:	**1**	**2**	**4**	**9**

Table 8-7: Recreational Vehicle Defect Reports by Problem Category, Calendar Years 2014 - 2017

Problem Category	Number of Defect Reports			
	2014	2015	2016	2017
Computer Related (other than OBD)	0	0	1	0
Crankcase Ventilation Component/System	0	0	1	0
Electrical, Mechanical & Cooling Systems	0	1	0	0
Engine Emission Control Information Label	0	0	0	1
Exhaust System	0	0	0	1
Fuel Delivery Component	1	1	1	5
Monitoring/Measuring Sensor/System	0	0	1	2
Total:	**1**	**2**	**4**	**9**

8.4 Recall Reporting

Recalls for recreational vehicles are shown by manufacturer and by problem category in Table 8-8 and Table 8-9, respectively.

Table 8-8: Recreational Vehicle Recalls by Manufacturer, Calendar Year 2014 - 2017

Manufacturer	2014		2015		2016		2017	
	Number of		Number of		Number of		Number of	
	Recalls	Affected Engines	Recalls	Affected Engines	Recalls	Affected Engines	Recalls	Affected Engines
Arctic Cat	0		0		0		1	1,079
Bombardier Recreational Products	0		1	244				
Kawasaki	2	20,016	0		0		4	89,472
Yamaha	0		0		1	800	0	
Total:	**2**	**20,016**	**1**	**244**	**1**	**800**	**5**	**90,551**

Table 8-9: Recreational Vehicle Recalls by Problem Type, Calendar Years 2014 - 2017

Problem Category	2014		2015		2016		2017	
	Number of		Number of		Number of		Number of	
	Recalls	Affected Engines	Recalls	Affected Engines	Recalls	Affected Engines	Recalls	Affected Engines
Crankcase Ventilation Component/System	0		0		1	800	0	
Exhaust System	0		0		0		1	22,456
Fuel Delivery Component	2	20,016	1	244	0		4	68,095
Total:	**2**	**20,016**	**1**	**244**	**1**	**800**	**5**	**90,551**

9. Alternative Fuels and Alternative Fuel Conversion Systems

This section is organized into three parts, as follows:

- Section 9.1: Information about the use of alternative fuels in the light-duty vehicle sector;
- Section 9.2: Information about heavy-duty highway engines, nonroad spark ignition engines, and recreational vehicles designed to operate on fuels other than gasoline and diesel by their original equipment manufacturers; and
- Section 9.3: Information about alternative fuel conversion systems, which are those systems that convert vehicles and engines initially certified to operate on gasoline or diesel fuel to operate on an alternative fuel. These systems are manufactured by "aftermarket providers" rather than original equipment manufacturers.

9.1 Use of Alternative Fuels in Light-Duty Vehicles

Light-duty vehicles produced for the U.S. in model years 2014 – 2017 ran on a variety of fuels. Gasoline vehicles comprise the dominant fuel type, followed by gasoline/ethanol, or "flexible fuel" vehicles. Other vehicle fuel types include gasoline/electric (i.e., plug-in hybrid vehicles (PHEV), which can run on either gasoline or electricity), electric, and hydrogen fuel cell.

Figure 9-1, which shows the percentage of vehicles produced for each fuel type for model year 2017, illustrates the dominance of gasoline fueled vehicles in the U.S. market.

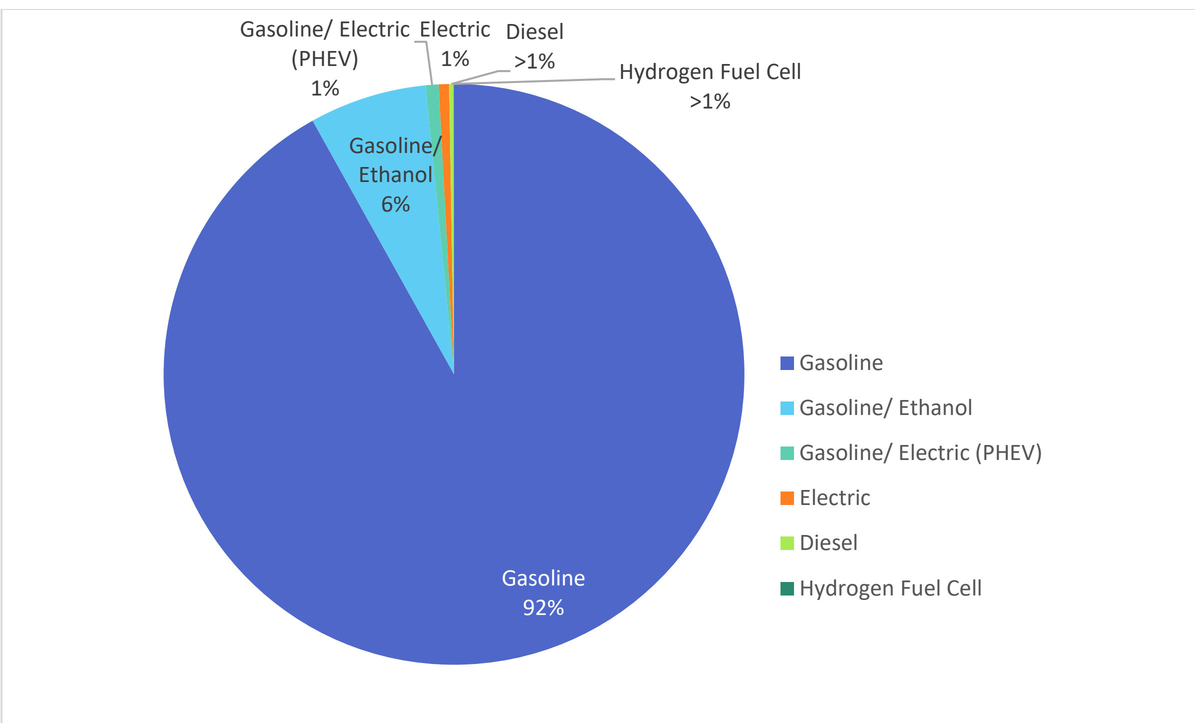

Figure 9-1: Light-Duty Vehicle Production by Fuel Type, Model Year 2017

The Figure 9-1 pie chart shows light-duty vehicle production by fuel type for only model year 2017; in contrast, Figure 9-2 and Figure 9-3 show light-duty vehicle production by fuel type for all four model years, 2014 – 2017. Figure 9-3 shows light-duty vehicle production by alternative fuel type for model year 2014-2017. That is, this figure omits gasoline and gasoline/ethanol fuel types so the other fuel types are more easily compared. In other words, the bars in Figure 9-3 are the tops of the bars in Figure 9-2; note the difference in scales in these two figures. As seen in these figures, U.S. production of diesel-fueled light-duty vehicles has declined over the four-year period, while production of electric vehicles has steadily increased. Production of plug-in hybrid vehicles in model year 2017 is more than double that of model year 2014. (The colors representing the fuel types are consistent across Figure 9-1, Figure 9-2, and Figure 9-3.)

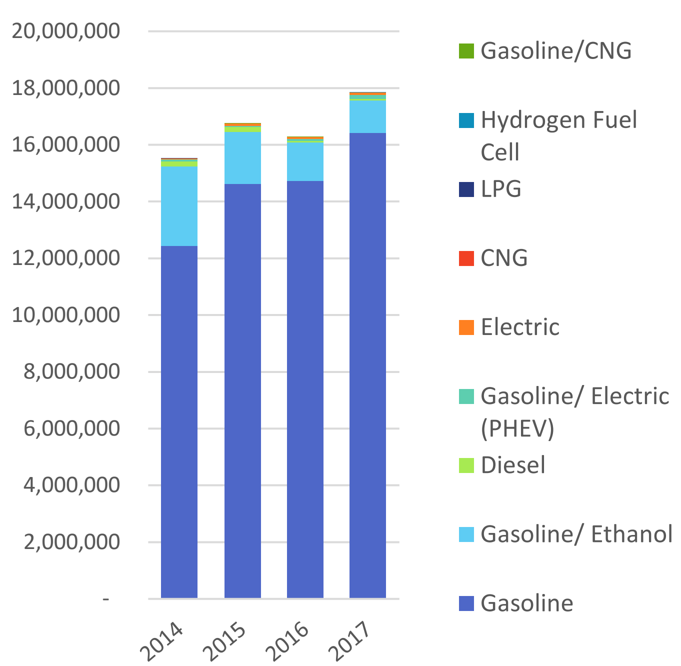

Figure 9-2: Light-Duty Vehicle Production Volume by Fuel Type, Model Years 2014 - 2017

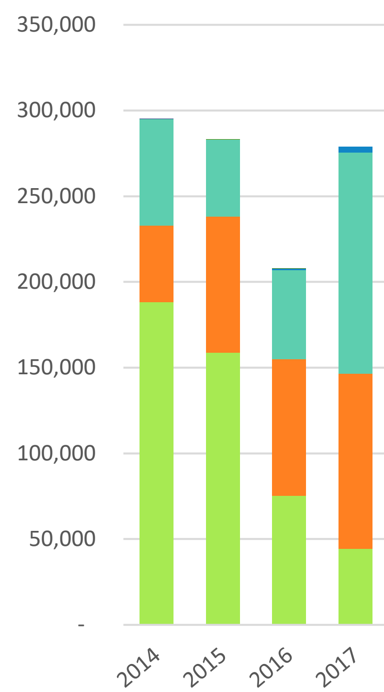

Figure 9-3: Light-Duty Vehicle Production Volume by Alternative Fuel Type, Model Years 2014 - 2017

9.2 Vehicles and Engines Designed to Operate on Alternative Fuels by Their Manufacturers

9.2.1 Heavy-Duty Highway Engines

Table 9-1 presents the heavy-duty highway engines that were certified to operate on alternative fuels in model years 2014 – 2017 by their original manufacturer.

Table 9-1: Heavy-Duty Highway Engine Alternative Fuel Engine Families by Original Equipment Manufacturer, Model Years 2014 - 2017

Alternative Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
LPG	CleanFuel USA Inc.	0	0	1	2
	Greenkraft Inc.	0	0	1	0
	Power Solutions International, Inc.	0	0	0	2
Natural Gas	Cummins Inc.	4	5	3	8
	Greenkraft Inc.	0	0	2	1
	Landi Renzo USA Corporation	0	1	0	0
	Power Solutions International, Inc.	0	0	0	2
	Roush Industries, Inc.	0	0	1	1
Propane	Greenkraft Inc.	0	0	1	1
Total:		**4**	**6**	**9**	**17**

9.2.2 Nonroad Spark Ignition Engines

There are numerous engine manufacturers that certify nonroad spark ignition engines to run on alternative fuels in both the Small SI and Large SI categories.

Table 9-2 shows the model years 2014-2017 alternative fuel Small SI engine families certified, by type of alternative fuel and manufacturer.

Table 9-2: Small SI Engine Families by Fuel Type and Original Equipment Manufacturer, Model Years 2014 -2017

Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
Gasoline - E85	Kohler Co.	1	1	1	1
Natural Gas	Aisin World Corp. of America	2	2	1	1
	Arrow Engine Company	6	6	5	5
	Cummins Power Generation	2	2	2	2
	Diadema Engine	2			
	Kubota Corporation	1	1	1	1
	Repair Processes, Incorporated	1	1	1	1
	Yanmar Co., Ltd.	2	2	1	3
Natural Gas/Propane	Aisin World Corp. of America			1	1
	American Honda Motor Co., Inc.	1	1	1	1
	Briggs & Stratton Corporation	5	5	4	3
	Carburetion & Turbo Systems, Inc.	1	1	1	1
	Chongqing Dajiang Power Equipment Co.,Ltd.	2	2	3	4
	Fuji Heavy Industries	1	1	1	1
	Generac Power Systems, Inc.	6	4	4	5
	Kohler Co.	1	4	4	4
	Lifan Industry (Group) Co., Ltd.	3	3	1	
	Marathon Engine Systems		1	1	1
	New England Gen-Connect LLC			2	2
	Shanghai Chenchang Power Technology Co., Ltd		2		
	Shanghai Grow Development Co., Ltd.	2			
	Zhejiang Yaofeng Power Technology Co., Ltd.		2	2	3
Natural Gas/ Propane/Gasoline	Chongqing Dajiang Power Equipment CO.,LTD	2	2	3	5
	Chongqing Maifeng Power Machinery Co., Ltd	2	4	4	4
	Chongqing Sanding General Power Machinery Co., Ltd.	2	4	4	4
	Gaoyou City Shenfa Electrical and Mechanical Manufacture Co.,Ltd			3	3
	Kohler Co.			1	2
	Kubota Corporation		1	1	1
	Lifan Industry (Group) Co., Ltd.	1	1	3	4
	Wenling Jennfeng Industry Inc.	1	2	2	2
	Winco	1	1	1	1
Propane	Amano Pioneer Eclipse Corporation	1	1	1	1
	Aztec Products Inc.	3	3	4	4
	BETCO Corporation	1	1	1	1

Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
	Blossman Services, Inc.	1	1		
	Briggs & Stratton Corporation				1
	Carburetion & Turbo Systems, Inc.		1	1	1
	China Xingyue Group Co.,Ltd.	1	1	1	
	Cummins Power Generation	3	3	3	3
	Feldmann Eng. & Mfg. Co., Inc.	2	2	2	2
	Fuji Heavy Industries	1	1	1	1
	Fuzhou Launtop M&E Co., Ltd.		2	2	2
	Gaoyou City Shenfa Electrical and Mechanical Manufacture Co.,Ltd		3		
	Generac Power Systems, Inc.	3	2	2	2
	Hendrix Industrial Gastrux, Inc.	3	3	3	3
	Jiangsu Jiangdong Group Co. Ltd.	4	4	4	4
	Kawasaki Motors Corp., U.S.A.	1	1	1	1
	Kohler Co.	2	2	1	3
	LEHR LLC		4	4	4
	Linyi Sanhe Yongjia Power Co.,Ltd.	1	1		
	Loncin Motor Co., Ltd.	2	2	2	2
	METROLAWN, LLC	7	8	8	
	New England Gen-Connect LLC			1	1
	Nilfisk Advance	2	2		1
	Onyx Environmental Solutions	2	2		
	Propane Power Systems, LLC		3	5	7
	Shandong Yongjia Power Co., Ltd.			1	1
	Shanghai Chenchang Power Technology Co., Ltd		1		
	Shanghai Grow Development Co., Ltd.	1			
	STK LLC	2	2	2	2
	Superabrasive Inc.			1	1
	Tacony Corporation	1	1	1	1
	TWEnterprises				1
	Whitestorm Inc.	1	1	1	1
	Yanmar Co., Ltd.	2	2		2
	Zhejiang Xingyue Industry Co.,Ltd				2
	Zhejiang Yaofeng Power Technology Co., Ltd.	1	1		
Propane/Gasoline	ChongQing AM Pride Power & Machinery Co., Ltd			1	1
	Chongqing Huansong Science And Technology Industrial Co.,Ltd.	1	1	1	1
	Gaoyou City Shenfa Electrical and Mechanical Manufacture Co.,Ltd		3		
	Kubota Corporation	3	3	3	3

Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
	Power Solutions International, Inc.	1	1	1	1
	Sumec Machinery & Electric Co., Ltd.			2	2
	Wenling Jennfeng Industry Inc.	2	6	4	5
	Yongkang Xingguang Electrical Manufacture Co., Ltd	8	8	8	7
	Yueqing Hejie Electric Co., Ltd	3			
	Zhejiang Constant Engine Mading Co., Ltd.		1		
	Zhejiang Yaofeng Power Technology Co., Ltd.	2	2	5	6
Total		**116**	**142**	**137**	**147**

Table 9-3 provides a summary of alternative fuel Small SI engine families by fuel type only.

Table 9-3: Small SI Engine Families by Fuel Type Only, Model Years 2014 - 2017

Fuel Type	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Gasoline - E85	1	1	1	1
Natural Gas	16	14	11	13
Natural Gas/Propane	22	26	25	26
Natural Gas/Propane/Gasoline	9	15	22	26
Propane	48	61	53	55
Propane/Gasoline	20	25	25	26
Total	**116**	**142**	**137**	**147**

Table 9-4 shows the model years 2014-2017 alternative fuel Large SI engine families certified, by type of alternative fuel and manufacturer.

Table 9-4: Large SI Engine Families by Fuel Type and Original Equipment Manufacturer, Model Years 2014 - 2017

Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
Natural Gas	2G Energietechnik GmbH			1	1
	Aegenco, Inc.		1	1	1
	Briggs & Stratton Corporation			1	
	Bucks Engines	4	4		
	Caterpillar Inc.			2	2
	Cummins Inc.	7	6	6	7
	Deutz AG	2	5	5	5
	ENER-G Rudox Inc.	2	3	3	2
	Engine Distributors, Inc.	1	1	1	3
	GE Jenbacher, Ltd.	1	1	1	1
	Generac Power Systems, Inc.	34	33	36	41
	Graham Ford Power Products	1	2		
	Guascor Power S.A.U.	5	8	8	8
	IMPCO Technologies, Inc.	2	2		
	Industrial Engines Ltd.	2	1	1	
	KEM Equipment, Inc.	1	1		
	Kohler Co.	2	2	3	3
	Mitsubishi Heavy Industries Engine & Turbocharger, Ltd.				2
	Mitsubishi Heavy Industries, Ltd.	2	2	2	
	Power Solutions International, Inc.	1	1	1	1
	Tecogen				4
	Weichai America Corporation		2		1
	Wisconsin Engines, LLC.			1	
	Wisconsin Motors, LLC.	1	1		
	Yanmar Co., Ltd.			1	2
	Zenith Power Products	1	1		
Natural Gas/Propane	Bucks Engines	2	2		
	Caterpillar Inc.	1	1	1	1
	Chongqing Panda Machinery Co., Ltd.	2	3	2	2
	Computer Science				1
	Cummins Inc.	5	6	8	10
	Don Hardy Race Cars, Inc.	1	1	1	1
	Dresser, Inc.	1	1	1	3
	Engine Distributors, Inc.				1
	Generac Power Systems, Inc.			1	1
	Graham Ford Power Products			1	
	KEM Equipment, Inc.	9	9	10	10
	Kubota Corporation	1	1	1	

Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
	MTU America, Inc.		5	5	7
	Origin Engines	2	3	3	4
	Power Solutions International, Inc.	14	14	13	13
	Springfield Remanufacturing Corp.			1	4
	SRC Power Systems, Inc.	5	4	3	
	Tognum America, Inc.	3			
	Weichai America Corporation				1
	Westport Power Inc.	1	1	2	1
	Zenith Power Products	2	3	7	7
Natural Gas/Propane/Gasoline	Engine Distributors, Inc.	3	4	4	4
	IMPCO Technologies, Inc.	1	1		
	Kubota Corporation	3	5	5	5
	Power Solutions International, Inc.	2	3	6	6
	Toyota Industrial Equipment Manufacturing, Inc.	1	1	1	1
	Zenith Power Products	2	3	3	3
Propane	Bucks Engines	1	1		
	Crown Equipment Corporation	1	1	1	2
	Engine Distributors, Inc.	1	1	1	3
	Generac Power Systems, Inc.	21	21	22	22
	Graham Ford Power Products	1	2	2	1
	IMPCO Technologies, Inc.	3	4	2	
	KEM Equipment, Inc.	2	2	2	2
	KION North America Corp.			2	2
	Kohler Co.	2	2	3	3
	Linde Material Handling N.A. Corp.	2	2		
	Power Solutions International, Inc.	2	2	3	4
	Weichai America Corporation				1
	Westport Power Inc.				1
	Woodward, Inc.	1	1	1	
Propane/Gasoline	Bucks Engines	2	2		
	EControls, Inc.	1		1	1
	Global Component Technologies Corporation	3	3	3	3
	IMPCO Technologies, Inc.	3	2	2	
	KEM Equipment, Inc.	3	3	3	3
	Kubota Corporation	1	1	1	1
	Power Solutions International, Inc.	2			
	Toyota Industrial Equipment Manufacturing, Inc.	1	1	1	1
	Westport Power Inc.				1

Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
	Wisconsin Engines, LLC.			1	1
	Wisconsin Motors, LLC.	1	1		
	Woodward, Inc.	2	2	1	1
	Zenith Power Products	3	2	2	
Total:		**189**	**204**	**207**	**223**

Table 9-5 provides a summary of Table 9-4, showing alternative fuel large spark ignition engine families by fuel type only.

Table 9-5: Large SI Engine Families by Fuel Type Only, Model Years 2014-2017

Fuel Type	Number of Engine Families			
	MY 2017	MY 2017	MY 2017	MY 2017
Natural Gas	69	77	74	84
Natural Gas/Propane	49	54	60	67
Natural Gas/Propane/Gasoline	12	17	19	19
Propane	37	39	39	41
Propane/Gasoline	22	17	15	12
Total	**189**	**204**	**207**	**223**

9.2.3 Recreational Vehicles

The majority of recreational vehicles are certified to operate on gasoline. However, a small number of manufacturers certified recreational vehicles to operate on diesel fuel in model year 2014 – 2017, as shown in Table 9-6.

Table 9-6: Recreational Vehicle Diesel Engine Families by Original Equipment Manufacturer, Model Years 2014-2017

Manufacturer	Number of Engine Families			
	MY 2014	MY 2015	MY 2016	MY 2017
Deere & Company	1	1	1	1
JCB, Inc.	1			
Polaris Industries Inc.	1			

9.3 Alternative Fuel Conversions Systems

Alternative fuel conversion systems modify vehicles and engines so that they can run on different fuels than the ones for which they were originally designed. Any change to the manufacturer's original vehicle or engine design is a potential violation of the Clean Air Act and can cause problems, including increased emissions. Therefore, EPA has established protocols through which conversion manufacturers can demonstrate that:

- Emission controls in the converted vehicle or engine will continue to function properly; and
- Pollution will not increase as a result of conversion.[42]

The process for converters of new vehicles is much like the certification process for original equipment manufacturers and involves obtaining a Certificate of Conformity. The regulations establish alternative pathways that do not involve certification for conversion systems intended for use on older vehicles and engines (40 CFR part 85, subpart F).

9.3.1 Light-Duty Vehicles

In the light-duty vehicle alternative fuel conversion sector, a total of 25 Alternative Fuel Conversion Manufacturers were issued conversion system certificates for MYs 2014 – 2017. These manufacturers are listed in Table 9-7, which shows the number of test groups for light-duty vehicle alternative fuel conversion systems by alternative fuel type in 2014 - 2017.

[42] For more information, see EPA's website at: www.epa.gov/vehicle-and-engine-certification/vehicle-and-engine-alternative-fuel-conversions.

Table 9-7: Light-Duty Alternative Fuel Conversion System Test Groups by Manufacturer, Model Years 2014 - 2017

Alternative Fuel Type	Manufacturer	Light-Duty Alternative Fuel Conversion Test Groups			
		2014	2015	2016	2017
CNG	AC Spolka Akcyjna	2	4	0	0
	AGA Systems, LLC	4	4	4	5
	Altech-Eco Corporation	8	6	14	15
	BAF Technologies	7	3	0	0
	CNG Interstate of Oklahoma, LLC	2	2	0	0
	Crazy Diamond Performance Inc.	1	1	1	0
	Encore TEC LLC	0	0	1	3
	IMPCO Technologies, Inc.	6	7	9	0
	Landi Renzo USA Corporation	2	1	3	8
	M-tech Solutions Inc	1	1	1	0
	Nat Gas Car LLC	5	2	1	0
	PowerFuel CNG Conversions, LLC	7	1	2	1
	STAG USA	0	0	2	2
	The CNG Store, LLC; dba Auto Gas America	5	0	0	0
	Westport Dallas, Inc	0	0	6	5
	Westport Power Inc.	1	1	0	0
	World CNG	3	5	0	0
LPG	AGA Systems, LLC	0	0	3	2
	American Alternative Fuel	2	1	0	0
	Blossman Services, Inc.	8	11	14	13
	CleanFuel USA Inc.	0	4	3	2
	Icom North America LLC	11	9	29	25
	Imega International USA	0	1	0	0
	IMPCO Technologies, Inc.	2	3	4	1
	Roush Industries, Inc.	2	1	1	0
	STAG USA	0	0	4	2
	Westport Dallas, Inc	0	0	4	6
	Yellow Checker Star Transportation	0	1	2	1
PHEV	VIA Motors, Inc.	1	1	0	0
Total:		**80**	**70**	**108**	**91**

9.3.2 Heavy-Duty Vehicles and Engines

Table 9-8 shows the heavy-duty highway alternative fuel conversion system certificates issued for model years 2014 - 2017.

Table 9-8: Heavy-Duty Highway Engine Alternative Fuel Conversion System Certificates by Manufacturer, Model Years 2014 - 2017

Alternative Fuel Type	Manufacturer	MY 2014	MY 2015	MY 2016	MY 2017
CNG	Encore TEC LLC	0	0	6	4
	Greenkraft Inc.	2	3	0	1
	IMPCO Technologies, Inc.	3	3	4	2
	Landi Renzo USA Corporation	3	3	3	3
	NGV Motori, USA, LLC	2	1	0	1
	Omnitek	1	1	0	0
	Power Solutions International, Inc.	0	1	1	0
	Westport Dallas, Inc/BAF	2	2	2	2
CNG/Gasoline	AGA Systems, LLC	4	1	1	1
	IMPCO Technologies, Inc.	1	1	0	0
	Landi Renzo USA Corporation	1	1	0	0
	Westport Dallas, Inc/BAF	1	0	0	0
LPG	Bi-Phase Technologies, LLC.	3	1	1	0
	Clean Fuel USA Inc.	2	2	0	0
	Greenkraft Inc.	2	1	0	1
	Icom North America LLC	1	1	0	2
	Parnell	0	0	2	0
	Power Solutions International, Inc.	0	1	3	0
	Propane Fuel Technologies LLC	0	1	0	0
	Roush Industries, Inc.	2	4	2	2
LPG/Gasoline	Blossman Services, Inc.	1	2	0	1
	Icom North America LLC	0	0	0	2
CNG/Diesel	Clean Air Power	0	1	0	0
Total		**31**	**31**	**25**	**22**

9.3.3 Conversion Systems for Intermediate Age and Outside Useful Life Vehicles

Table 9-9 shows the number of EPA-listed alternative fuel conversion systems intended for use on older vehicles for model years 2014 – 2017. This table includes both light-duty and heavy-duty vehicle alternative fuel conversion systems.

Table 9-9: Alternative Fuel Conversions Systems by Program Type, Model Years 2014 - 2017

Program	MY 2014	MY 2015	MY 2016	MY 2017
Intermediate Age	42	68	20	5
Outside Useful Life	10	2	1	1