List of Subjects in 33 CFR Part 165

Harbors, Marine safety, Navigation (water), Reporting and recordkeeping requirements, Security measures, Waterways.

For the reasons discussed in the preamble, the Coast Guard amends 33 CFR part 165 as follows:

PART 165—REGULATED NAVIGATION AREAS AND LIMITED ACCESS AREAS

■ 1. The authority citation for part 165 continues to read as follows:

Authority: 46 U.S.C. 70034, 70051, 70124; 33 CFR 1.05–1, 6.04–1, 6.04–6, and 160.5; Department of Homeland Security Delegation No. 00170.1, Revision No. 01.3.

■ 2. Add § 165.T08–0797 to read as follows:

§ 165.T08–0797 Safety Zone; Cumberland River, Nashville, TN.

(a) *Location.* The following area is a safety zone: All navigable waters of the Cumberland River from Mile Marker 190 through 191, extending the entire width of the river.

(b) *Definitions.* As used in this section, *designated representative* means a Coast Guard Patrol Commander, including a Coast Guard coxswain, petty officer, or other officer operating a Coast Guard vessel and a Federal, State, and local officer designated by or assisting the Captain of the Port Sector Ohio Valley (COTP) in the enforcement of the safety zone.

(c) *Regulations.* (1) Under the general safety zone regulations in subpart C of this part, you may not enter the safety zone described in paragraph (a) of this section unless authorized by the COTP or the COTPs designated representative.

(2) To seek permission to enter, contact the COTP or the COTP's representative by 502–779–5422 or on VHR–FM channel 16. Those in the safety zone must comply with all lawful orders or directions given to them by the COTP or the COTP's designated representative.

(d) *Enforcement period.* This section will be enforced from 7 a.m. through 6 p.m. daily on October 21, 2023 through October 22, 2023.

Dated: October 16, 2023.

H.R. Mattern,

Captain, U.S. Coast Guard, Captain of the Port Sector Ohio Valley.

[FR Doc. 2023–23236 Filed 10–19–23; 8:45 am]

BILLING CODE 9110–04–P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 87, 1031, and 1068

[EPA–HQ–OAR–2022–0389; FRL–5934–02–OAR]

RIN 2060–AT10

Finding That Lead Emissions From Aircraft Engines That Operate on Leaded Fuel Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final action.

SUMMARY: In this action, the Administrator finds that lead air pollution may reasonably be anticipated to endanger the public health and welfare within the meaning of the Clean Air Act. The Administrator also finds that engine emissions of lead from certain aircraft cause or contribute to the lead air pollution that may reasonably be anticipated to endanger public health and welfare under the Clean Air Act.

DATES: These findings are effective on November 20, 2023.

ADDRESSES: The EPA has established a docket for this action under Docket ID No. EPA–HQ–OAR–2022–0389. All documents in the docket are listed in the *https://www.regulations.gov* website. Publicly available docket materials are available either electronically in *https://www.regulations.gov* or in hard copy at the EPA Air and Radiation Docket and Information Center, William Jefferson Clinton West Building, Room 3334, 1301 Constitution Ave. NW, Washington, DC. The Public Reading Room is open from 8:30 a.m. to 4:30 p.m., Monday through Friday, excluding legal holidays. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566–1742.

FOR FURTHER INFORMATION CONTACT: Ken Davidson, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency; telephone number: (415) 972–3633; email address: *davidson.ken@epa.gov.*

SUPPLEMENTARY INFORMATION:

A. General Information

Does this action apply to me?

Regulated entities: These final findings do not themselves apply new requirements to entities other than the EPA and the FAA. With respect to requirements for the EPA and the FAA, as indicated in the proposal for this action, if the EPA issues final findings that emissions of lead from certain classes of engines used in certain aircraft cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, the EPA then becomes subject to a duty to propose and promulgate emission standards pursuant to section 231 of the Clean Air Act. Upon EPA's issuance of regulations, the FAA shall prescribe regulations to ensure compliance with the EPA's emission standards pursuant to section 232 of the Clean Air Act. In contrast to the findings, those future standards would apply to and have an effect on other entities outside the Federal Government. In addition, pursuant to 49 U.S.C. 44714, the FAA has a statutory mandate to prescribe standards for the composition or chemical or physical properties of an aircraft fuel or fuel additive to control or eliminate aircraft emissions which the EPA has found endanger public health or welfare under section 231(a) of the Clean Air Act. In issuing these final findings, the EPA is making such a finding for emissions of lead from engines in covered aircraft.

The classes of aircraft engines and of aircraft relevant to this final action are referred to as ''covered aircraft engines'' and as ''covered aircraft,'' respectively throughout this document. Covered aircraft engines in this context means any aircraft engine that is capable of using leaded aviation gasoline. Covered aircraft in this context means all aircraft and ultralight vehicles [1] equipped with covered engines. Covered aircraft would, for example, include smaller piston-engine aircraft such as the Cessna 172 (single-engine aircraft) and the Beechcraft Baron G58 (twin-engine aircraft), as well as the largest piston-engine aircraft such as the Curtiss C–46 and the Douglas DC–6. Other examples of covered aircraft would include rotorcraft,[2] such as the Robinson R44 helicopter, light-sport aircraft, and ultralight vehicles equipped with piston engines. Because the majority of covered aircraft are piston-engine powered, this document focuses on those aircraft (in some contexts the EPA refers to these same engines as reciprocating engines). All such references and examples used in this document are covered aircraft as defined in this paragraph.

[1] The FAA regulates ultralight vehicles under 14 CFR part 103.

[2] Rotorcraft encompass helicopters, gyroplanes, and any other heavier-than-air aircraft that depend principally for support in flight on the lift generated by one or more rotors.

Entities potentially interested in this final action include those that manufacture and sell covered aircraft engines and covered aircraft in the United States and those who own or operate covered aircraft. Categories that may be affected by a future regulatory action include, but are not limited to, those listed here:

Category	NAICS [a] code	SIC [b] code	Examples of potentially affected entities
Industry	3364412	3724	Manufacturers of new aircraft engines.
Industry	336411	3721	Manufacturers of new aircraft.
Industry	481219	4522	Aircraft charter services (*i.e.,* general purpose aircraft used for a variety of specialty air and flying services). Aviation clubs providing a variety of air transportation activities to the general public.
Industry	611512	8249 and 8299	Flight training.

[a] North American Industry Classification System (NAICS).
[b] Standard Industrial Classification (SIC) code.

This table is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be interested in this final action. This table lists examples of the types of entities that the EPA is now aware of that could potentially have an interest in this final action. Other types of entities not listed in the table could also be interested and potentially affected by subsequent actions at some future time. If you have any questions regarding the scope of this final action, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section of this document.

B. Children's Health

Children are generally more vulnerable to environmental exposures and/or the associated health effects, and therefore more at risk than adults. These risks to children may arise because infants and children generally eat more food, drink more water and breathe more air than adults do, relative to their size, and consequently they may be exposed to relatively higher amounts of contaminants. In addition, normal childhood activity, such as putting hands in mouths or playing on the ground, can result in exposures to contaminants that adults do not typically have. Furthermore, environmental contaminants may pose health risks specific to children because children's bodies are still developing. For example, during periods of rapid growth such as fetal development, infancy and puberty, their developing systems and organs may be more easily harmed.[3]

Protecting children's health from environmental risks is fundamental to the EPA's mission. This action is subject to EPA's Policy on Children's Health because this action has considerations for human health.[4] Consistent with this policy this document includes discussion and analysis that is focused particularly on children including early life exposure (the lifestages from conception, infancy, early childhood and through adolescence until 21 years of age) and lifelong health. For example, as described in section IV. of this document, the scientific evidence has long been established demonstrating that young children (due to rapid growth and development of the brain) are vulnerable to a range of neurological effects resulting from exposure to lead. Low levels of lead in young children's blood have been linked to adverse effects on intellect, concentration, and academic achievement, and as the EPA has previously noted ''there is no evidence of a threshold below which there are no harmful effects on cognition from [lead] exposure.'' [5] Evidence suggests that while some neurocognitive effects of lead in children may be transient, some lead-related cognitive effects may be irreversible and persist into adulthood, potentially contributing to lower educational attainment and financial well-being.[6] The 2013 Lead Integrated Science Assessment notes that in epidemiologic studies, postnatal (early childhood) blood lead levels are consistently associated with cognitive function decrements in children and adolescents.[7] In addition, in section II.A.5. of this document, we describe the number of children living near and attending school near airports and provide a proximity analysis of the potential for greater representation of children in the near-airport environment compared with neighboring areas.

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

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

[5] EPA (2013) ISA for Lead. Executive Summary ''Effects of Pb Exposure in Children.'' pp. lxxxvii–lxxxviii. EPA/600/R–10/075F, 2013. See also, National Toxicology Program (NTP) (2012) NTP Monograph: Health Effects of Low-Level Lead. Available at *https://ntp.niehs.nih.gov/go/36443.*

[6] EPA (2013) ISA for Lead. Executive Summary ''Effects of Pb Exposure in Children.'' pp. lxxxvii–lxxxviii. EPA/600/R–10/075F, 2013.

[7] EPA (2013) ISA for Lead. Section 1.9.4. ''Pb Exposure and Neurodevelopmental Deficits in Children.'' p. I–75. EPA/600/R–10/075F, 2013.

I. Executive Summary

Pursuant to section 231(a)(2)(A) of the Clean Air Act (CAA or Act), the Administrator finds that emissions of lead from covered aircraft engines cause or contribute to lead air pollution that may reasonably be anticipated to endanger public health and welfare. Covered aircraft include, for example, smaller piston-engine aircraft such as the Cessna 172 (single-engine aircraft) and the Beechcraft Baron G58 (twin-engine aircraft), as well as the largest piston-engine aircraft such as the Curtiss C–46 and the Douglas DC–6. Other examples of covered aircraft include rotorcraft, such as the Robinson R44 helicopter, light-sport aircraft, and ultralight vehicles equipped with piston engines.

For purposes of this action, the EPA defines the ''air pollution'' referred to in section 231(a)(2)(A) of the CAA as lead, which we also refer to as the lead air pollution in this document.[8] In finding that the lead air pollution may reasonably be anticipated to endanger the public health and welfare, the EPA relies on the extensive scientific evidence critically assessed in the 2013 Integrated Science Assessment for Lead (2013 Lead ISA) and the previous Air Quality Criteria Documents (AQCDs) for Lead, which the EPA prepared to serve as the scientific foundation for periodic reviews of the National Ambient Air Quality Standards (NAAQS) for lead.[9 10 11 12]

Further, for purposes of this action, the EPA defines the ''air pollutant'' referred to in CAA section 231(a)(2)(A) as lead, which we also refer to as the lead air pollutant in this document.[13] Accordingly, the Administrator finds that emissions of the lead air pollutant from covered aircraft engines cause or contribute to the lead air pollution that may reasonably be anticipated to endanger public health and welfare under CAA section 231(a)(2)(A).

This final action follows the Administrator's proposed findings[14] and includes responses to public comments submitted to the EPA on that proposal. The proposal was posted on the EPA website on October 7, 2022, and published in the **Federal Register** on October 17, 2022. The EPA held a virtual public hearing on November 1, 2022, and the public comment period closed on January 17, 2023. During the public comment period, we received more than 53,000 comments.[15] The EPA received late comments, and to the extent feasible we have responded to those comments in the Response to Comments document for this action.

A broad range of stakeholders provided comments, including state and local governments; non-governmental organizations; industry trade associations representing aircraft engine and airframe manufacturers, fuel producers, fuel distributors, fuel providers, the helicopter industry, and aircraft owners and operators; environmental organizations; environmental justice organizations; one Tribe; private citizens; and others. In this notice for this final action, we summarize and respond to certain issues raised by commenters, and we provide responses to the remainder of comments in the Response to Comments document that is available in the public docket for this action.[16]

Section II. of this action includes an overview and background information that is helpful to understanding the source sector in the context of this action, a brief summary of some of the Federal actions focused on reducing lead exposures, and a brief summary of the petitions for rulemaking regarding lead emissions from aircraft engines. Section III. of this document provides the legal framework for this action, section IV. provides the EPA's final determination on the endangerment finding, section V. provides the EPA's final determination on the cause or contribute finding, and section VI. discusses various statutory authorities and executive orders.

II. Overview and Context for This Final Action

We summarize here background information that provides additional context for this final action. This includes information on the population of aircraft that have piston engines, information on the use of leaded aviation gasoline (avgas) in covered aircraft, physical and chemical characteristics of lead emissions from engines used in covered aircraft, concentrations of lead in air from these engine emissions, and the fate and transport of lead emitted by engines used in such aircraft. We also include here an analysis of populations residing near and attending school near airports and an analysis of potential environmental justice implications with regard to residential proximity to runways where covered aircraft operate. This section ends with a description of a broad range of Federal actions to reduce lead exposure from a variety of environmental media and a brief summary of citizen petitions for rulemaking regarding lead emissions from covered aircraft and the EPA responses.

A. Background Information Helpful To Understanding This Final Action

This final action draws extensively from the EPA's scientific assessments for lead, which are developed as part of the EPA's periodic reviews of the air quality criteria[17] for lead and the lead

[8] As noted in section IV.A. of this document, the lead air pollution can occur as elemental lead or in lead-containing compounds.

[9] EPA (2013) ISA for Lead. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[10] EPA (2006) Air Quality Criteria for Lead. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[11] EPA (1986) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–83/028aF-dF, 1986.

[12] EPA (1977) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[13] As noted in section V.A. of this document, the lead air pollutant can occur as elemental lead or in lead-containing compounds.

[14] EPA (2022) Proposed Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution that May Reasonably Be Anticipated to Endanger Public Health and Welfare 87 FR 62753 (October 17, 2022).

[15] Of these comments, more than 600 were unique letters, some of which provided data and other information for EPA to consider; the remaining comments were mass mailers sponsored by four different organizations, all of which urged the EPA to take action to finalize the findings and/or to take regulatory action to eliminate lead emissions from aircraft operating on leaded avgas.

[16] U.S. EPA, ''Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution that May Reasonably Be Anticipated to Endanger Public Health and Welfare—Response to Comments,'' Docket EPA–HQ–OAR–2022–0389.

[17] Under section 108(a)(2) of the CAA, air quality criteria are intended to ''accurately reflect the latest

NAAQS.[18] These scientific assessments provide a comprehensive review, synthesis, and evaluation of the most policy-relevant science that builds upon the conclusions of previous assessments. In the information that follows, we discuss and describe scientific evidence summarized in the most recent assessment for lead, the 2013 Lead ISA,[19 20] as well as information summarized in previous assessments, including the 1977, 1986, and 2006 AQCDs.[21 22 23]

As described in the 2013 Lead ISA, lead emitted to ambient air is transported through the air and is distributed from air to other environmental media through deposition.[24] Lead emitted in the past can remain available for environmental or human exposure for an extended time in some areas.[25] Depending on the environment where it is deposited, it may to various extents be resuspended into the ambient air, integrated into the media on which it deposits, or transported in surface water runoff to other areas or nearby waterbodies.[26] Lead in the environment today may have been airborne yesterday or emitted to the air long ago.[27] Over time, lead that was initially emitted to air can become less available for environmental circulation by sequestration in soil, sediment and other reservoirs.[28]

The multimedia distribution of lead emitted into ambient air creates multiple air-related pathways of human and ecosystem exposure. These pathways may involve media other than air, including indoor and outdoor dust, soil, surface water and sediments, vegetation and biota. The human exposure pathways for lead emitted into air include inhalation of ambient air or ingestion of food, water or other materials, including dust and soil, that have been contaminated through a pathway involving lead deposition from ambient air.[29] Ambient air inhalation pathways include both inhalation of air outdoors and inhalation of ambient air that has infiltrated into indoor environments.[30] The air-related ingestion pathways occur as a result of lead emissions to air being distributed to other environmental media, where humans can be exposed to it via contact with and ingestion of indoor and outdoor dusts, outdoor soil, food and drinking water.

The scientific evidence documents exposure to many sources of lead emitted to the air that have resulted in higher blood lead levels, particularly for people living or working near sources, including stationary sources, such as mines and smelters, and mobile sources, such as cars and trucks when lead was a gasoline additive.[31 32 33 34 35 36] Similarly, with regard to emissions from engines used in covered aircraft, there have been studies reporting positive associations of children's blood lead levels with proximity to airports and activity by covered aircraft,[37 38 39] thus indicating potential for children's exposure to lead from covered aircraft engine emissions. A recent study evaluating cardiovascular mortality rates in adults 65 and older living within a few kilometers and downwind of runways, while not evaluating blood lead levels, found higher mortality rates in adults living near single-runway airports in years with more piston-engine air traffic, but not in adults living near multi-runway airports, suggesting the potential for adverse adult health effects near some airports.[40]

1. Piston-Engine Aircraft and the Use of Leaded Aviation Gasoline

Aircraft operating in the U.S. are largely powered by either turbine engines or piston engines, although other propulsion systems are in use and in development. Turbine-engine powered aircraft and a small percentage of piston-engine aircraft (*i.e.,* those with diesel engines) operate on fuel that does not contain a lead additive. Covered aircraft, which are predominantly piston-engine powered aircraft, operate on leaded avgas. Examples of covered aircraft include smaller piston-powered aircraft such as the Cessna 172 (single-engine aircraft) and the Beechcraft Baron G58 (twin-engine aircraft), as well as the largest piston-engine aircraft such as the Curtiss C–46 and the Douglas DC–6. Additionally, some rotorcraft, such as the Robinson R44 helicopter, light-sport aircraft, and ultralight vehicles can have piston engines that operate using leaded avgas. In limited cases, some turbopropeller-powered aircraft (also

scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health or welfare which may be expected from the presence of [a] pollutant in the ambient air . . . .'' Section 109 of the CAA directs the Administrator to propose and promulgate ''primary'' and ''secondary'' NAAQS for pollutants for which air quality criteria are issued. Under CAA section 109(d)(1), EPA must periodically complete a thorough review of the air quality criteria and the NAAQS and make such revisions as may be appropriate in accordance with sections 108 and 109(b) of the CAA. A fuller description of these legislative requirements can be found, for example, in the ISA (see 2013 Lead ISA, p. lxix).

[18] Section 109(b)(1) defines a primary standard as one ''the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health.'' A secondary standard, as defined in section 109(b)(2), must ''specify a level of air quality the attainment and maintenance of which in the judgment of the Administrator, based on such criteria, is requisite to protect the public welfare from any known or anticipated adverse effects associated with the presence of [the] pollutant in the ambient air.''

[19] EPA (2013) ISA for Lead. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[20] The EPA released the ISA for Lead External Review Draft as part of the Agency's current review of the science regarding health and welfare effects of lead. EPA/600/R–23/061. This draft assessment is undergoing peer review by the Clean Air Scientific Advisory Committee (CASAC) and public comment, and is available at: *https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=357282.*

[21] EPA (1977) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[22] EPA (1986) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–83/028aF-dF (NTIS PB87142386), 1986.

[23] EPA (2006) Air Quality Criteria for Lead. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[24] EPA (2013) ISA for Lead. Section 3.1.1. ''Pathways for Pb Exposure.'' p. 3–1. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[25] EPA (2013) ISA for Lead. Section 3.7.1. ''Exposure.'' p. 3–144. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[26] EPA (2013) ISA for Lead. Section 6.2. ''Fate and Transport of Pb in Ecosystems.'' p. 6–62. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[27] EPA (2013) ISA for Lead. Section 2.3. ''Fate and Transport of Pb.'' p. 2–24. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[28] EPA (2013) ISA for Lead. Section 1.2.1. ''Sources, Fate and Transport of Ambient Pb;'' p. 1–6. Section 2.3. ''Fate and Transport of Pb.'' p. 2–24. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[29] EPA (2013) ISA for Lead. Section 3.1.1.''Pathways for Pb Exposure.'' p. 3–1. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[30] EPA (2013) ISA for Lead. Sections 1.3. ''Exposure to Ambient Pb.'' p. 1–11. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[31] EPA (2013) ISA for Lead. Sections 3.4.1. ''Pb in Blood.'' p. 3–85; Section 5.4. ''Summary.'' p. 5–40. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[32] EPA (2006) Air Quality Criteria for Lead. Chapter 3. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[33] EPA (1986) Air Quality Criteria for Lead. Section 1.11.3. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[34] EPA (1977) Air Quality Criteria for Lead. Section 12.3.1.1. ''Air Exposures.'' p. 12–10. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[35] EPA (1977) Air Quality Criteria for Lead. Section 12.3.1.2. ''Air Exposures.'' p. 12–10. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[36] EPA (1977) Air Quality Criteria for Lead. Section 12.3.1.1. ''Air Exposures.'' p. 12–10. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[37] Miranda et al., 2011. A Geospatial Analysis of the Effects of Aviation Gasoline on Childhood Blood Lead Levels. *Environmental Health Perspectives.* 119:1513–1516.

[38] Zahran et al., 2017. The Effect of Leaded Aviation Gasoline on Blood Lead in Children. *Journal of the Association of Environmental and Resource Economists.* 4(2):575–610.

[39] Zahran et al., 2022. Leaded Aviation Gasoline Exposure Risk and Child Blood Lead Levels. *Proceedings of the National Academy of Sciences Nexus.* 2:1–11.

[40] Klemick et al., 2022. Cardiovascular Mortality and Leaded Aviation Fuel: Evidence from Piston-Engine Air Traffic in North Carolina. *International Journal of Environmental Research and Public Health.* 19(10):5941.

referred to as turboprops), can use leaded avgas.

Lead is added to avgas in the form of tetraethyl lead. Tetraethyl lead helps boost fuel octane, prevents engine knock, and prevents valve seat recession and subsequent loss of compression for engines without hardened valves. There are three main types of leaded avgas: 100 Octane, which can contain up to 4.24 grams of lead per gallon (1.12 grams of lead per liter), 100 Octane Low Lead (100LL), which can contain up to 2.12 grams of lead per gallon (0.56 grams of lead per liter), and 100 Octane Very Low Lead (100VLL), which can contain up to 0.71 grams of lead per gallon (0.45 grams of lead per liter).[41] Currently, 100LL is the most commonly available and most commonly used type of avgas.[42] Tetraethyl lead was first used in piston-engine aircraft in 1927.[43] Commercial and military aircraft in the U.S. operated on 100 Octane leaded avgas into the 1950s, but in subsequent years, the commercial and military aircraft fleet largely converted to turbine-engine powered aircraft which do not use leaded avgas.[44 45] The use of avgas containing approximately 4 grams of lead per gallon continued in piston-engine aircraft until the early 1970s when 100LL became the dominant leaded fuel in use.

There are two sources of data from the Federal Government that provide annual estimates of the volume of leaded avgas supplied and consumed in the U.S.: the Department of Energy, Energy Information Administration (DOE EIA) provides information on the volume of leaded avgas supplied in the U.S.,[46] and the FAA provides information on the volume of leaded avgas consumed in the U.S.[47] Over the ten-year period from 2011 through 2020, DOE estimates of the annual volume of leaded avgas supplied averaged 184 million gallons, with year-on-year fluctuations in fuel supplied ranging from a 25 percent increase to a 29 percent decrease. Over the same period, from 2011 through 2020, the FAA estimates of the annual volume of leaded avgas consumed averaged 196 million gallons, with year-on-year fluctuations in fuel consumed ranging from an eight percent increase to a 14 percent decrease. The FAA forecast for consumption of leaded avgas in the U.S. ranges from 185 million gallons in 2026 to 179 million gallons in 2041, a decrease of three percent in that period.[48] As described later in this section, while the national consumption of leaded avgas is expected to decrease three percent from 2026 to 2041, the FAA projects increased activity at some airports and decreased activity at other airports out to 2045.

The FAA's National Airspace System Resource (NASR)[49] provides a complete list of operational airport facilities in the U.S. Among the approximately 19,600 airports listed in the NASR, approximately 3,300 are included in the National Plan of Integrated Airport Systems (NPIAS) and support the majority of piston-engine aircraft activity that occurs annually in the U.S.[50] While less aircraft activity occurs at the remaining 16,300 airports, that activity is conducted predominantly by piston-engine aircraft. Approximately 6,000 airports have been in operation since the early 1970s when the leaded fuel being used contained up to 4.24 grams of lead per gallon of avgas.[51] The activity by piston-engine aircraft spans a range of purposes, as described further below.

As of 2019, there were 171,934 piston-engine aircraft in the U.S.[52] This total includes 128,926 single-engine aircraft, 12,470 twin-engine aircraft, and 3,089 rotorcraft.[53] The average age of single-engine aircraft in 2018 was 46.8 years, and the average age of twin-engine aircraft in 2018 was 44.7 years old.[54] In 2019, 883 new piston-engine aircraft were manufactured in the U.S., some of which are exported.[55] For the period from 2019 through 2041, the fleet of fixed-wing[56] piston-engine aircraft is projected to decrease at an annual average rate of 0.9 percent, and the hours flown by these aircraft are projected to decrease 0.9 percent per year from 2019 to 2041.[57] An annual average growth rate in the production of piston-engine powered rotorcraft of 0.9 percent is forecast, with a commensurate 1.9 percent increase in hours flown in that period by piston-engine powered rotorcraft.[58] There were approximately 664,565 pilots certified to fly general aviation aircraft in the U.S. in 2021.[59] This included 197,665

[41] ASTM International (May 1, 2021) Standard Specification for Leaded Aviation Gasolines D910–21.

[42] National Academies of Sciences, Engineering, and Medicine (NAS). 021. Options for Reducing Lead Emissions from Piston-Engine Aircraft. Washington, DC: The National Academies Press. *https://doi.org/10.17226/26050.*

[43] Ogston 1981. A Short History of Aviation Gasoline Development, 1903–1980. *Society of Automotive Engineers.* p. 810848.

[44] U.S. Department of Commerce Civil Aeronautics Administration. Statistical Handbook of Aviation (Years 1930–1959). *https://babel.hathitrust.org/cgi/pt?id=mdp.39015027813032&view=1up&seq=899.*

[45] U.S. Department of Commerce Civil Aeronautics Administration. Statistical Handbook of Aviation (Years 1960–1971). *https://babel.hathitrust.org/cgi/pt?id=mdp.39015004520279&view=1up&seq=9&skin=2021.*

[46] DOE. EIA. Petroleum and Other Liquids; Supply and Disposition. Aviation Gasoline in Annual Thousand Barrels. Fuel production volume data obtained from *https://www.eia.gov/dnav/pet/pet_sum_snd_a_eppv_mbbl_a_cur-1.htm* and *https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=C400000001&f=A* on Dec. 30, 2021.

[47] Department of Transportation (DOT). FAA. Aviation Policy and Plans. FAA Aerospace Forecast Fiscal Years 2009–2025. p. 81. Retrieved on Mar. 22, 2022, from *https://www.faa.gov/data_research/aviation/aerospace_forecasts/2009-2025/media/2009%20Forecast%20Doc.pdf.* This document provides historical data for 2000–2008 as well as forecast data.

[48] DOT. FAA. Aviation Policy and Plans. Table 23. p. 111. FAA Aerospace Forecast Fiscal Years 2021–2041. Available at *https://www.faa.gov/sites/faa.gov/files/data_research/aviation/aerospace_forecasts/FY2021-41_FAA_Aerospace_Forecast.pdf.*

[49] *See* FAA. NASR. Available at *https://www.faa.gov/air_traffic/flight_info/aeronav/aero_data/eNASR_Browser/.*

[50] FAA (2020) National Plan of Integrated Airport Systems (NPIAS) 2021–2025 Published by the Secretary of Transportation Pursuant to Title 49 U.S. Code, section 47103. Retrieved on Nov. 3, 2021 from: *https://www.faa.gov/airports/planning_capacity/npias/current/media/NPIAS-2021-2025-Narrative.pdf.*

[51] *See* FAA's NASR. Available at *https://www.faa.gov/air_traffic/flight_info/aeronav/aero_data/eNASR_Browser/.*

[52] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 1: Historical General Aviation and Air Taxi Measures. Table 1.1—General Aviation and Part 135 Number of Active Aircraft By Aircraft Type 2008–2019. Retrieved on Dec. 27, 2021 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.* Separately, FAA maintains a database of FAA registered aircraft and as of January 6, 2022 there were 222,592 piston engine aircraft registered with FAA. See: *https://registry.faa.gov/aircraftinquiry/.*

[53] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 1: Historical General Aviation and Air Taxi Measures. Table 1.1—General Aviation and Part 135 Number of Active Aircraft By Aircraft Type 2008–2019. Retrieved on Dec. 27, 2021 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[54] General Aviation Manufacturers Association (GAMA) (2019) General Aviation Statistical Databook and Industry Outlook, p. 27. Retrieved on October 7, 2021 from: *https://gama.aero/wp-content/uploads/GAMA_2019Databook_Final-2020-03-20.pdf.*

[55] GAMA (2019) General Aviation Statistical Databook and Industry Outlook, p. 16. Retrieved on October 7, 2021 from: *https://gama.aero/wp-content/uploads/GAMA_2019Databook_Final-2020-03-20.pdf.*

[56] There are both fixed-wing and rotary-wing aircraft; and airplane is an engine-driven, fixed-wing aircraft and a rotorcraft is an engine-driven rotary-wing aircraft.

[57] *See* FAA Aerospace Forecast Fiscal Years 2021–2041. p. 28. Available at *https://www.faa.gov/sites/faa.gov/files/data_research/aviation/aerospace_forecasts/FY2021-41_FAA_Aerospace_Forecast.pdf.*

[58] FAA Aerospace Forecast Fiscal Years 2021–2041. Table 28. p. 116., and Table 29. p. 117. Available at *https://www.faa.gov/sites/faa.gov/files/data_research/aviation/aerospace_forecasts/FY2021-41_FAA_Aerospace_Forecast.pdf.*

[59] FAA. U.S. Civil Airmen Statistics. 2021 Active Civil Airman Statistics. Retrieved from *https://*

student pilots and 466,900 non-student pilots. In addition, there were more than 301,000 FAA Non-Pilot Certificated mechanics.[60]

Piston-engine aircraft are used to conduct flights that are categorized as either general aviation or air taxi. General aviation flights are defined as all aviation other than military and those flights by scheduled commercial airlines. Air taxi flights are short duration flights made by small commercial aircraft on demand. The hours flown by aircraft in the general aviation fleet are comprised of personal and recreational transportation (67 percent), business (12 percent), instructional flying (8 percent), medical transportation (less than one percent), and the remainder includes hours spent in other applications such as aerial observation and aerial application.[61] Aerial application for agricultural activity includes crop and timber production, which involve fertilizer and pesticide application and seeding cropland. In 2019, aerial application in agriculture represented 883,600 hours flown by general aviation aircraft, and approximately 17.5 percent of these total hours were flown by piston-engine aircraft.[62] While the majority of leaded avgas is consumed by piston-engine aircraft, in 2019, 403,700 gallons (0.2 percent) of leaded avgas was consumed by turboprop aircraft.[63]

Approximately 71 percent of the hours flown that are categorized as general aviation activity are conducted by piston-engine aircraft, and 17 percent of the hours flown that are categorized as air taxi are conducted by piston-engine aircraft.[64] From the period 2012 through 2019, the total hours flown by piston-engine aircraft increased nine percent from 13.2 million hours in 2012 to 14.4 million hours in 2019.[65] [66]

As noted earlier, the U.S. has a dense network of airports where piston-engine aircraft operate, and a small subset of those airports have air traffic control towers which collect daily counts of aircraft operations at the facility (one takeoff or landing event is termed an ''operation''). These daily operations are provided by the FAA in the Air Traffic Activity System (ATADS).[67] The ATADS reports three categories of airport operations that can be conducted by piston-engine aircraft: Itinerant General Aviation, Local Civil, and Itinerant Air Taxi. The sum of Itinerant General Aviation and Local Civil at a facility is referred to as general aviation operations. Piston-engine aircraft operations in these categories are not reported separately from operations conducted by aircraft using other propulsion systems (*e.g.,* turboprop). Because piston-engine aircraft activity generally comprises the majority of general aviation activity at an airport, general aviation activity is often used as a surrogate measure for understanding piston-engine activity.

In order to understand the trend in airport-specific piston-engine activity in the past ten years, we evaluated the trend in general aviation activity. We calculated the average activity at each of the airports in ATADS over three-year periods for the years 2010 through 2012 and for the years 2017 through 2019. We focused this trend analysis on the airports in ATADS because these data are collected daily at an airport-specific control tower (in contrast with annual activity estimates provided at airports without control towers). There were 513 airports in ATADS for which data were available to determine annual average activity for both the 2010–2012 period and the 2017–2019 time period. The annual average operations by general aviation at each of these airports in the period 2010 through 2012 ranged from 31 to 346,415, with a median of 34,368; the annual average operations by general aviation in the period from 2017 through 2019 ranged from 2,370 to 396,554, with a median of 34,365. Of the 513 airports, 211 airports reported increased general aviation activity over the period evaluated.[68] The increase in the average annual number of operations by general aviation aircraft at these 211 facilities ranged from 151 to 136,872 (an increase of two percent and 52 percent, respectively).

While national consumption of leaded avgas is forecast to decrease three percent from 2026 to 2045, this change in fuel consumption is not expected to occur uniformly across airports in the U.S. The FAA produces the Terminal Area Forecast (TAF), which is the official forecast of aviation activity for the 3,300 U.S. airports that are in the NPIAS.[69] For the 3,306 airports in the TAF, we compared the average activity by general aviation at each airport from 2017–2019 with the FAA forecast for general aviation activity at those airports in 2045. The FAA forecasts that activity by general aviation will decrease at 234 of the airports in the TAF, remain the same at 1,960 airports, and increase at 1,112 of the airports. To evaluate the magnitude of potential increases in activity for the same 513 airports for which we evaluated activity trends in the past ten years, we compared the 2017–2019 average general aviation activity at each of these airports with the forecasted activity for 2045 in the TAF.[70] The annual operations estimated for the 513 airports in 2045 ranges from 2,914 to 427,821 with a median of 36,883. The TAF forecasts an increase in activity at 442 of the 513 airports out to 2045, with the increase in operations at those facilities ranging from 18 to 83,704 operations annually (an increase of 0.2 percent and 24 percent, respectively).

www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics on May 20, 2022.

[60] FAA. U.S. Civil Airmen Statistics. 2021 Active Civil Airman Statistics. Retrieved from *https://www.faa.gov/data_research/aviation_data_statistics/civil_airmen_statistics* on May 20, 2022.

[61] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 1: Historical General Aviation and Air Taxi Measures. Table 1.4—General Aviation and Part 135 Total Hours Flown By Actual Use 2008–2019 (Hours in Thousands). Retrieved on Dec. 27, 2021 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[62] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 3: Primary and Actual Use. Table 3.2—General Aviation and Part 135 Total Hours Flown by Actual Use 2008–2019 (Hours in Thousands). Retrieved on Mar., 22, 2022 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[63] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 3: Primary and Actual Use. Table 5.1—General Aviation and Part 135 Total Fuel Consumed and Average Fuel Consumption Rate by Aircraft Type. Retrieved on Feb. 16, 2023 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[64] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 3: Primary and Actual Use. Table 3.2—General Aviation and Part 135 Total Hours Flown by Actual Use 2008–2019 (Hours in Thousands). Retrieved on Mar. 22, 2022 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[65] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 3: Primary and Actual Use. Table 1.3—General Aviation and Part 135 Total Hours Flown by Aircraft Type 2008–2019 (Hours in Thousands). Retrieved on Dec. 27, 2021 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[66] In 2012, the FAA Aerospace Forecast projected a 0.03 percent increase in hours flown by the piston-engine aircraft fleet for the period 2012 through 2032. FAA Aerospace Forecast Fiscal Years 2012–2032. p. 53. Retrieved on Mar. 22, 2022 from *https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/2012%20FAA%20Aerospace%20Forecast.pdf.*

[67] *See* FAA's Air Traffic Activity Data. Available at *https://aspm.faa.gov/opsnet/sys/airport.asp.*

[68] Geidosch. Memorandum to Docket EPA–HQ–OAR–2022–0389. Past Trends and Future Projections in General Aviation Activity and Emissions. June 1, 2022. Docket ID EPA–HQ–2022–0389.

[69] FAA's TAF Fiscal Years 2020–2045 describes the forecast method, data sources, and review process for the TAF estimates. The documentation for the TAF is available at *https://taf.faa.gov/Downloads/TAFSummaryFY2020-2045.pdf.*

[70] The TAF is prepared to assist the FAA in meeting its planning, budgeting, and staffing requirements. In addition, state aviation authorities and other aviation planners use the TAF as a basis for planning airport improvements. The TAF is available on the internet. The TAF database can be accessed at: *https://taf.faa.gov.*

2. Emissions of Lead From Piston-Engine Aircraft

This section describes the physical and chemical characteristics of lead emitted by covered aircraft and the national, state, county and airport-specific annual inventories of these engine emissions of lead. Information regarding lead emissions from motor vehicle engines operating on leaded fuel is summarized in prior AQCDs for Lead, and the 2013 Lead ISA also includes information on lead emissions from piston-engine aircraft.[71 72 73] Lead is added to avgas in the form of tetraethyl lead along with ethylene dibromide, both of which were used in leaded gasoline for motor vehicles in the past. The piston engines in which leaded fuel was used in motor vehicles in the past have similarities to piston engines used in aircraft including the same combustion cycle and the absence of aftertreatment devices to limit pollutant emissions. Because the same chemical form of lead was used in these fuels and because of the similarity in the engines combusting these leaded fuels, the summary of the science regarding emissions of lead from motor vehicles presented in the 1997 and 1986 AQCDs for Lead is relevant to understanding some of the properties of lead emitted from piston-engine aircraft and the atmospheric chemistry these emissions are expected to undergo. Recent studies relevant to understanding lead emissions from piston-engine aircraft have also been published and are discussed here.

a. Physical and Chemical Characteristics of Lead Emitted by Piston-Engine Aircraft

As with motor vehicle engines, when leaded avgas is combusted in aircraft engines, the lead is oxidized to form lead oxide. In the absence of the ethylene dibromide lead scavenger in the fuel, lead oxide can collect on the valves and spark plugs, and if the deposits become thick enough, the engine can be damaged. Ethylene dibromide reacts with the lead oxide, converting it to brominated lead and lead oxybromides. These brominated forms of lead remain volatile at high combustion temperatures and are emitted from the engine along with the other combustion by-products.[74] Upon cooling to ambient temperatures these brominated lead compounds are converted to particulate matter. The presence of lead dibromide particles in the exhaust from a piston-engine aircraft has been confirmed by Griffith (2020) and is the primary form of lead emitted by engines operating on leaded fuel.[75] In addition to lead bromides, ammonium salts of other lead halides were also emitted by motor vehicles, and therefore, ammonium salts of lead bromide compounds would be expected in the exhaust of piston-engine aircraft.[76]

Uncombusted alkyl lead was also measured in the exhaust of motor vehicles operating on leaded gasoline and is therefore likely to be present in the exhaust from piston-engine aircraft.[77] Alkyl lead is the general term used for organic lead compounds and includes the lead additive tetraethyl lead. Summarizing the available data regarding emissions of alkyl lead from piston-engine aircraft, the 2013 Lead ISA notes that lead in the exhaust that might be in organic form may potentially be 20 percent (as an upper bound estimate).[78 79] In addition, tetraethyl lead is a highly volatile compound, and therefore, a portion of tetraethyl lead in fuel exposed to air will partition into the vapor phase.[80]

Particles emitted by piston-engine aircraft are in the submicron size range (less than one micron in diameter). The Swiss Federal Office of Civil Aviation (FOCA) published a study of piston-engine aircraft emissions including measurements of lead.[81] The Swiss FOCA reported the mean particle diameter of particulate matter emitted by one single-engine piston-powered aircraft operating on leaded fuel that ranged from 0.049 to 0.108 microns under different power conditions (lead particles would be expected to be present, but these particles were not separately identified in this study). The particle number concentration ranged from $5.7x10^6$ to $8.6x10^6$ particles per cm^3. The authors noted that these particle emission rates are comparable to those from a typical diesel passenger car engine without a particle filter.[82] Griffith (2020) collected exhaust particles from a piston-engine aircraft operating on leaded avgas and examined the particles using electron microscopy. Griffith reported that the mean diameter of particles collected in exhaust was 13 nanometers (0.013 microns) consisting of a 4 nanometer (0.004 micron) lead dibromide particle surrounded by hydrocarbons.

b. Inventory of Lead Emitted by Piston-Engine Aircraft

Lead emissions from covered aircraft are the largest single source of lead to air in the U.S., contributing over 50 percent of lead emissions to air starting in 2008 (Table 1).[83] In 2017, approximately 470 tons of lead were emitted by engines in piston-powered aircraft, which constituted 70 percent of the annual emissions of lead to air in that year.[84] Lead is emitted at and near thousands of airports in the U.S. as described in section II.A.1. of this document. The EPA's method for developing airport-specific lead estimates is described in the EPA's Advance Notice of Proposed Rulemaking on Lead Emissions from Piston-Engine Aircraft Using Leaded

[71] EPA (1977) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[72] EPA (1986) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[73] EPA (2013) ISA for Lead. Section 2.2.2.1 ''Pb Emissions from Piston-engine Aircraft Operating on Leaded Aviation Gasoline and Other Non-road Sources.'' pp. 2–7 through 2–10. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[74] EPA (1986) Air Quality Criteria for Lead. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[75] Griffith 2020. Electron microscopic characterization of exhaust particles containing lead dibromide beads expelled from aircraft burning leaded gasoline. *Atmospheric Pollution Research* 11:1481–1486.

[76] EPA (1986) Air Quality Criteria for Lead. Volume 2: Chapters 5 & 6. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[77] EPA (2013) ISA for Lead. Table 2–1. ''Pb Compounds Observed in the Environment.'' p. 2–8. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[78] EPA (2013) ISA for Lead. Section 2.2.2.1 ''Pb Emissions from Piston-engine Aircraft Operating on Leaded-Aviation Gasoline and Other Non-road Sources.'' p. 2–10. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[79] One commenter asserts that the information summarized in the 2013 Lead ISA regarding emission of alkyl lead from piston-engine aircraft is a supposition and should not inform this action. We respond to this comment in the Response to Comments document for this action.

[80] Memorandum to Docket EPA–HQ–OAR–2022–0389. Potential Exposure to Non-exhaust Lead and Ethylene Dibromide. June 15, 2022. Docket ID EPA–HQ–2022–0389.

[81] Swiss FOCA (2007) Aircraft Piston Engine Emissions Summary Report. 33–05–003 Piston Engine Emissions_Swiss FOCA_Summary. Report_070612_rit. Available at *https://www.bazl.admin.ch/bazl/en/home/specialists/regulations-and-guidelines/environment/pollutant-emissions/aircraft-engine-emissions/report--appendices--database-and-data-sheets.html.* Retrieved on June 15, 2022.

[82] Swiss FOCA (2007) Aircraft Piston Engine Emissions Summary Report. 33–05–003 Piston Engine Emissions_Swiss FOCA_Summary. Report_070612_rit. Section 2.2.3.a. Available at *https://www.bazl.admin.ch/bazl/en/home/specialists/regulations-and-guidelines/environment/pollutant-emissions/aircraft-engine-emissions/report--appendices--database-and-data-sheets.html.* Retrieved on June 15, 2022.

[83] The lead inventories for 2008, 2011 and 2014 are provided in the U.S. EPA (2018b) Report on the Environment Exhibit 2. Anthropogenic lead emissions in the U.S. Available at *https://cfpub.epa.gov/roe/indicator.cfm?i=13#2.*

[84] EPA 2017 NEI. Available at *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.*

Aviation Gasoline [85] and in the document titled ''Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 National Emissions Inventory.'' [86] The EPA's National Emissions Inventory (NEI) reports airport estimates of lead emissions as well as estimates of lead emitted in-flight, which are allocated to states based on the fraction of piston-engine aircraft activity estimated for each state. These inventory data are briefly summarized here at the state, county, and airport level.[87]

TABLE 1—PISTON-ENGINE EMISSIONS OF LEAD TO AIR

	2008	2011	2014	2017	2020 [a]
Piston-engine emissions of lead to air, tons	560	490	460	470	427
Total U.S. lead emissions, tons	950	810	720	670	621
Piston-engine emissions as a percent of the total U.S. lead inventory	59%	60%	64%	70%	69%

[a] Due to the Covid-19 Pandemic, a substantial decrease in activity by aircraft occurred in 2020, impacting the total lead emissions for this year. The 2020 NEI is available at: *https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data.*

At the state level, the EPA estimates of lead emissions from piston-engine aircraft range from 0.3 tons (Rhode Island) to 50.5 tons (California), 47 percent of which is emitted in the landing and takeoff cycle and 53 percent of which the EPA estimates is emitted in-flight, outside the landing and takeoff cycle.[88] Among the counties in the U.S. where the EPA estimates engine emissions of lead from covered aircraft, these lead inventories range from 0.00005 tons per year to 4.3 tons per year and constitute the only source of air-related lead in 1,140 counties (the county estimates of lead emissions include the lead emitted during the landing and takeoff cycle and not lead emitted in-flight).[89] In the counties where engine emissions of lead from aircraft are the sole source of lead to these estimates, annual lead emissions from the landing and takeoff cycle ranged from 0.00015 to 0.74 tons. Among the 1,872 counties in the U.S. with multiple sources of lead, including engine emissions from covered aircraft, the contribution of aircraft engine emissions ranges from 0.00005 to 4.3 tons, comprising 0.15 to 98 percent of the county total, respectively.

The EPA estimates that among the approximately 20,000 airports in the U.S., airport lead inventories range from 0.00005 tons per year to 0.9 tons per year.[90] In 2017, the EPA's NEI includes 638 airports where the EPA estimates engine emissions of lead from covered aircraft were 0.1 ton or more of lead annually. Using the FAA's forecasted activity in 2045 for the approximately 3,300 airports in the NPIAS (as described in section II.A.1. of this document), the EPA estimates airport-specific inventories may range from 0.00003 tons to 1.28 tons of lead (median of 0.03 tons), with 656 airports estimated to have inventories above 0.1 tons in 2045.[91]

We estimate that piston-engine aircraft have consumed approximately 38.6 billion gallons of leaded avgas in the U.S. since 1930, excluding military aircraft use of this fuel, emitting approximately 113,000 tons of lead to the air.[92]

3. Concentrations of Lead in Air Attributable to Emissions From Piston-Engine Aircraft

In this section, we describe the concentrations of lead in air resulting from emissions of lead from covered aircraft. Air quality monitoring and modeling studies for lead at and near airports have identified elevated

[85] Advance Notice of Proposed Rulemaking on Lead Emissions from Piston-Engine Aircraft Using Leaded Aviation Gasoline. 75 FR 2440 (April 28, 2010).

[86] Airport lead annual emissions data used were reported in the 2017 NEI. Available at *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.* The methods used to develop these inventories are described in EPA (2010) Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 NEI. EPA, Washington, DC, EPA–420–B–10–044, 2010. (Also available in the docket for this action, EPA–HQ–OAR–2022–0389).

[87] The 2017 NEI utilized 2014 aircraft activity data to develop airport-specific lead inventories. Details can be found on page 3–17 of the document located here: *https://www.epa.gov/sites/default/files/2021-02/documents/nei2017_tsd_full_jan2021.pdf#page=70&zoom=100,68,633.* Because the 2020 inventory was impacted by the Covid–19 pandemic-related decrease in activity by aircraft in 2020, the EPA is focusing on the 2017 inventory in this final action.

[88] Lead emitted in-flight is assigned to states based on their overall fraction of total piston-engine aircraft operations. The state-level estimates of engine emissions of lead include both lead emitted in the landing and takeoff cycle as well as lead emitted in-flight. The method used to develop these estimates is described in EPA (2010) Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 NEI, available here: *https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009I13.PDF?Dockey=P1009I13.PDF.*

[89] Airport lead annual emissions data cited were reported in the 2017 NEI. Available at *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.* In addition to the triennial NEI, the EPA collects from state, local, and Tribal air agencies point source data for larger sources every year (see *https://www.epa.gov/air-emissions-inventories/air-emissions-reporting-requirements-aerr* for specific emissions thresholds). While these data are not typically published as a new NEI, they are available publicly upon request and are also included in *https://www.epa.gov/air-emissions-modeling/emissions-modeling-platforms* that are created for years other than the triennial NEI years. County estimates of lead emissions from non-aircraft sources used in this action are from the 2019 inventory. There are 3,012 counties and statistical equivalent areas where EPA estimates engine emissions of lead occur.

[90] *See* EPA lead inventory data available at *https://www.epa.gov/air-emissions-modeling/emissions-modeling-platforms.*

[91] EPA used the method described in EPA (2010) Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 NEI to estimate airport lead inventories in 2045. This document is available here: *https://nepis.epa.gov/Exe/ZyPDF.cgi/P1009I13.PDF?Dockey=P1009I13.PDF.*

[92] Geidosch. Memorandum to Docket EPA–HQ–OAR–2022–0389. Lead Emissions from the use of Leaded Aviation Gasoline from 1930 through 2020. June 1, 2022. Docket ID EPA–HQ–2022–0389.

concentrations of lead in air from piston-engine aircraft exhaust at, and downwind of, airports where these aircraft are active.[93 94 95 96 97 98 99] This section provides a summary of the literature regarding the local-scale impact of aircraft emissions of lead on concentrations of lead at and near airports, with specific focus on the results of air monitoring for lead that the EPA required at a subset of airports and an analysis conducted by the EPA to estimate concentrations of lead at 13,000 airports in the U.S., titled ''Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports.'' [100 101]

Gradient studies evaluate how lead concentrations change with distance from an airport where piston-engine aircraft operate. These studies indicate that concentrations of lead in air, averaged over periods of 18 hours to three months, are estimated to be one to two orders of magnitude higher at locations proximate to aircraft emissions, compared to nearby locations not impacted by a source of lead air emissions.[102 103 104 105 106] The magnitude of lead concentrations at and near airports is highly influenced by the amount of aircraft activity (*i.e.,* the number of take-off and landing operations, particularly if concentrated at one runway) and the time spent by aircraft in specific modes of operation. The most significant emissions in terms of ground-based activity, and therefore ground-level concentrations of lead in air, occur near the areas with greatest fuel consumption where the aircraft are stationary and running.[107 108 109] For piston-engine aircraft these areas are most commonly locations in which pilots conduct engine tests during run-up operations prior to take-off (*e.g.,* magneto checks during the run-up operation mode). Run-up operations are conducted while the brakes are engaged so the aircraft is stationary and are often conducted adjacent to the runway end from which the aircraft will take off. Additional modes of operation by piston-engine aircraft, such as taxiing or idling near the runway, may result in additional hotspots of elevated lead concentration (*e.g.,* start-up and idle, maintenance run-up).[110]

The lead NAAQS was revised in 2008.[111] The 2008 decision revised the level, averaging time and form of the standards to establish the current primary and secondary standards, which are both 0.15 micrograms per cubic meter of air, in terms of the average of three consecutive monthly averages of lead in total suspended particles within a three-year period.[112] In conjunction with strengthening the lead NAAQS in 2008, the EPA enhanced the existing lead monitoring network by requiring monitors to be placed in areas with sources such as industrial facilities and airports with estimated lead emissions of 1.0 ton or more per year. Lead monitoring was conducted at two airports following from these requirements (Deer Valley Airport, AZ, and the Van Nuys Airport, CA). In 2010, the EPA made further revisions to the monitoring requirements such that state and local air quality agencies are required to monitor near industrial facilities with estimated lead emissions of 0.50 tons or more per year and at airports with estimated emissions of 1.0 ton or more per year.[113] As part of this 2010 requirement to expand lead monitoring, the EPA also required a one-year monitoring study of 15 additional airports with estimated lead emissions between 0.50 and 1.0 ton per year in an effort to better understand how these emissions affect concentrations of lead in the air at and near airports. Further, to help evaluate airport characteristics that could lead to ambient lead concentrations that approach or exceed the lead NAAQS, airports for this one-year monitoring study were selected based on factors such as the level of piston-engine aircraft activity and the predominant use of one runway due to wind patterns.

As a result of these requirements, state and local air authorities collected and certified lead concentration data for at least one year at 17 airports with most monitors starting in 2012 and generally continuing through 2013. The data

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[93] Carr et al., 2011. Development and evaluation of an air quality modeling approach to assess near-field impacts of lead emissions from piston-engine aircraft operating on leaded aviation gasoline. *Atmospheric Environment,* 45 (32), 5795–5804. DOI: *https://dx.doi.org/10.1016/j.atmosenv.2011.07.017.*

[94] Feinberg et al., 2016. Modeling of Lead Concentrations and Hot Spots at General Aviation Airports. *Journal of the Transportation Research Board,* No. 2569, Transportation Research Board, Washington, DC, pp. 80–87. DOI: 10.3141/2569–09.

[95] Municipality of Anchorage (2012). *Merrill Field Lead Monitoring Report.* Municipality of Anchorage Department of Health and Human Services. Anchorage, Alaska. Available at *https://www.muni.org/Departments/health/Admin/environment/AirQ/Documents/Merrill%20Field%20Lead%20Monitoring%20Study_2012/Merrill%20Field%20Lead%20Study%20Report%20-%20final.pdf.*

[96] Environment Canada (2000) Airborne Particulate Matter, Lead and Manganese at Buttonville Airport. Toronto, Ontario, Canada: Conor Pacific Environmental Technologies for Environmental Protection Service, Ontario Region.

[97] Fine et al., 2010. *General Aviation Airport Air Monitoring Study.* South Coast Air Quality Management District. Available at *https://www.aqmd.gov/docs/default-source/air-quality/air-quality-monitoring-studies/general-aviation-study/study-of-air-toxins-near-van-nuys-and-santa-monica-airport.pdf.*

[98] Lead emitted from piston-engine aircraft in the particulate phase would also be measured in samples collected to evaluate total ambient $PM_{2.5}$ concentrations.

[99] One commenter provided results from a monitoring and modeling study at a general aviation airport in Wisconsin that reports increased lead concentrations with increasing proximity to the airport. See attachments provided to the comments from the Town of Middleton (EPA–HQ–OAR–2022–0389–0178_attachment_2.pdf and EPA–HQ–OAR–2022–0389–0178_attachment_3.pdf) available in the docket for this action EPA–HQ–OAR–2022–0389.

[100] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf.* EPA responses to peer review comments on the report are available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YIWD.pdf.* These documents are also available in the docket for this action (Docket EPA–HQ–OAR–2022–0389).

[101] EPA (2022) Technical Support Document (TSD) for the EPA's Proposed Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution that May Reasonably Be Anticipated to Endanger Public Health and Welfare. EPA, Washington, DC, EPA–420–R–22–025, 2022. Available in the docket for this action.

[102] Carr et al., 2011. Development and evaluation of an air quality modeling approach to assess near-field impacts of lead emissions from piston-engine aircraft operating on leaded aviation gasoline. *Atmospheric Environment,* 45 (32), 5795–5804. DOI: *https://dx.doi.org/10.1016/j.atmosenv.2011.07.017.*

[103] Heiken et al., 2014. Quantifying Aircraft Lead Emissions at Airports. ACRP Report 133. Available at *https://www.nap.edu/catalog/22142/quantifying-aircraft-lead-emissions-at-airports.*

[104] Hudda et al., 2022. Substantial Near-Field Air Quality Improvements at a General Aviation Airport Following a Runway Shortening. *Environmental Science & Technology.* DOI: 10.1021/acs.est.1c06765.

[105] Fine et al., 2010. General Aviation Airport Air Monitoring Study. South Coast Air Quality Management District. Available at *https://www.aqmd.gov/docs/default-source/air-quality/air-quality-monitoring-studies/general-aviation-study/study-of-air-toxins-near-van-nuys-and-santa-monica-airport.pdf.*

[106] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[107] EPA (2010) Development and Evaluation of an Air Quality Modeling Approach for Lead Emissions from Piston-Engine Aircraft Operating on Leaded Aviation Gasoline. EPA, Washington, DC, EPA–420–R–10–007, 2010. *https://nepis.epa.gov/Exe/ZyPDF.cgi/P1007H4Q.PDF?Dockey=P1007H4Q.PDF.*

[108] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[109] Feinberg et al., 2016. Modeling of Lead Concentrations and Hot Spots at General Aviation Airports. *Journal of the Transportation Research Board,* No. 2569, Transportation Research Board, Washington, DC, pp. 80–87. DOI: 10.3141/2569–09.

[110] Feinberg et al., 2016. Modeling of Lead Concentrations and Hot Spots at General Aviation Airports. *Journal of the Transportation Research Board,* No. 2569, Transportation Research Board, Washington, DC, pp. 80–87. DOI: 10.3141/2569–09.

[111] 73 FR 66965 (Nov. 12, 2008).

[112] 40 CFR 50.16 (Nov. 12, 2008).

[113] 75 FR 81126 (Dec. 27, 2010).

presented in Table 2 are based on the certified data for these sites and represent the maximum concentration monitored in a rolling three-month average for each location.[114] [115]

TABLE 2—LEAD CONCENTRATIONS MONITORED AT 17 AIRPORTS IN THE U.S.

Airport, State	Lead design value,[116] μg/m³
Auburn Municipal Airport, WA	0.06
Brookhaven Airport, NY	0.03
Centennial Airport, CO	0.02
Deer Valley Airport, AZ	0.04
Gillespie Field, CA	0.07
Harvey Field, WA	0.02
McClellan-Palomar Airport, CA	0.17
Merrill Field, AK	0.07
Nantucket Memorial Airport, MA	0.01
Oakland County International Airport, MI	0.02
Palo Alto Airport, CA	0.12
Pryor Field Regional Airport, AL	0.01
Reid-Hillview Airport, CA	0.10
Republic Airport, NY	0.01
San Carlos Airport, CA	0.33
Stinson Municipal, TX	0.03
Van Nuys Airport, CA	0.06

Monitored lead concentrations violated the lead NAAQS at two airports in 2012: the McClellan-Palomar Airport and the San Carlos Airport. At both of these airports, monitors were located in close proximity to the area at the end of the runway most frequently used for pre-flight safety checks (*i.e.,* run-up). Alkyl lead emitted by piston-engine aircraft would be expected to partition into the vapor phase and would not be collected by the monitoring conducted in this study, which is designed to quantitatively collect particulate forms of lead.[117]

Airport lead monitoring and modeling studies have identified the sharp decrease in lead concentrations with distance from the run-up area and therefore the importance of considering monitor placement relative to the run-up area when evaluating the maximum impact location attributable to lead emissions from piston-engine aircraft. The monitoring data in Table 2 reflect differences in monitor placement relative to the run-up area as well as other factors; this study also provided evidence that air lead concentrations at and downwind from airports could be influenced by factors such as the use of more than one run-up area, wind speed, and the number of operations conducted by single- versus twin-engine aircraft.[118]

The EPA recognized that the airport lead monitoring study provided a small sample of the potential locations where emissions of lead from piston-engine aircraft could potentially cause concentrations of lead in ambient air to exceed the lead NAAQS. Because we considered that additional airports and conditions could lead to exceedances of the lead NAAQS at and near airports where piston-engine aircraft operate, and in order to understand the range of lead concentrations at airports nationwide, we developed an analysis of 13,000 airports in the peer-reviewed report titled, ''Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports.'' [119] [120] This report provides estimated ranges of lead concentrations that may occur at and near airports where leaded avgas is used. The study extrapolated modeling results from one airport to estimate air lead concentrations at the maximum impact area near the run-up location for over 13,000 U.S. airports.[121] The model-extrapolated lead estimates in this study indicate that some additional U.S. airports may have air lead concentrations above the NAAQS at this area of maximum impact. The report also indicates that, at the levels of activity analyzed at the 13,000 airports, estimated lead concentrations decrease to below the standard within 50 meters

[114] EPA (2015) Program Overview: Airport Lead Monitoring. EPA, Washington, DC, EPA–420–F–15–003, 2015. Available at: *https://nepis.epa.gov/Exe/ZyPDF.cgi/P100LJDW.PDF?Dockey=P100LJDW.PDF.*

[115] EPA (2022) Technical Support Document (TSD) for the EPA's Proposed Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution that May Reasonably Be Anticipated to Endanger Public Health and Welfare. EPA, Washington, DC, EPA–420–R–22–025, 2022. Available in the docket for this action.

[116] A design value is a statistic that summarizes the air quality data for a given area in terms of the indicator, averaging time, and form of the standard. Design values can be compared to the level of the standard and are typically used to designate areas as meeting or not meeting the standard and assess progress towards meeting the NAAQS.

[117] As noted earlier, when summarizing the available data regarding emissions of alkyl lead from piston-engine aircraft, the 2013 Lead ISA notes that an upper bound estimate of lead in the exhaust that might be in organic form may potentially be 20 percent (2013 Lead ISA, p. 2–10). Organic lead in engine exhaust would be expected to influence receptors within short distances of the point of emission from piston-engine aircraft. Airports with large flight schools and/or facilities with substantial delays for aircraft queued for takeoff could experience higher concentrations of alkyl lead in the vicinity of the aircraft exhaust.

[118] The data in Table 2 represent concentrations measured at one location at each airport and monitors were not consistently placed in close proximity to the run-up areas. As described in section II.A.3., monitored concentrations of lead in air near airports are highly influenced by proximity of the monitor to the run-up area. In addition to monitor placement, there are individual airport factors that can influence lead concentrations (*e.g.,* the use of multiple run-up areas at an airport, fleet composition, and wind speed). The monitoring data reported in Table 2 reflect a range of lead concentrations indicative of the location at which measurements were made and the specific operations at an airport.

[119] EPA (2020) Model-Extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[120] EPA (2022) Technical Support Document (TSD) for the EPA's Proposed Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution that May Reasonably Be Anticipated to Endanger Public Health and Welfare. EPA, Washington, DC, EPA–420–R–22–025, 2022. Available in the docket for this action.

[121] In this study, the EPA defined the maximum impact site as 15 meters downwind of the tailpipe of an aircraft conducting run-up operations in the area designated for these operations at a runway end. The maximum impact area was defined as approximately 50 meters surrounding the maximum impact site.

from the location of highest concentration.

To estimate the potential ranges of lead concentrations at and downwind of the anticipated area of highest concentration at airports in the U.S., the relationship between piston-engine aircraft activity and lead concentration at and downwind of the maximum impact site at one airport was applied to piston-engine aircraft activity estimates for each U.S. airport.[122] This approach for conducting a nationwide analysis of airports was selected due to the impact of piston-engine aircraft run-up operations on ground-level lead concentrations, which creates a maximum impact area that is expected to be generally consistent across airports. Specifically, these aircraft consistently take off into the wind and typically conduct run-up operations immediately adjacent to the take-off runway end, and thus, modeling lead concentrations from this source is constrained by variation in a few key parameters. These parameters include (1) total amount of piston-engine aircraft activity, (2) the proportion of activity conducted at one runway end, (3) the proportion of activity conducted by multi-piston-engine aircraft, (4) the duration of run-up operations, (5) the concentration of lead in avgas, (6) wind speed at the model airport relative to the extrapolated airport, and (7) additional meteorological, dispersion model, or operational parameters. These parameters were evaluated through sensitivity analyses as well as quantitative or qualitative uncertainty analyses. To generate robust concentration estimates, the EPA evaluated these parameters, conducted wind-speed correction of extrapolated estimates, and used airport-specific information regarding airport layout and prevailing wind directions for the 13,000 airports.[123]

Results of this national analysis show that model-extrapolated three-month average lead concentrations in the maximum impact area may potentially exceed the lead NAAQS at some airports with activity ranging from 3,616–26,816 Landing and Take-Off events (LTOs) in a three-month period.[124] The lead concentration estimates from this model-extrapolation approach account for lead engine emissions from aircraft only, and do not include other sources of air-related lead. The broad range in LTOs that may lead to concentrations of lead exceeding the lead NAAQS is due to the piston-engine aircraft fleet mix at individual airports such that airports where the fleet is dominated by twin-engine aircraft would potentially reach concentrations of lead exceeding the lead NAAQS with fewer LTOs compared with airports where single-engine aircraft dominate the piston-engine fleet.[125] Model-extrapolated three-month average lead concentrations from aircraft engine emissions were estimated to be above background for a distance of at least 500 meters from the maximum impact area at airports with activity ranging from 1,275–4,302 LTOs in that three-month period.[126] In a separate modeling analysis at an airport at which hundreds of take-off and landing events by piston-engine aircraft occur per day, the EPA found that modeled 24-hour concentrations of lead from aircraft engine emissions were estimated to be above background for almost 1,000 meters downwind from the runway.[127]

Model-extrapolated estimates of lead concentrations in the EPA report ''Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports'' were compared with monitored values reported in Table 2 and show general agreement, suggesting that the extrapolation method presented in this report provides reasonable estimates of the range in concentrations of lead in air attributable to three-month activity periods of piston-engine aircraft at airports. The assessment included detailed evaluation of the potential impact of run-up duration, the concentration of lead in avgas, and the impact of meteorological parameters on model-extrapolated estimates of lead concentrations attributable to engine emissions of lead from piston-powered aircraft. Additionally, this study included a range of sensitivity analyses as well as quantitative and qualitative uncertainty analyses.

The EPA's model-extrapolation analysis of lead concentrations from engine emissions resulting from covered aircraft found that annual airport emissions of lead estimated to result in air lead concentrations potentially exceeding the NAAQS ranged from 0.1 to 0.6 tons per year. There are key pieces of airport-specific data that are needed to fully evaluate the potential for piston-engine aircraft operating at an airport to cause concentrations of lead in the air to exceed the lead NAAQS, and the EPA's report ''Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports'' provides quantitative and qualitative analyses of these factors.[128] The EPA's estimate for airports that have annual lead inventories of 0.1 ton or more are illustrative of and provide one approach for an initial screening evaluation of locations where engine emissions of lead from aircraft may increase localized lead concentrations in air. Airport-specific assessments would be needed to determine the magnitude of the potential range in lead concentrations at and downwind of each facility.

As described in Section II.A.1 of this document, the FAA forecasts 0.9 percent decreases in piston-engine aircraft activity out to 2041; however, these decreases are not projected to occur uniformly across airports. Among the more than 3,300 airports in the FAA TAF, the FAA forecasts both decreases and increases in general aviation, which is largely comprised of piston-engine aircraft. If the current conditions on which the forecast is based persist, then lead concentrations in the air may increase at the airports where general aviation activity is forecast to increase.

In addition to airport-specific modeled estimates of lead concentrations, the EPA also provides annual estimates of lead concentrations for each census tract in the U.S. as part of the Air Toxics Screening Assessment (AirToxScreen).[129] The census tract concentrations are averages of the area-weighted census block concentrations within the tract. Lead concentrations reported in the AirToxScreen are based on emissions estimates from

[122] Prior to this model extrapolation study, the EPA developed and evaluated an air quality modeling approach (this study is available here: *https://nepis.epa.gov/Exe/ZyPDF.cgi/P1007H4Q.PDF?Dockey=P1007H4Q.PDF*), and subsequently applied the approach to a second airport and again performed an evaluation of the model output using air monitoring data (this second study is available here: *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf*).

[123] EPA (2022) Technical Support Document (TSD) for the EPA's Proposed Finding that Lead Emissions from Aircraft Engines that Operate on Leaded Fuel Cause or Contribute to Air Pollution that May Reasonably Be Anticipated to Endanger Public Health and Welfare. EPA, Washington, DC, EPA–420–R–22–025, 2022. Available in the docket for this action.

[124] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. Table 6. p. 53. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[125] *See* methods used in EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. Table 2. p.23. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[126] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports, Table 6. p.53. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[127] Carr et al., 2011. Development and evaluation of an air quality modeling approach to assess near-field impacts of lead emissions from piston-engine aircraft operating on leaded aviation gasoline. *Atmospheric Environment* 45: 5795–5804.

[128] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. Table 6. p.53. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[129] *See* EPA's 2019 AirToxScreen. Available at *https://www.epa.gov/AirToxScreen/2019-airtoxscreen.*

anthropogenic and natural sources of lead, including aircraft engine emissions.[130] The 2019 AirToxScreen provides lead concentration estimates in air for 73,449 census tracts in the U.S.[131] Lead concentrations associated with emissions from piston-engine aircraft comprised more than 50 percent of these census block area-weighted lead concentration estimates in over half of the census tracts, which included tracts in all 50 states, as well as Puerto Rico and the Virgin Islands.

4. Fate and Transport of Emissions of Lead From Piston-Engine Aircraft

This section summarizes the chemical transformation that piston-engine aircraft lead emissions are anticipated to undergo in the atmosphere and describes what is known about the deposition of piston-engine aircraft lead and its potential impacts on soil, food, and aquatic environments.

a. Atmospheric Chemistry and Transport of Emissions of Lead From Piston-Engine Aircraft

Lead emitted by piston-engine aircraft can have impacts in the local environment, and, due to their small size (*i.e.,* typically less than one micron in diameter),[132 133] lead-bearing particles emitted by piston engines may disperse widely in the environment. However, lead emitted during the landing and takeoff cycle, particularly during ground-based operations such as start-up, idle, preflight run-up checks, taxi and the take-off roll on the runway, may deposit to the local environment and/or infiltrate into buildings.[134 135]

The Lead AQCDs summarize the literature reporting on the atmospheric chemical transformation of lead compounds emitted by engines operating on leaded fuel. Briefly, lead halides emitted by motor vehicles operating on leaded fuel were reported to undergo compositional changes upon cooling and mixing with the ambient air as well as during transport, and we would anticipate lead bromides emitted by piston-engine aircraft to behave similarly in the atmosphere. The water solubility of these lead-bearing particles was reported to be higher for the smaller lead-bearing particles.[136] Lead halides emitted in motor vehicle exhaust were reported to break down rapidly in the atmosphere via redox reactions in the presence of atmospheric acids.[137] Depending on ambient conditions (*e.g.,* ozone and hydroxyl concentrations in the atmosphere), alkyl lead may exist in the atmosphere for hours to days [138] and may therefore be transported off airport property into nearby communities. Tetraethyl lead reacts with the hydroxyl radical in the gas phase to form a variety of products that include ionic trialkyl lead, dialkyl lead and metallic lead. Trialkyl lead is slow to react with the hydroxyl radical and is quite persistent in the atmosphere.[139]

b. Deposition of Lead Emissions From Piston-Engine Aircraft and Soil Lead Concentrations to Which Piston-Engine Aircraft May Contribute

Lead is removed from the atmosphere and deposited on soil, into aquatic systems and on other surfaces via wet or dry deposition.[140] Meteorological factors (*e.g.,* wind speed, convection, rain, humidity) influence local deposition rates. With regard to deposition of lead from aircraft engine emissions, the EPA modeled the deposition rate for aircraft lead emissions at one airport in a temperate climate in California with dry summer months. In this location, the average lead deposition rate from aircraft emissions of lead was 0.057 milligrams per square meter per year.[141]

Studies summarized in the 2013 Lead ISA suggest that soil is a reservoir for contemporary and historical emissions of lead to air.[142] Once deposited to soil, lead can be absorbed onto organic material, can undergo chemical and physical transformation depending on a number of factors (*e.g.,* pH of the soil and the soil organic content), and can participate in further cycling through air or other media.[143] The extent of atmospheric deposition of lead from aircraft engine emissions would be expected to depend on a number of factors including the size of the particles emitted (smaller particles, such as those in aircraft emissions, have lower settling velocity and may travel farther distances before being deposited compared with larger particles), the temperature of the exhaust (the high temperature of the exhaust creates plume buoyancy), as well as meteorological factors (*e.g.,* wind speed, precipitation rates). As a result of the size of the lead particulate matter emitted from piston-engine aircraft and as a result of these emissions occurring at various altitudes, lead emitted from these aircraft may distribute widely through the environment.[144] Murphy et al. (2008) reported weekend increases in ambient air lead concentrations monitored at remote locations in the U.S. that the authors hypothesized were related to weekend increases in piston-engine powered general aviation activity.[145]

Heiken et al. (2014) assessed air lead concentrations potentially attributable to resuspended lead that previously deposited onto soil relative to air lead concentrations resulting directly from

[130] These concentration estimates are not used for comparison to the level of the Lead NAAQS due to different temporal averaging times and underlying assumptions in modeling. The AirToxScreen estimates are provided to help state, local and Tribal air agencies and the public identify which pollutants, emission sources and places they may wish to study further to better understand potential risks to public health from air toxics. There are uncertainties inherent in these estimates described by the EPA, some of which are relevant to these estimates of lead concentrations; however, these estimates provide perspective on the potential influence of piston-engine emissions of lead on air quality. *See https://www.epa.gov/AirToxScreen/airtoxscreen-limitations.*

[131] As airports are generally in larger census blocks within a census tract, concentrations for airport blocks dominate the area-weighted average in cases where an airport is the predominant lead emissions source in a census tract.

[132] Swiss FOCA (2007) Aircraft Piston Engine Emissions Summary Report. 33–05–003 Piston Engine Emissions_Swiss FOCA_Summary. Report_070612_rit. Available at *https://www.bazl.admin.ch/bazl/en/home/specialists/regulations-and-guidelines/environment/pollutant-emissions/aircraft-engine-emissions/report-appendices--database--and-data-sheets.html.* Retrieved on June 15, 2022.

[133] Griffith 2020. Electron microscopic characterization of exhaust particles containing lead dibromide beads expelled from aircraft burning leaded gasoline. *Atmospheric Pollution Research* 11:1481–1486.

[134] EPA (2013) ISA for Lead. Section 1.3. ''Exposure to Ambient Pb.'' p. 1–11. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[135] The EPA received comments on the information provided in this section to which we respond in the Response to Comments document for this action.

[136] EPA (1977) Air Quality Criteria for Lead. Section 6.2.2.1. EPA, Washington, DC, EPA–600/8–77–017, 1977.

[137] EPA (2006) Air Quality Criteria for Lead. Section E.6. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[138] EPA (2006) Air Quality Criteria for Lead. Section E.6. p. 2–5. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[139] EPA (2006) Air Quality Criteria for Lead. Section 2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[140] EPA (2013) ISA for Lead. Section 1.2.1. ''Sources, Fate and Transport of Ambient Pb;'' p. 1–6; and Section 2.3. ''Fate and Transport of Pb.'' p. 2–24 through 2–25. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[141] Memorandum to Docket EPA–HQ–OAR–2022–0389. Deposition of Lead Emitted by Piston-engine Aircraft. June 15, 2022. Docket ID EPA–HQ–2022–0389.

[142] EPA (2013) ISA for Lead. Section 2.6.1. ''Soils.'' p. 2–118. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[143] EPA (2013) ISA for Lead. Chapter 6. ''Ecological Effects of Pb.'' p. 6–57. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[144] Murphy et al., 2008. Weekly patterns of aerosol in the United States. *Atmospheric Chemistry and Physics.* 8:2729–2739.

[145] Lead concentrations collected as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) network and the National Oceanic and Atmospheric Administration (NOAA) monitoring sites.

aircraft engine emissions.[146] Based on comparisons of lead concentrations in total suspended particulate (TSP) and fine particulate matter ($PM_{2.5}$) measured at the three airports, coarse particle lead was observed to account for about 20–30 percent of the lead found in TSP. The authors noted that based on analysis of lead isotopes present in the air samples collected at these airports, the original source of the lead found in the coarse particle range appeared to be from aircraft exhaust emissions of lead that previously deposited to soil and were resuspended by wind or aircraft-induced turbulence. Results from lead isotope analysis in soil samples collected at the same three airports led the authors to conclude that lead emitted from piston-engine aircraft was not the dominant source of lead in soil in the samples measured at the airports they studied. The authors note the complex history of topsoil can create challenges in understanding the extent to which aircraft lead emissions impact soil lead concentrations at and near airports (*e.g.,* the source of topsoil can change as a result of site renovation, construction, landscaping, natural events such as wildfire and hurricanes, and other activities). Concentrations of lead in soil at and near airports servicing piston-engine aircraft have been measured using a range of approaches.[147 148 149 150 151 152] Kavouras et al. (2013) collected soil samples at three airports and reported that construction at an airport involving removal and replacement of topsoil complicated interpretation of the findings at that airport and that the number of runways at an airport may influence resulting lead concentrations in soil (*i.e.,* multiple runways may provide for more wide-spread dispersal of the lead over a larger area than that potentially affected at a single-runway airport).

c. Potential for Lead Emissions From Piston-Engine Aircraft To Impact Agricultural Products

Studies conducted near stationary sources of lead emissions (*e.g.,* smelters) have shown that atmospheric lead sources can lead to contamination of agricultural products, such as vegetables.[153 154] In this way, air lead sources may contribute to dietary exposure pathways.[155] As described in section II.A.1. of this document, piston-engine aircraft are used in the application of pesticides, fertilizers and seeding crops for human and animal consumption and, as such, provide a potential route of exposure for lead in food. To minimize drift of pesticides and other applications from the intended target, pilots are advised to maintain a height between eight and 12 feet above the target crop during application.[156] An unintended consequence of this practice is that exhaust emissions of lead have a substantially increased potential for directly depositing on vegetation and surrounding soil. Lead halides, the primary form of lead emitted by engines operating on leaded fuel,[157] are slightly water soluble and, therefore, may be more readily absorbed by plants than other forms of inorganic lead.

The 2006 AQCD indicated that surface deposition of lead onto plants may be significant.[158] Atmospheric deposition of lead provides a pathway for lead in vegetation as a result of contact with above-ground portions of the plant.[159 160 161] Livestock may subsequently be exposed to lead in vegetation (*e.g.,* grasses and silage) and in surface soils via incidental ingestion of soil while grazing.[162]

d. Potential for Lead Emissions From Piston-Engine Aircraft To Impact Aquatic Ecosystems

As discussed in section 6.4 of the 2013 Lead ISA, lead bioaccumulates in the tissues of aquatic organisms through ingestion of food and water or direct uptake from the environment (*e.g.,* across membranes such as gills or skin).[163] Alkyl lead, in particular, has been identified by the EPA as a Persistent, Bioaccumulative, and Toxic (PBT) pollutant.[164] There are 527 seaport facilities in the U.S., and landing and take-off activity by seaplanes at these facilities provides a direct pathway for emission of organic and inorganic lead to the air near/above inland waters and ocean seaports where these aircraft operate.[165] Inland airports may also provide a direct pathway for emission of organic and inorganic lead to the air near/above inland waters. Lead emissions from piston-engine aircraft operating at seaplane facilities as well as airports and heliports near water bodies can enter the aquatic ecosystem by either deposition from ambient air or runoff of lead deposited to surface soils.

In addition to deposition of lead from engine emissions by piston-powered aircraft, lead may enter aquatic systems from the pre-flight inspection of the fuel for contaminants that pilots conduct. While some pilots return the checked fuel to their fuel tank or dispose of it in a receptacle provided on the airfield, some pilots discard the fuel onto the tarmac, ground, or water, in the case of

[146] Heiken et al., 2014. ACRP Web-Only Document 21: Quantifying Aircraft Lead Emissions at Airports. Contractor's Final Report for ACRP 02–34. Available at *https://www.trb.org/Publications/Blurbs/172599.aspx.*

[147] McCumber and Strevett 2017. A Geospatial Analysis of Soil Lead Concentrations Around Regional Oklahoma Airports. *Chemosphere* 167:62–70.

[148] Kavouras et al., 2013. Bioavailable Lead in Topsoil Collected from General Aviation Airports. *The Collegiate Aviation Review International* 31(1):57–68. Available at *https://doi.org/10.22488/okstate.18.100438.*

[149] Heiken et al., 2014. ACRP Web-Only Document 21: Quantifying Aircraft Lead Emissions at Airports. Contractor's Final Report for ACRP 02–34. Available at *https://www.trb.org/Publications/Blurbs/172599.aspx.*

[150] EPA (2010) Development and Evaluation of an Air Quality Modeling Approach for Lead Emissions from Piston-Engine Aircraft Operating on Leaded Aviation Gasoline. EPA, Washington, DC, EPA–420–R–10–007, 2010. *https://nepis.epa.gov/Exe/ZyPDF.cgi/P1007H4Q.PDF?Dockey=P1007H4Q.PDF.*

[151] Environment Canada (2000) Airborne Particulate Matter, Lead and Manganese at Buttonville Airport. Toronto, Ontario, Canada: Conor Pacific Environmental Technologies for Environmental Protection Service, Ontario Region.

[152] Lejano and Ericson 2005. Tragedy of the Temporal Commons: Soil-Bound Lead and the Anachronicity of Risk. *Journal of Environmental Planning and Management.* 48(2):301–320.

[153] EPA (2013) ISA for Lead. Section 3.1.3.3. ''Dietary Pb Exposure.'' p. 3–20 through 3–24. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[154] EPA (2006) Air Quality Criteria for Lead. Section 8.2.2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[155] EPA (2006) Air Quality Criteria for Lead. Section 8.2.2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[156] O'Connor-Marer. Aerial Applicator's Manual: A National Pesticide Applicator Certification Study Guide. p. 40. National Association of State Departments of Agriculture Research Foundation. Available at *https://www.epa.gov/system/files/documents/2022-09/national-pesticide-applicator-cert-core-manual-2014.pdf.*

[157] The additive used in the fuel to scavenge lead determines the chemical form of the lead halide emitted; because ethylene dibromide is added to leaded aviation gasoline used in piston-engine aircraft, the lead halide emitted is in the form of lead dibromide.

[158] EPA (2006) Air Quality Criteria for Lead. pp. 7–9 and AXZ7–39 (citing U.S. studies of the 1990s). EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[159] EPA (2006) Air Quality Criteria for Lead. p. AXZ7–39. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[160] EPA (1986) Air Quality Criteria for Lead. Sections 6.5.3. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[161] EPA (1986) Air Quality Criteria for Lead. Section 7.2.2.2.1.EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[162] EPA (1986) Air Quality Criteria for Lead. Section 7.2.2.2.2. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[163] EPA (2013) ISA for Lead. Section 6.4.2. ''Biogeochemistry and Chemical Effects of Pb in Freshwater and Saltwater Systems.'' p. 6–147. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[164] EPA (2002) Persistent, Bioaccumulative, and Toxic Pollutants (PBT) Program. PBT National Action Plan for Alkyl-Pb. Washington, DC. June. 2002.

[165] *See* FAA's NASR. Available at *https://www.faa.gov/air_traffic/flight_info/aeronav/aero_data/eNASR_Browser/.*

a fuel check being conducted on a seaplane. Lead in the fuel discarded to the environment may evaporate to the air and may be taken up by the surface on which it is discarded. Lead on tarmac or soil surfaces is available for runoff to surface water. Tetraethyl lead in the avgas directly discarded to water will be available for uptake and bioaccumulation in aquatic life. The National Academy of Sciences Airport Cooperative Research Program (ACRP) conducted a survey study of pilots' fuel sampling and disposal practices. Among the 146 pilots responding to the survey, 36 percent indicated they discarded all fuel check samples to the ground regardless of contamination status, and 19 percent of the pilots indicated they discarded only contaminated fuel to the ground.[166] Leaded avgas discharged to the ground and water includes other hazardous fuel components such as ethylene dibromide.[167]

5. Consideration of Environmental Justice and Children in Populations Residing Near Airports

This section provides a description of how many people live in close proximity to airports where they may be exposed to airborne lead from aircraft engine emissions of lead (referred to here as the "near-airport" population). This section also provides the demographic composition of the near-airport population, with attention to implications related to environmental justice (EJ) and the population of children in this near-source environment.[168]

Executive Order 14096, "Revitalizing Our Nation's Commitment to Environmental Justice for All," defines environmental justice as "the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment so that people: (i) are fully protected from disproportionate and adverse human health and environmental effects (including risks) and hazards, including those related to climate change, the cumulative impacts of environmental and other burdens, and the legacy of racism or other structural or systemic barriers; and (ii) have equitable access to a healthy, sustainable, and resilient environment in which to live, play, work, learn, grow, worship, and engage in cultural and subsistence practices." [169] Providing this information regarding potential EJ implications in the population living near airports is important for purposes of public information and awareness. Here, EPA finds that blood lead levels in children from low-income households remain higher than those in children from higher income households, and blood lead levels in Black children are higher than those in non-Hispanic White children.[170] [171] [172]

The analysis described here provides information regarding whether some demographic groups are more highly represented in the near-airport environment compared with people who live farther from airports.[173] Residential proximity to airports implies that there is an increased potential for exposure to lead from covered aircraft engine emissions.[174] As described in section II.A.3. of this document, several studies have measured higher concentrations of lead in air near airports with piston-engine aircraft activity. Additionally, as noted in section II.A. of this document, three studies have reported increased blood lead levels in children with increasing proximity to airports.[175] [176] [177]

We first summarize here the literature on disparity among near-airport populations. Then we describe the analyses the EPA conducted to evaluate potential disparity in the population groups living near runways where piston-engine aircraft operate compared to those living elsewhere.

Numerous studies have found that environmental hazards such as air pollution are more prevalent in areas where people of color and low-income populations represent a higher fraction

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[166] National Academies of Sciences, Engineering, and Medicine 2014. Best Practices for General Aviation Aircraft Fuel-Tank Sampling. Washington, DC: The National Academies Press. *https://doi.org/10.17226/22343.*

[167] Memorandum to Docket EPA–HQ–OAR–2022–0389. Potential Exposure to Non-exhaust Lead and Ethylene Dibromide. June 15, 2022. Docket ID EPA–HQ–2022–0389.

[168] As described in this section, the EPA evaluated environmental justice consistent with the EPA 2016 Technical Guidance. However, the final decisions in this action are based on EPA's consideration under CAA section 231(a)(2)(A) of potential risks to public health and welfare from the lead air pollution, as well as its evaluation of whether emissions of lead from engines in covered aircraft contribute to that air pollution. See section III. for further discussion of the statutory authority for this action and sections IV. and V. for further discussion of the basis for these findings.

[169] See, *https://www.federalregister.gov/documents/2023/04/26/2023-08955/revitalizing-our-nations-commitment-to-environmental-justice-for-all.* When the analysis discussed in this section was performed, EPA defined environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that "no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental and commercial operations or programs and policies." Meaningful involvement occurs when "1) potentially affected populations have an appropriate opportunity to participate in decisions about a proposed activity [*e.g.,* rulemaking] that will affect their environment and/or health; 2) the public's contribution can influence the regulatory Agency's decision; 3) the concerns of all participants involved will be considered in the decision-making process; and 4) [the EPA will] seek out and facilitate the involvement of those potentially affected." See, EPA's Guidance on Considering Environmental Justice During the Development of Regulatory Actions. Available at *https://www.epa.gov/sites/default/files/2015-06/documents/considering-ej-in-rulemaking-guide-final.pdf.* See also *https://www.epa.gov/environmentaljustice.*

[170] EPA (2013) ISA for Lead. Section 5.4. "Summary." p. 5–40. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[171] EPA. America's Children and the Environment. Summary of blood lead levels in children updated in 2022, available at *https://www.epa.gov/americaschildrenenvironment/biomonitoring-lead.* Data source: Centers for Disease Control and Prevention, National Report on Human Exposure to Environmental Chemicals. Blood Lead (2011–2018). Updated March 2022. Available at *https://www.cdc.gov/exposurereport/report/pdf/cgroup2_LBXBPB_2011-p.pdf.*

[172] The relative contribution of lead emissions from covered aircraft engines to these disparities has not been determined and is not a goal of the evaluation described here.

[173] This analysis used the U.S. Census and demographic data from 2010 which was the most recent data available at the time of this assessment.

[174] Residential proximity to a source of a specific air pollutant(s) is a widely used surrogate measure to evaluate the potential for higher exposures to that pollutant (EPA 2016 Technical Guidance for Assessing Environmental Justice in Regulatory Analysis. Section 4.2.1). Data presented in section II.A.3. demonstrate that lead concentrations in air near the runup area can exceed the lead NAAQS and concentrations decrease sharply with distance from the ground-based aircraft exhaust and vary with the amount of aircraft activity at an airport. Not all people living within 500 meters of a runway are expected to be equally exposed to lead.

[175] Miranda et al., 2011. A Geospatial Analysis of the Effects of Aviation Gasoline on Childhood Blood Lead Levels. *Environmental Health Perspectives.* 119:1513–1516.

[176] Zahran et al., 2017. The Effect of Leaded Aviation Gasoline on Blood Lead in Children. *Journal of the Association of Environmental and Resource Economists.* 4(2):575–610.

[177] Zahran et al., 2022. Leaded Aviation Gasoline Exposure Risk and Child Blood Lead Levels. *Proceedings of the National Academy of Sciences Nexus.* 2:1–11.

of the population compared with the general population, including near transportation sources.[178 179 180 181 182] The literature includes studies that have reported on communities in close proximity to airports that are disproportionately represented by people of color and low-income populations. McNair (2020) described nineteen major airports that underwent capacity expansion projects between 2000 and 2010, thirteen of which had a large concentration or presence of persons of color, foreign-born persons or low-income populations nearby.[183] Woodburn (2017) reported on changes in communities near airports from 1970–2010, finding suggestive evidence that at many hub airports over time, the presence of marginalized groups residing in close proximity to airports increased.[184] Rissman et al. (2013) reported that with increasing proximity to the Hartsfield-Jackson Atlanta International Airport, exposures to particulate matter were higher, and there were lower home values, income, education, and percentage of white residents.[185]

The EPA used two approaches to understand whether some members of the population (*e.g.,* children five and under, people of color, indigenous populations, low-income populations) represent a larger share of the people living in proximity to airports where piston-engine aircraft operate compared with people who live farther away from these airports. In the first approach, we evaluated people living within, and children attending school within, 500 meters of all of the approximately 20,000 airports in the U.S., using methods described in the EPA's report titled ''National Analysis of the Populations Residing Near or Attending School Near U.S. Airports.'' [186] In the second approach, we evaluated people living near the NPIAS airports in the conterminous 48 states. As noted in section II.A.1. of this document, the NPIAS airports support the majority of piston-engine aircraft activity that occurs in the U.S. Among the NPIAS airports, we compared the demographic composition of people living within one kilometer of runways with the demographic composition of people living at a distance of one to five kilometers from the same airports.

The distances analyzed for those people living closest to airports (*i.e.,* distances of 500 meters and 1,000 meters) were chosen for evaluation following from the air quality monitoring and modeling data presented in section II.A.3. of this document. Specifically, the EPA's modeling and monitoring data indicate that concentrations of lead from piston-engine aircraft emissions can be elevated above background levels at distances of 500 meters over a rolling three-month period. On individual days, concentrations of lead from piston-engine aircraft emissions can be elevated above background levels at distances of 1,000 meters downwind of a runway, depending on aircraft activity and prevailing wind direction.[187 188 189]

Because the U.S. has a dense network of airports, many of which have neighboring communities, we quantified the number of people living and children attending school within 500 meters of the approximately 20,000 airports in the U.S.[190] From this analysis, the EPA estimates that approximately 5.2 million people live within 500 meters of an airport runway, 363,000 of whom are children aged five and under. The EPA also estimates that 573 schools attended by 163,000 children in kindergarten through twelfth grade are within 500 meters of an airport runway.[191]

In order to identify potential disparities in the near-airport population, we also evaluated populations at the state level. Using the U.S. Census population data for each state in the U.S., we compared the percent of people by age, race and indigenous peoples (*i.e.,* children five and under, Black, Asian, and Native American or Alaska Native) living within 500 meters of an airport runway with the percent by age, race, and indigenous peoples comprising the state population.[192] Using the methodology described in Clarke (2022), the EPA identified states in which children, Black, Asian, and Native American or Alaska Native populations represent a greater fraction of the population living within 500 meters of a runway compared with the percent of these groups in the state population.[193] Results of this analysis are presented in the following tables.[194] This state-level analysis presents summary information for a subset of potentially relevant demographic characteristics. We present data in this section regarding a wider array of demographic characteristics when evaluating populations living near NPIAS airports.

Among children five and under, there were three states (Nevada, South Carolina, and South Dakota) in which the percent of children five and under

[178] Rowangould 2013. A census of the near-roadway population: public health and environmental justice considerations. *Transportation Research Part* D 25:59–67. *https://dx.doi.org/10.1016/j.trd.2013.08.003.*

[179] Marshall et al., 2014. Prioritizing environmental justice and equality: diesel emissions in Southern California. *Environmental Science & Technology* 48: 4063–4068. *https://doi.org/10.1021/es405167f.*

[180] Marshall 2008. Environmental inequality: air pollution exposures in California's South Coast Air Basin. *Atmospheric Environment* 21:5499–5503. *https://doi.org/10.1016/j.atmosenv.2008.02.005.*

[181] Tessum et al., 2021. $PM_{2.5}$ polluters disproportionately and systemically affect people of color in the United States. *Science Advances* 7:eabf4491.

[182] Mohai et al., 2009. Environmental justice. *Annual Reviews* 34:405–430. Available at *https://doi.org/10.1146/annurev-environ-082508-094348.*

[183] McNair 2020. Investigation of environmental justice analysis in airport planning practice from 2000 to 2010. *Transportation Research Part D* 81:102286.

[184] Woodburn 2017. Investigating neighborhood change in airport-adjacent communities in multiairport regions from 1970 to 2010. *Journal of the Transportation Research Board,* 2626, 1–8.

[185] Rissman et al., 2013. Equity and health impacts of aircraft emissions at the Hartfield-Jackson Atlanta International Airport. *Landscape and Urban Planning,* 120: 234–247.

[186] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[187] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020.

[188] Carr et al., 2011. Development and evaluation of an air quality modeling approach to assess near-field impacts of lead emissions from piston-engine aircraft operating on leaded aviation gasoline. *Atmospheric Environment,* 45 (32), 5795–5804. DOI: *https://dx.doi.org/10.1016/j.atmosenv.2011.07.017.*

[189] We do not assume or expect that all people living within 500m or 1,000m of a runway are exposed to lead from piston-engine aircraft emissions, and the wide range of activity of piston-engine aircraft at airports nationwide suggests that exposure to lead from aircraft emissions is likely to vary widely.

[190] In this analysis, we included populations living in census blocks that intersected the 500-meter buffer around each runway in the U.S. Potential uncertainties in this approach are described in our report National Analysis of the Populations Residing Near or Attending School Near U.S. Airports. EPA–420–R–20–001, available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG4A.pdf,* and in the EPA responses to peer review comments on the report, available here: *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YISM.pdf.*

[191] EPA (2020) National Analysis of the Populations Residing Near or Attending School Near U.S. Airports. EPA–420–R–20–001. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG4A.pdf.*

[192] Clarke. Memorandum to Docket EPA–HQ–OAR–2022–0389. Estimation of Population Size and Demographic Characteristics among People Living Near Airports by State in the United States. May 31, 2022. Docket ID EPA–HQ–2022–0389.

[193] Clarke. Memorandum to Docket EPA–HQ–OAR–2022–0389. Estimation of Population Size and Demographic Characteristics among People Living Near Airports by State in the United States. May 31, 2022. Docket ID EPA–HQ–2022–0389.

[194] These data are presented in tabular form for all states in this memorandum located in the docket: Clarke. Memorandum to Docket EPA–HQ–OAR–2022–0389. Estimation of Population Size and Demographic Characteristics among People Living Near Airports by State in the United States. May 31, 2022. Docket ID EPA–HQ–2022–0389.

living within 500 meters of a runway represents a greater fraction of the population by a difference of one percent or greater compared with the percent of children five and under in the state population (Table 3).

TABLE 3—THE POPULATION OF CHILDREN FIVE YEARS AND UNDER WITHIN 500 METERS OF AN AIRPORT RUNWAY COMPARED TO THE STATE POPULATION OF CHILDREN FIVE YEARS AND UNDER

State	Percent of children aged five years and under within 500 meters	Percent of children aged five years and under within the state	Number of children aged five years and under within 500 meters	Number of children aged five years and under in the state
Nevada	10	8	1000	224,200
South Carolina	9	8	400	361,400
South Dakota	11	9	3,000	71,300

There were nine states in which the Black population represented a greater fraction of the population living in the near-airport environment by a difference of one percent or greater compared with the state as a whole. These states were California, Kansas, Kentucky, Louisiana, Mississippi, Nevada, South Carolina, West Virginia, and Wisconsin (Table 4).

TABLE 4—THE BLACK POPULATION WITHIN 500 METERS OF AN AIRPORT RUNWAY AND THE BLACK POPULATION, BY STATE

State	Percent black within 500 meters	Percent black within the state	Black population within 500 meters	Black population in the state
California	8	7	18,981	2,486,500
Kansas	8	6	1,240	173,300
Kentucky	9	8	3,152	342,800
Louisiana	46	32	14,669	1,463,000
Mississippi	46	37	8,542	1,103,100
Nevada	12	9	1,794	231,200
South Carolina	31	28	10,066	1,302,900
West Virginia	10	3	1,452	63,900
Wisconsin	9	6	4,869	367,000

There were three states with a greater fraction of Asians in the near-airport environment compared with the state as a whole by a difference of one percent or greater: Indiana, Maine, and New Hampshire (Table 5).

TABLE 5—THE ASIAN POPULATION WITHIN 500 METERS OF AN AIRPORT RUNWAY AND THE ASIAN POPULATION, BY STATE

State	Percent asian within 500 meters	Percent asian within the state	Asian population within 500 meters	Asian population in the state
Indiana	4	2	1,681	105,500
Maine	2	1	406	13,800
New Hampshire	4	2	339	29,000

There were five states (Alaska, Arizona, Delaware, South Dakota, and New Mexico) where the near-airport population had greater representation by Native Americans and Alaska Natives compared with the portion of the population they comprise at the state level by a difference of one percent or greater. In Alaska, the disparity in residential proximity to a runway was the largest: 16,020 Alaska Natives were estimated to live within 500 meters of a runway, representing 48 percent of the population within 500 meters of an airport runway. In contrast, Alaska Natives comprise 15 percent of the Alaska state population (Table 6).

TABLE 6—THE NATIVE AMERICAN AND ALASKA NATIVE POPULATION WITHIN 500 METERS OF AN AIRPORT RUNWAY AND THE NATIVE AMERICAN AND ALASKA NATIVE POPULATION, BY STATE

State	Percent Native American and Alaska Native within 500 meters	Percent Native American and Alaska Native within the state	Native American and Alaska Native population within 500 meters	Native American and Alaska Native population in the state
Alaska	48	15	16,020	106,300
Arizona	18	5	5,017	335,300
Delaware	2	1	112	5,900
New Mexico	21	10	2,265	208,900
South Dakota	22	9	1,606	72,800

In a separate analysis, the EPA focused on evaluating the potential for disparities in populations residing near the NPIAS airports. The EPA compared the demographic composition of people living within one kilometer of runways at 2,022 of the approximately 3,300 NPIAS airports with the demographic composition of people living at a distance of one to five kilometers from the same airports.[195] [196] In this analysis, over one-fourth of airports (*i.e.,* 515) were identified at which children under five were more highly represented in the zero to one kilometer distance compared with the percent of children under five living one to five kilometers away (Table 7). There were 666 airports where people of color had a greater presence in the zero to one kilometer area closest to airport runways than in populations farther away. There were 761 airports where people living at less than two-times the Federal Poverty Level represented a higher proportion of the overall population within one kilometer of airport runways compared with the proportion of people living at less than two times the Federal Poverty Level among people living one to five kilometers away.

TABLE 7—NUMBER OF AIRPORTS (AMONG THE 2,022 AIRPORTS EVALUATED) WITH DISPARITY FOR CERTAIN DEMOGRAPHIC POPULATIONS WITHIN ONE KILOMETER OF AN AIRPORT RUNWAY IN RELATION TO THE COMPARISON POPULATION BETWEEN ONE AND FIVE KILOMETERS FROM AN AIRPORT RUNWAY

Demographic group	Number of airports with disparity				
	Total airports with disparity	Disparity 1–5%	Disparity 5–10%	Disparity 10–20%	Disparity 20%+
Children under five years of age	515	507	7	1	0
People with income less than twice the Federal Poverty Level	761	307	223	180	51
People of Color (all non-White races, ethnicities and indigenous peoples)	666	377	126	123	40
Non-Hispanic Black	405	240	77	67	21
Hispanic	551	402	85	47	17
Non-Hispanic Asian	268	243	18	4	3
Non-Hispanic Native American or Alaska Native [197]	144	130	6	7	1
Non-Hispanic Hawaiian or Pacific Islander	18	17	1	0	0
Non-Hispanic Other Race	11	11	0	0	0
Non-Hispanic Two or More Races	226	226	0	0	0

To understand the extent of the potential disparity among the 2,022 NPIAS airports, Table 7 provides information about the distribution in the percent differences in the proportion of children, individuals with incomes below two times the Federal Poverty Level, and people of color living within one kilometer of a runway compared with those living one to five kilometers away. For children, Table 7 indicates that for the vast majority of these airports where there is a higher percentage of children represented in the near-airport population, differences are relatively small (*e.g.,* less than five percent). For the airports where disparity is evident on the basis of poverty, race and ethnicity, the disparities are potentially large, ranging up to 42 percent for those with incomes below two times the Federal Poverty Level, and up to 45 percent for people of color.[198]

There are uncertainties in the results provided here inherent to the proximity-based approach used. These uncertainties include the use of block group data to provide population numbers for each demographic group analyzed, and uncertainties in the Census data, including from the use of data from different analysis years (*e.g.,* 2010 Census Data and 2018 income data). These uncertainties are described

[195] For this analysis, we evaluated the 2,022 airports with a population of greater than 100 people inside the zero to one kilometer distance to avoid low population counts distorting the assessment of percent contributions of each group to the total population within the zero to one kilometer distance.

[196] Kamal et al., Memorandum to Docket EPA–HQ–OAR–2022–0389. Analysis of Potential Disparity in Residential Proximity to Airports in the Conterminous United States. May 24, 2022. Docket ID EPA–HQ–2022–0389. Methods used are described in this memo and include the use of block group resolution data to evaluate the representation of different demographic groups near-airport and for those living one to five kilometers away.

[197] This analysis of 2,022 NPIAS airports did not include airports in Alaska.

[198] Kamal et al., Memorandum to Docket EPA–HQ–OAR–2022–0389. Analysis of Potential Disparity in Residential Proximity to Airports in the Conterminous United States. May 24, 2022. Docket ID EPA–HQ–2022–0389.

and their implications discussed in Kamal et al. (2022).[199]

The data summarized in this section indicate that there is a greater prevalence of children under five years of age, an at-risk population for lead effects, within 500 meters or one kilometer of some airports compared to more distant locations. This information also indicates that there is a greater prevalence of people of color and of low-income populations within 500 meters or one kilometer of some airports compared with people living more distant. If such differences were to contribute to disproportionate and adverse impacts on particular communities, they could indicate an EJ concern. Given the number of children in close proximity to runways, including those in communities with EJ concerns, there is a potential for substantial implications for children's health, depending on lead exposure levels and associated risk.

Some commenters on the proposed findings expressed concern that communities in close proximity to general aviation airports are often low-income communities and communities of color who are disproportionately burdened by lead exposure.[200] Some commenters also noted that children who attend school near airports may experience higher levels of exposure compared with children who attend school more distant from an airport, and they cite recent research reporting higher blood lead levels in children who attend school near one highly active general aviation airport.[201] The EPA responds to these comments in the Response to Comments document for this action.

B. Federal Actions To Reduce Lead Exposure

The Federal Government has a longstanding commitment to programs to reduce exposure to lead, particularly for children. In December 2018, the President's Task Force on Environmental Health Risks and Safety Risks to Children released the Federal Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts (Federal Lead Action Plan), detailing the Federal Government's commitments and actions to reduce lead exposure in children, some of which are described in this section.[202] Building on the 2018 Federal Lead Action Plan, in October 2022, the EPA finalized its Strategy to Reduce Lead Exposures and Disparities in U.S. Communities (Lead Strategy).[203] The Lead Strategy describes the EPA-wide and government-wide approaches to strengthen public health protections, address legacy lead contamination for communities with the greatest exposures, and promote environmental justice. In this section, we describe some of the EPA's actions to reduce lead exposures from air, water, lead-based paint, and contaminated sites.

In 1976, the EPA listed lead under CAA section 108, making it what is called a ''criteria air pollutant.'' [204] Once lead was listed, the EPA issued primary and secondary NAAQS under sections 109(b)(1) and (2), respectively. The EPA issued the first NAAQS for lead in 1978 and revised the lead NAAQS in 2008 by reducing the level of the standard from 1.5 micrograms per cubic meter to 0.15 micrograms per cubic meter and revising the averaging time and form to an average over a consecutive three-month period, as described in 40 CFR 50.16.[205] The EPA's 2016 **Federal Register** document describes the Agency's decision to retain the existing Lead NAAQS.[206] The Lead NAAQS is currently undergoing review.[207] [208]

States are primarily responsible for ensuring attainment and maintenance of the NAAQS. Under section 110 of the Act and related provisions, states are to submit, for the EPA's review and, if appropriate, approval, state implementation plans that provide for the attainment and maintenance of such standards through control programs directed to sources of the pollutants involved.

Additional EPA programs to address lead in the environment include the prohibition on gasoline containing lead or lead additives for highway use under section 211 of the Act; the new source performance standards under section 111 of the Act; and emissions standards for solid waste incineration units and the national emission standards for hazardous air pollutants (NESHAP) under sections 129 and 112 of the Act, respectively.

The EPA has taken a number of actions associated with these air pollution control programs, including completion of several regulations requiring reductions in lead emissions from stationary sources regulated under the CAA sections 111, 112 and 129. For example, in January 2012, the EPA updated the NESHAP for the secondary lead smelting source category.[209] These amendments to the original maximum achievable control technology standards apply to facilities nationwide that use furnaces to recover lead from lead-bearing scrap, mainly from automobile batteries. Regulations completed in 2013 for commercial and industrial solid waste incineration units also require reductions in lead emissions.[210] In February 2023, the EPA finalized amendments to the NSPS (as a new subpart) and the Area Source NESHAP for the Lead Acid Battery Manufacturing source category.[211] The amendments to the standards for affected processes including grid casting, lead reclamation, and paste mixing operations at lead acid battery facilities will result in reductions in lead emissions and improvements in compliance assurance measures.

A broad range of Federal programs beyond those that focus on air pollution control provide for nationwide reductions in environmental releases and human exposures to lead. For example, pursuant to section 1417 of the Safe Drinking Water Act (SDWA), any pipe, pipe or plumbing fitting or fixture, solder, or flux may not be used in new installations or repairs of any public water system or plumbing in a

[199] Kamal et al., Memorandum to Docket EPA–HQ–OAR–2022–0389. Analysis of Potential Disparity in Residential Proximity to Airports in the Conterminous United States. May 24, 2022. Docket ID EPA–HQ–2022–0389.

[200] During the public comment period on the proposed findings for this action, commenters provided an additional evaluation of populations living near airports that they conclude to indicate that disparity by race and income is larger and occurs more frequently at airports that have the highest lead emissions and the highest residential population density compared with airports where less lead is emitted and population density is lower. This comment is available in the docket at *regulations.gov:* EPA–HQ–OAR–2022–0389–0238.

[201] Zahran et al., 2022. Leaded Aviation Gasoline Exposure Risk and Child Blood Lead Levels. *Proceedings of the National Academy of Sciences Nexus.* 2:1–11.

[202] Federal Lead Action Plan to Reduce Childhood Lead Exposures and Associated Health Impacts. (2018) President's Task Force on Environmental Health Risks and Safety Risks to Children. Available at *https://www.epa.gov/sites/default/files/2018-12/documents/fedactionplan_lead_final.pdf.*

[203] EPA (2022) EPA Strategy to Reduce Lead Exposures and Disparities in U.S. Communities. EPA 540R22006. Available at *https://www.epa.gov/system/files/documents/2022-11/Lead%20Strategy_1.pdf.*

[204] 41 FR 14921 (April 8, 1976). *See also, e.g.,* 81 FR 71910 (Oct. 18, 2016) for a description of the history of the listing decision for lead under CAA section 108.

[205] 73 FR 66965 (Nov. 12, 2008).

[206] 81 FR 71912–71913 (Oct. 18, 2016).

[207] Documents pertaining to the current review of the NAAQS for Lead can be found here: *https://www.epa.gov/naaqs/lead-pb-air-quality-standards.*

[208] The EPA released the ISA for Lead, External Review Draft, as part of the Agency's current review of the science regarding health and welfare effects of lead. EPA/600/R–23/061. This draft assessment is undergoing peer review by the Clean Air Scientific Advisory Committee (CASAC) and public comment, and is available at: *https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=357282.*

[209] 77 FR 555 (Jan. 5, 2012).

[210] 78 FR 9112 (Feb. 7, 2013).

[211] 88 FR 11556 (Feb. 23, 2023).

residential or non-residential facility providing water for human consumption or introduced into commerce (except uses for manufacturing or industrial purposes) unless it is considered ''lead free'' as defined by that Act.[212] The EPA's Lead and Copper Rule,[213] first promulgated in 1991, regulates lead in public drinking water systems through a treatment technique that requires water systems to monitor drinking water at customer taps and, if an action level is exceeded, undertake a number of actions including those to control corrosion to minimize lead exposure.[214] On January 15, 2021, the agency published the most recent revisions, the Lead and Copper Rule Revisions (LCRR),[215] and subsequently reviewed the rule in accordance with Executive Order 13990.[216] While the LCRR took effect in December 2021, the agency concluded that there are significant opportunities to improve the LCRR.[217] The EPA is developing a new proposed rule, the Lead and Copper Rule Improvements (LCRI),[218] to further strengthen the lead drinking water regulations. The EPA identified priority improvements for the LCRI: proactive and equitable lead service line replacement (LSLR), strengthening compliance tap sampling to better identify communities most at risk of lead in drinking water and to compel lead reduction actions, and reducing the complexity of the regulation through improvement of the action and trigger level construct.[219] The EPA intends to propose and promulgate the LCRI prior to October 16, 2024.

While the EPA continues to improve regulatory actions to reduce lead exposure in drinking water, the EPA recognizes that directly assisting states and communities and providing dedicated funding provided in the Bipartisan Infrastructure Law for lead service line identification and replacement of full lead service lines (LSLs) is also important in safeguarding public health. The EPA is providing $15 billion through the Drinking Water State Revolving Fund (DWSRF) dedicated exclusively to lead service line identification and replacement. In addition, $11.7 billion in DWSRF general supplemental funding, provided by the Bipartisan Infrastructure Law, is going to projects to improve drinking water quality, including those to reduce lead in drinking water. For this funding, states are required to provide 49% as additional subsidization in the form of principal forgiveness and/or grants. States must provide additional subsidization to water systems that meet the state's disadvantaged community criteria as described in section 1452(d) of SDWA, furthering the objectives of the Justice40 Initiative. In October 2022, the EPA announced projects selected to receive over $30 million in grant funding that will help communities and schools address lead in drinking water and remove lead pipes across the country in underserved and other disadvantaged communities through the Water Infrastructure Improvements for the Nation Act's Reducing Lead in Drinking Water grant program. The EPA recently announced the Lead Service Line Replacement Accelerators initiative which will provide targeted technical assistance to communities in Connecticut, Pennsylvania, New Jersey, and Wisconsin to support expanded access to funding and to accelerate lead pipe replacement. While the EPA is focusing initial efforts in four states, the Agency anticipates this work will serve as a roadmap for additional lead service line replacement efforts across the nation in the future.

Federal programs to reduce exposure to lead in paint, dust, and soil are specified under the comprehensive Federal regulatory framework developed under the Residential Lead-Based Paint Hazard Reduction Act (Title X). Under Title X (codified, in part, as Title IV of the Toxic Substances Control Act [TSCA]), the EPA has established regulations and associated programs in six categories: (1) Training, certification and work practice requirements for persons engaged in lead-based paint activities (abatement, inspection and risk assessment); accreditation of training providers; and authorization of state and Tribal lead-based paint programs; (2) training, certification, and work practice requirements for persons engaged in home renovation, repair and painting (RRP) activities; accreditation of RRP training providers; and authorization of state and Tribal RRP programs; (3) ensuring that, for most housing constructed before 1978, information about lead-based paint and lead-based paint hazards flows from sellers to purchasers, from landlords to tenants, and from renovators to owners and occupants; (4) establishing standards for identifying dangerous levels of lead in paint, dust and soil; (5) providing grant funding to establish and maintain state and Tribal lead-based paint programs; and (6) providing information on lead hazards to the public, including steps that people can take to protect themselves and their families from lead-based paint hazards.

The most recent rules issued under Title IV of TSCA revised the dust-lead hazard standards (DLHS) and dust-lead clearance levels (DLCL) which were established in a 2001 final rule entitled ''Identification of Dangerous Levels of Lead.'' [220] The DLHS are incorporated into the requirements and risk assessment work practice standards in the EPA's Lead-Based Paint Activities Rule, codified at 40 CFR part 745, subpart L. They provide the basis for risk assessors to determine whether dust-lead hazards are present in target housing (*i.e.,* most pre-1978 housing) and child-occupied facilities (pre-1978 nonresidential properties where children 6 years of age or under spend a significant amount of time such as daycare centers and kindergartens). If dust-lead hazards are present, the risk assessor will identify acceptable options for controlling the hazards in the respective property, which may include abatements and/or interim controls. In July 2019, the EPA published a final rule revising the DLHS from 40 micrograms per square foot and 250 micrograms per square foot to 10 micrograms per square foot and 100 micrograms per square foot of lead in dust on floors and windowsills, respectively.[221] The DLCL are used to evaluate the effectiveness of a cleaning following an abatement. If the dust-lead levels are not below the clearance levels, the components (*i.e.,* floors, windowsills, troughs) represented by the failed sample(s) shall be recleaned and retested. In January 2021, the EPA published a final rule revising the DLCL to match the DLHS, lowering them from 40 micrograms per square foot and 250 micrograms per square foot to 10 micrograms per square foot and 100 micrograms per square foot on floors and windowsills, respectively.[222] The EPA is now reconsidering the 2019 and 2021 rules in accordance with Executive Order 13990 [223] and in response to a

[212] Effective in Jan. 2014, the amount of lead permitted in pipes, fittings, and fixtures was lowered. *See,* section 1417 of the Safe Drinking Water Act: Prohibition on Use of Lead Pipes, Solder, and Flux at *https://www.epa.gov/sdwa/use-lead-free-pipes-fittings-fixtures-solder-and-flux-drinking-water.*

[213] 40 CFR part 141, subpart I (June 7, 1991).

[214] 40 CFR part 141, subpart I (June 7, 1991).

[215] 86 FR 4198. (Jan. 15, 2021).

[216] E.O. 13990. Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis. 86 FR 7037 (Jan. 20, 2021).

[217] 86 FR 31939 (Dec. 17, 2021).

[218] *See https://www.epa.gov/ground-water-and-drinking-water/review-national-primary-drinking-water-regulation-lead-and-copper.* Accessed on Nov. 30, 2021.

[219] 86 FR 31939 (Dec. 17, 2021).

[220] 66 FR 1206 (Jan. 5, 2001).

[221] 84 FR 32632 (July 9, 2019).

[222] 86 FR 983 (Jan. 7, 2021).

[223] 86 FR 7037 (Jan. 20, 2021).

May 2021 decision by U.S. Court of Appeals for the Ninth Circuit. In August 2023, EPA proposed updating the DLHS and DLCL again.[224] If finalized as proposed, the DLHS for floors and window sills would be any reportable level greater than zero, as analyzed by any laboratory recognized by EPA's National Lead Laboratory Accreditation Program. The new DLCL would be 3 micrograms per square foot (μg/ft²) for floors, 20 μg/ft² for window sills and 25 μg/ft² for window troughs.

Programs associated with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)[225] and Resource Conservation Recovery Act (RCRA)[226] also implement removal and remedial response programs that reduce or abate exposures to releases or threatened releases of lead and other hazardous substances. Furthermore, CERCLA section 104(a)(1) authorizes the EPA and other Federal agencies to respond to releases or threatened releases of pollutants or contaminants when the release, or potential release, may present an imminent and substantial danger to the public health or welfare. In addition, CERCLA section 104(a)(1) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) authorize remedial investigations (*e.g.,* monitoring, testing, information collection) and removal actions for hazardous substances, pollutants, or contaminants.

The EPA develops and implements protective levels for lead in soil (and other media when appropriate) at Superfund sites and, together with states, at RCRA corrective action facilities. The Office of Land and Emergency Management develops policy and guidance for addressing multimedia lead contamination and determining appropriate response actions at lead-contaminated sites. Federal programs, including those implementing RCRA, provide for management of hazardous substances such as lead in hazardous and municipal solid waste (*e.g.,* 50 FR 28702, July 15, 1985; 52 FR 45788, December 1, 1987).

C. Lead Endangerment Petitions for Rulemaking and the EPA Responses

The Administrator's final findings further respond to several citizen petitions on this subject, including the following: petition for rulemaking submitted by Friends of the Earth in 2006, petition for rulemaking submitted by Friends of the Earth, Oregon Aviation Watch and Physicians for Social Responsibility in 2012, petition for reconsideration submitted by Friends of the Earth, Oregon Aviation Watch, and Physicians for Social Responsibility in 2014, and petition for rulemaking from Alaska Community Action on Toxics, Center for Environmental Health, Friends of the Earth, Montgomery-Gibbs Environmental Coalition, Oregon Aviation Watch, the County of Santa Clara, CA, and the Town of Middleton, WI, in 2021. These petitions and the EPA's responses are described more fully in the proposal for this action.[227] [228]

In the most recent of these petitions, submitted in 2021, Alaska Community Action on Toxics, Center for Environmental Health, Friends of the Earth, Montgomery-Gibbs Environmental Coalition, Oregon Aviation Watch, the County of Santa Clara, CA, and the Town of Middleton, WI, again petitioned the EPA to conduct a proceeding under CAA section 231 regarding whether lead emissions from piston-engine aircraft cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare.[229] The EPA responded in 2022 noting our intent to develop a proposal under CAA section 231(a)(2)(A) regarding whether lead emissions from piston-engine aircraft cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, and, after evaluating public comments on the proposal, issue any final determination in 2023, as the Agency is doing in this action.[230]

III. Legal Framework for This Action

In this action, the EPA is finalizing two separate determinations—an endangerment finding and a cause or contribute finding—under section 231(a)(2)(A) of the Clean Air Act. The EPA has, most recently, finalized such findings under CAA section 231 for greenhouse gases (GHGs) in 2016 (2016 Findings), and in that action the EPA provided a detailed explanation of the legal framework for making such findings and the statutory interpretations and caselaw supporting its approach.[231] In this final action, the Administrator used the same approach of applying a two-part test under section 231(a)(2)(A) as described in the 2016 Findings and relied on the same interpretations supporting that approach, which are briefly described in this section, and set forth in greater detail in the 2016 Findings.[232] This is also the same approach that the EPA used in making endangerment and cause or contribute findings for GHGs under section 202(a) of the CAA in 2009 (2009 Findings),[233] which was affirmed by the U.S. Court of Appeals for the D.C. Circuit in 2012.[234] As explained further in the 2016 Findings, the text of the CAA section 231(a)(2)(A), which concerns aircraft emissions, mirrors the text of CAA section 202(a), which concerns motor vehicle emissions and which was the basis for the 2009 Findings.[235] [236] Accordingly, for the same reasons as discussed in the 2016 Findings, the EPA believes it is reasonable to use the same approach under section 231(a)(2)(A)'s similar text as was used under section 202(a) for the 2009 Findings, and it is acting consistently with that framework for purposes of these final findings under section 231.[237] As this approach has

[224] 88 FR 50444 (August 1, 2023).

[225] For more information about the EPA's CERCLA program, see *https://www.epa.gov/superfund.*

[226] For more information about the EPA's RCRA program, see *https://www.epa.gov/rcra.*

[227] *See https://www.epa.gov/regulations-emissions-vehicles-and-engines/petitions-and-epa-response-memorandums-related-lead.*

[228] 87 FR 62772 (Oct. 17, 2022).

[229] The 2021 petition is available at *https://www.epa.gov/system/files/documents/2022-01/aviation-leaded-avgas-petition-exhibits-final-2021-10-12.pdf.*

[230] EPA's response to the 2021 petition is available at *https://www.epa.gov/system/files/documents/2022-01/ltr-response-aircraft-lead-petitions-aug-oct-2022-01-12.pdf.*

[231] 81 FR 54422–54475 (Aug. 15, 2016).

[232] *See e.g.,* 81 FR 55434–54440 (Aug. 15, 2016).

[233] 74 FR 66505–66510 (Dec. 15, 2009).

[234] *Coalition for Responsible Regulation, Inc.* v. *EPA,* 684 F.3d 102 (D.C. Cir. 2012) (*CRR*) (*rev'd in part on other grounds sub nom. Utility Air Regulatory Group* v. *EPA,* 573 U.S. 302 (2014)). As discussed in greater detail in the 2016 Findings, the Supreme Court granted some of the petitions for *certiorari* that were filed on *CRR,* while denying others, but agreed to decide only the question: ''Whether EPA permissibly determined that its regulation of greenhouse gas emissions from new motor vehicles triggered permitting requirements under the Clean Air Act for stationary sources that emit greenhouse gases.'' 81 FR 54422, 54442 (Aug. 15, 2016). Thus, the Supreme Court did not disturb the D.C. Circuit's holding in *CRR* that affirmed the 2009 Endangerment Finding.

[235] For example, the text in CAA section 202(a) that was the basis for the 2009 Findings addresses ''the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in [the Administrator's] judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' Similarly, section 231(a)(2)(A) concerns ''the emission of any air pollutant from any class or classes of aircraft engines which in [the Administrator's] judgment causes, or contributes to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' Additional discussion of the parallels in the statutory text and legislative history between CAA section 202(a) and 231(a)(2)(A) can be found in the 2016 Findings. *See* 81 FR 55434—55437 (Aug. 15, 2016).

[236] 81 FR 55434 (Aug. 15, 2016).

[237] 81 FR 55434 (Aug. 15, 2016).

been previously discussed at length in the 2016 Findings, as well as in the 2009 Findings, the EPA provides only a brief description in this final action.

A. Statutory Text and Basis for This Action

Section 231(a)(2)(A) of the CAA provides that the ''Administrator shall, from time to time, issue proposed emission standards applicable to the emission of any air pollutant from any class or classes of aircraft engines which in his judgment causes, or contributes to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' [238] In this action, the EPA is addressing the predicate for regulatory action under CAA section 231 through a two-part test, which as noted previously, is the same as the test used in the 2016 Findings under section 231 and in the 2009 Findings under section 202 of the CAA.

As the first step of the two-part test, the Administrator must decide whether, in his judgment, the air pollution under consideration may reasonably be anticipated to endanger public health or welfare. As the second step, the Administrator must decide whether, in his judgment, emissions of an air pollutant from certain classes of aircraft engines cause or contribute to this air pollution. If the Administrator answers both questions in the affirmative, he will issue standards under section 231.[239]

In accordance with the EPA's interpretation of the text of section 231(a)(2)(A), as described in the 2016 Findings, the phrase ''may reasonably be anticipated'' and the term ''endanger'' in section 231(a)(2)(A) authorize, if not require, the Administrator to act to prevent harm and to act in conditions of uncertainty.[240] They do not limit him to merely reacting to harm or to acting only when certainty has been achieved; indeed, the references to anticipation and to endangerment imply that the failure to look to the future or to less than certain risks would be to abjure the Administrator's statutory responsibilities. As the D.C. Circuit explained, the language ''may reasonably be anticipated to endanger public health or welfare'' in CAA section 202(a) requires a ''precautionary, forward-looking scientific judgment about the risks of a particular air pollutant, consistent with the CAA's precautionary and preventive orientation.'' [241] The court determined that ''[r]equiring that the EPA find 'certain' endangerment of public health or welfare before regulating greenhouse gases would effectively prevent the EPA from doing the job that Congress gave it in [section] 202(a)—utilizing emission standards to prevent reasonably anticipated endangerment from maturing into concrete harm.'' [242] The same language appears in section 231(a)(2)(A), and the same interpretation applies in that context.

Moreover, by instructing the Administrator to consider whether emissions of an air pollutant cause or contribute to air pollution in the second part of the two-part test, the Act makes clear that he need not find that emissions from any one sector or class of sources are the sole or even the major part of the air pollution considered. This is clearly indicated by the use of the term ''contribute.'' Further, the phrase ''in his judgment'' authorizes the Administrator to weigh risks and to consider projections of future possibilities, while also recognizing uncertainties and extrapolating from existing data.

Finally, when exercising his judgment in making both the endangerment and cause-or-contribute findings, the Administrator balances the likelihood and severity of effects. Notably, the phrase ''in his judgment'' modifies both ''may reasonably be anticipated'' and ''cause or contribute.''

Often, past endangerment and cause or contribute findings have been proposed concurrently with proposed standards under various sections of the CAA, including section 231.[243] Comment has been taken on these proposed findings as part of the notice and comment process for the emission standards.[244] However, there is no requirement that the Administrator propose or finalize the endangerment and cause or contribute findings concurrently with proposed standards and, most recently under section 231, the EPA made endangerment and cause or contribute findings for GHGs separate from, and prior to, proceeding to set standards.

As noted in the proposal,[245] the Administrator is applying the procedural provisions of CAA section 307(d) to this action, pursuant to CAA section 307(d)(1)(V), which provides that the provisions of 307(d) apply to ''such other actions as the Administrator may determine.'' [246] Any subsequent standard-setting rulemaking under CAA section 231 would also be subject to the procedures under CAA section 307(d), as provided in CAA section 307(d)(1)(F) (applying the provisions of CAA section 307(d) to the promulgation or revision of any aircraft emission standard under CAA section 231). Thus, these final findings are subject to the same procedural requirements that would apply if the final findings were part of a standard-setting rulemaking.

B. Considerations for the Endangerment and Cause or Contribute Analyses Under Section 231(a)(2)(A)

In the context of this final action, the EPA understands section 231(a)(2)(A) of the CAA to call for the Administrator to exercise his judgment and make two separate determinations: first, whether the relevant kind of air pollution (here, lead air pollution) may reasonably be anticipated to endanger public health or welfare, and second, whether emissions of any air pollutant from classes of the sources in question (here, any aircraft engine that is capable of using leaded aviation gasoline), cause or contribute to this air pollution.[247]

This analysis entails a scientific judgment by the Administrator about the potential risks posed by lead emissions to public health and welfare. In this final action, the EPA used the same approach in making scientific judgments regarding endangerment as it has previously described in the 2016

[238] Regarding ''welfare,'' the CAA states that ''[a]ll language referring to effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility, and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well-being, whether caused by transformation, conversion, or combination with other air pollutants.'' CAA section 302(h). Regarding ''public health,'' there is no definition of ''public health'' in the Clean Air Act. The Supreme Court has discussed the concept of ''public health'' in the context of whether costs can be considered when setting NAAQS. *Whitman* v. *American Trucking Ass'n,* 531 U.S. 457 (2001). In *Whitman,* the Court imbued the term with its most natural meaning: ''the health of the public.'' *Id.* at 466.

[239] *See Massachusetts* v. *EPA,* 549 U.S. 497, 533 (2007) (interpreting an analogous provision in CAA section 202).

[240] *See* 81 FR 54435 (Aug. 15, 2016).

[241] *CRR,* 684 F.3d at 122 (internal citations omitted) (June 26, 2012).

[242] *CRR,* 684 F.3d at 122 (internal citations omitted) (June 26, 2012).

[243] 81 FR 54425 (Aug. 15, 2016).

[244] *See, e.g.,* Rulemaking for non-road compression-ignition engines under section 213(a)(4) of the CAA, Proposed Rule at 58 FR 28809, 28813–14 (May 17, 1993), Final Rule at 59 FR 31306, 31318 (June 17, 1994); Rulemaking for highway heavy-duty diesel engines and diesel sulfur fuel under sections 202(a) and 211(c) of the CAA, Proposed Rule at 65 FR 35430 (June 2, 2000), and Final Rule at 66 FR 5002 (Jan. 18, 2001).

[245] 87 FR 62773–62774 (Oct. 17, 2022).

[246] As the Administrator is applying the provisions of CAA section 307(d) to this action under section 307(d)(1)(V), we need not determine whether those provisions would apply to this action under section 307(d)(1)(F).

[247] *See CRR,* 684 F.3d at 117 (explaining two-part analysis under section 202(a)) (June 26, 2012).

Findings, and its analysis was guided by the same five principles that guided the Administrator's analysis in those Findings.[248]

Similarly, the EPA took the same approach to the cause or contribute analysis as was previously explained in the 2016 Findings.[249] For example, as previously noted, section 231(a)(2)(A)'s instruction to consider whether emissions of an air pollutant cause or contribute to air pollution makes clear that the Administrator need not find that emissions from any one sector or class of sources are the sole or even the major part of an air pollution problem.[250] Moreover, like the language in CAA section 202(a) that governed the 2009 Findings, the statutory language in section 231(a)(2)(A) does not contain a modifier on its use of the term ''contribute.''[251] Unlike other CAA provisions, it does not require ''significant'' contribution. Compare, *e.g.,* CAA sections 111(b); 213(a)(2), (4). Congress made it clear that the Administrator is to exercise his judgment in determining contribution, and authorized regulatory controls to address air pollution even if the air pollution problem results from a wide variety of sources.[252] While the endangerment test looks at the air pollution being considered as a whole and the risks it poses, the cause or contribute test is designed to authorize the EPA to identify and then address what may well be many different sectors, classes, or groups of sources that are each part of the problem.[253]

Moreover, as the EPA has previously explained, the Administrator has ample discretion in exercising his reasonable judgment and determining whether, under the circumstances presented, the cause or contribute criterion has been met.[254] As noted in the 2016 Findings, in addressing provisions in section 202(a), the D.C. Circuit has explained that the Act at the endangerment finding step did not require the EPA to identify a precise numerical value or ''a minimum threshold of risk or harm before determining whether an air pollutant endangers.''[255] Accordingly, the EPA ''may base an endangerment finding on 'a lesser risk of greater harm . . . or a greater risk of lesser harm' or any combination in between.''[256] As the language in section 231(a)(2)(A) is analogous to that in section 202(a), it is reasonable to apply this interpretation to the endangerment determination under section 231(a)(2)(A).[257] Moreover, the logic underlying this interpretation supports the general principle that under CAA section 231 the EPA is not required to identify a specific minimum threshold of contribution from potentially subject source categories in determining whether their emissions ''cause or contribute'' to the endangering air pollution.[258] The reasonableness of this principle is further supported by the fact that section 231 does not impose on the EPA a requirement to find that such contribution is ''significant,'' let alone the sole or major cause of the endangering air pollution.[259]

Finally, as also described in the 2016 Findings, there are a number of possible ways of assessing whether air pollutants cause or contribute to the air pollution which may reasonably be anticipated to endanger public health and welfare, and no single approach is required or has been used exclusively in previous cause or contribute determinations under title II of the CAA.[260]

C. Regulatory Authority for Emission Standards

Though the EPA is not proposing standards in this final action, in issuing these final findings, the EPA becomes subject to a duty under CAA section 231 regarding emission standards applicable to emissions of lead from aircraft engines. As noted in section III.A. of this document, section 231(a)(2)(A) of the CAA directs the Administrator of the EPA to propose and promulgate emission standards applicable to the emission of any air pollutant from classes of aircraft engines which in his or her judgment causes or contributes to air pollution that may reasonably be anticipated to endanger public health or welfare.

CAA section 231(a)(2)(B) further directs the EPA to consult with the Administrator of the FAA on such standards, and it prohibits the EPA from changing aircraft emission standards if such a change would significantly increase noise and adversely affect safety. CAA section 231(a)(3) provides that after we provide an opportunity for a public hearing on standards, the Administrator shall issue standards ''with such modifications as he deems appropriate.'' In addition, under CAA section 231(b), the effective date of any standards shall provide the necessary time to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance, as determined by the EPA in consultation with the U.S. Department of Transportation (DOT).

Once the EPA adopts standards, CAA section 232 then directs the Secretary of DOT to prescribe regulations to ensure compliance with the EPA's standards. Finally, section 233 of the CAA vests the authority to promulgate emission standards for aircraft or aircraft engines only in the Federal Government. States are preempted from adopting or enforcing any standard respecting aircraft or aircraft engine emissions unless such standard is identical to the EPA's standards.[261]

D. Response to Certain Comments on the Legal Framework for This Action

In commenting on the legal framework for this action, some commenters assert that the EPA does have authority under CAA section 231(a)(2)(A) to both find that lead air pollution may reasonably be anticipated to endanger the public health and welfare and to find that engine emissions of lead from certain aircraft cause or contribute to the lead air pollution that may reasonably be anticipated to endanger the public health and welfare. We agree with these comments.

Other commenters assert that the EPA does not have the legal authority to proceed with this proposal or regulate aviation fuel. These commenters state that Congress excluded aircraft from the CAA of 1970, that the EPA does not have authority to regulate aircraft fuel (citing a regulatory definition of ''transportation fuel'' in 40 CFR 80.1401) and that aircraft are not motor vehicles (citing a regulatory definition of ''motor vehicles'' in 40 CFR 85.1703). These commenters say that the definitions of transportation fuel and motor vehicles were not changed through 1977 or 1990 amendments to the CAA. Additionally, commenters assert that the ''EPA points to findings for Green House Gases (GHGs) under section 202(a) supportive of its proposed authority,'' quoting that section and emphasizing the terms ''new motor vehicles'' and ''new motor vehicle engines'' which are used in it.

In response, the EPA notes that these commenters have fundamentally misunderstood the nature of this action and the legal authority upon which it relies. These final findings do not

[248] *See, e.g.,* 81 FR 54434–55435 (Aug. 15, 2016).

[249] *See, e.g.,* 81 FR 54437–54438 (Aug. 15, 2016).

[250] *See, e.g.,* 81 FR 54437–54438 (Aug. 15, 2016).

[251] *See, e.g.,* 81 FR 54437–54438 (Aug. 15, 2016).

[252] *See* 81 FR 54437–54438 (Aug. 15, 2016).

[253] *See* 81 FR 54437–54438 (Aug. 15, 2016).

[254] *See* 81 FR 54437–54438 (Aug. 15, 2016).

[255] CRR, 684 F.3d at 122–123 (June 26, 2012).

[256] CRR, 684 F.3d at 122–123. (quoting Ethyl Corp., 541 F.2d at 18) (June 26, 2012).

[257] 81 FR 54438 (Aug. 15, 2016).

[258] 81 FR 54438 (Aug. 15, 2016).

[259] 81 FR 54438 (Aug. 15, 2016).

[260] *See* 81 FR 54462 (Aug. 15, 2016).

[261] CAA section 233.

establish regulatory standards for leaded avgas, nor are they related in any way to the regulatory definitions of transportation fuels in 40 CFR 80.1401 or of motor vehicles in 40 CFR 85.1703, which implement EPA programs under Part A of Title II of the CAA and do not apply to aircraft that are governed by Part B of Title II. EPA's regulatory provisions implementing Title II Part B and related to air pollution from aircraft are found in 40 CFR parts 87, 1030, and 1031. The EPA's authority for this action is not based on its authority to regulate fuels under CAA section 211 or its authority to regulate motor vehicles or motor vehicle engines under CAA section 202(a). Rather, the EPA's authority for this action comes from CAA section 231(a)(2). Further, this action is focused on the threshold endangerment and cause or contribute criteria, which are being undertaken in proceedings that are separate and distinct from any follow-on regulatory action; no regulatory provisions were proposed and none are being finalized in this action.

In response to the claims that aircraft are excluded from the CAA and that the EPA does not have authority to conduct this endangerment and cause or contribute finding, we disagree. As described in the proposal, the EPA is acting under the express authority prescribed by Congress in section 231(a)(2)(A) of the CAA, which, as amended, provides that the Administrator ''shall, from time to time, issue proposed emission standards applicable to the emission of any air pollutant from any class or classes of aircraft engines which in his judgment causes, or contributes to, air pollution which may reasonably be anticipated to endanger public health or welfare.'' The D.C. Circuit recognized EPA's authority to promulgate emission standards applicable to air pollutants from aircraft engines under CAA section 231 in *National Association of Clean Air Agencies* v. *EPA,* 489 F.3d 1221 (D.C. Cir. 2007) (''*NACAA*''). Similarly, in the 1970 amendments to the CAA, section 231(a)(2) provided that the Administrator ''shall issue proposed emission standards applicable to emissions of any air pollutant from any class or classes of aircraft or aircraft engines which in his judgment cause or contribute to or are likely to cause or contribute to air pollution which endangers the public health or welfare.'' Public Law 91–604. Thus, the statement in the comment that the 1970 CAA excluded aircraft is incorrect.[262]

Further, the EPA has previously made endangerment and cause or contribute findings related to emissions from aircraft engines under section 231 of the CAA.

As explained in the proposal, and in section III. above, in this action the Administrator is using the same approach of applying a two-part test under section 231(a)(2)(A) as described in the finalized endangerment and cause or contribute findings under CAA section 231 for greenhouse gases (GHGs) emissions from aircraft in 2016.[263] We further explained that this approach is the same approach that the EPA used in making endangerment and cause and contribute findings for GHGs under section 202(a) of the CAA in 2009 (2009 Findings), which is reasonable in light of the parallels of the language and structure between sections 231(a)(2)(A) and 202(a)(1) of the CAA.[264] Some comments misconstrued EPA's discussion of section 202(a) in the proposal to infer that EPA was relying on its authority under section 202(a) in this action. That is not the case. While using the same approach as in the 2009 Findings, the EPA is not acting under the authority of section 202(a) in making these final findings, but rather, is relying on the authority under section 231(a)(2)(A) as described herein, which expressly authorizes regulation of emissions of air pollutants from aircraft engines which the Administrator judges to cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.

Additional commenters state that they are opposed to any rulemaking that could lead to the elimination of leaded avgas before a comparatively priced substitute fuel is available for widespread use. As an initial matter, the EPA notes that, as described in section III.A. of this document, in this action, the EPA is addressing the predicate to regulatory action under CAA section 231 through a two-part test. In the first step of the two-part test, the Administrator must decide whether, in his judgment, the air pollution under consideration may reasonably be anticipated to endanger public health or welfare. As the second step, the Administrator must decide whether, in his judgment, emissions of an air pollutant from certain classes of aircraft engines cause or contribute to this air pollution. If the Administrator answers both questions in the affirmative, as he is doing here, the EPA becomes subject to a duty to propose and promulgate standards under section 231, but the EPA is not proposing or promulgating any standards in this action. These commenters have concerns regarding the cost and availability of unleaded fuels that might be required to meet a future emission standard for lead. To reiterate, the EPA is not proposing or promulgating any standards in this action, nor is the EPA reaching any conclusions about the possible elimination of leaded avgas or the cost or availability of comparatively priced substitute fuels; those issues will be addressed, if at all, only in a future standard-setting rulemaking. As for future standards, the delegation of authority in CAA section 231 to the EPA ''is both explicit and extraordinarily broad,'' *NACAA,* 489 F.3d at 1229, and ''confer[s] broad discretion to the [EPA] Administrator to weigh various factors in arriving at appropriate standards,'' *id.* at 1230. However, as described in section III.C. of this document, CAA section 231(a)(2)(B) directs the EPA to consult with the Administrator of the FAA on such standards, and it prohibits the EPA from changing aircraft emission standards if such a change would significantly increase noise and adversely affect safety. Further, under CAA section 231(b), the effective date of any standards shall provide the necessary time to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance, as determined by the EPA in consultation with the U.S. Department of Transportation (DOT).

IV. The Final Endangerment Finding Under CAA Section 231

In this action, the Administrator finds that lead air pollution may reasonably be anticipated to endanger the public health and welfare within the meaning of CAA section 231(a)(2)(A). This section discusses both the public health and welfare aspects of the endangerment finding and describes the scientific evidence that informs the Administrator's final determination. The vast majority of comments supported the EPA's proposal and agreed with the EPA's description of the health and welfare effects of lead air pollution. The Agency's responses to public comments on the proposed endangerment finding, including those opposing finalizing the finding, can be

[262] The change to the current language in section 231(a)(2) occurred in 1977, *see* Clean Air Act Amendments of 1977, Public Law 95–95, 91 Stat. 685, 791 (1977).

[263] *See e.g.,* 81 FR 55434–54440 (Aug. 15, 2016).

[264] 74 FR 66496, 66505–10 (Dec. 15, 2009); *see also Coalition for Responsible Regulation, Inc.* v. *EPA,* 684 F.3d 102 (D.C. Cir. 2012) (*CRR*) (subsequent history omitted) (affirming EPA's approach in the 2009 Findings).

found in the Response to Comments document for this action. After consideration of the comments on this topic, the EPA concludes that the scientific evidence supports finalizing the finding as proposed.

A. Scientific Basis of the Endangerment Finding

1. Lead Air Pollution

Lead is emitted and exists in the atmosphere in a variety of forms and compounds and is emitted by a wide range of sources.[265] Lead is persistent in the environment. Atmospheric transport distances of airborne lead vary depending on its form and particle size, as discussed in section II.A. of this document, with coarse lead-bearing particles deposited to a greater extent near the source, while fine lead-bearing particles can be transported long distances before being deposited. Through atmospheric deposition, lead is distributed to other environmental media, including soils and surface water bodies.[266] Lead is retained in soils and sediments, where it provides a historical record and, depending on several factors, can remain available in some areas for extended periods for environmental or human exposure, with any associated potential public health and public welfare impacts.

For purposes of this action, the EPA defines the ''air pollution'' referred to in section 231(a)(2)(A) of the CAA as lead, which we also refer to as lead air pollution in this document.[267]

2. Health Effects and Lead Air Pollution

In 2013, the EPA completed the Integrated Science Assessment for Lead which built on the findings of previous AQCDs for Lead. These documents critically assess and integrate relevant scientific information regarding the health and welfare effects of lead and have undergone extensive critical review by the EPA, the Clean Air Scientific Advisory Committee (CASAC), and the public. As such, these assessments provide the primary scientific and technical basis for the Administrator's finding that lead air pollution is reasonably anticipated to endanger public health and welfare.[268] [269]

As summarized in section II.A. of this document, human exposure to lead that is emitted into the air can occur by multiple pathways. Inhalation pathways include both ambient air outdoors and ambient air that has infiltrated into indoor environments. Additional exposure pathways may involve media other than air, including indoor and outdoor dust, soil, surface water and sediments, vegetation and biota. The bioavailability of air-related lead is modified by several factors in the environment (*e.g.,* the chemical form of lead, environmental fate of lead emitted to air). That notwithstanding, as described in section II.A. of this document, it is well-documented that exposures to lead emitted into the air can result in increased blood lead levels, particularly for children living near air lead sources, due to their proximity to these sources of exposure.[270]

As described in the EPA's 2013 Lead ISA and in prior AQCDs, lead has been demonstrated to exert a broad array of deleterious effects on multiple organ systems. The 2013 Lead ISA characterizes the causal nature of relationships between lead exposure and health effects using a weight-of-evidence approach.[271] We summarize here those health effects for which the EPA in the 2013 Lead ISA has concluded that the evidence supports a determination of either a ''causal relationship,'' ''likely to be causal relationship,'' or ''suggestive of a causal relationship'' between lead exposure and a health effect.[272] In the discussion that follows, we summarize findings regarding effects observed in children, effects observed in adults, and additional effects observed that are not specific to an age group.

The EPA has concluded that there is a ''causal relationship'' between lead exposure during childhood (pre and postnatal) and a range of health effects in children, including the following: cognitive function decrements; the group of externalizing behaviors comprising attention, increased impulsivity, and hyperactivity; and developmental effects (*i.e.,* delayed pubertal onset).[273] In addition, the EPA has concluded that the evidence supports a conclusion that there is a ''likely to be causal relationship'' between lead exposure and conduct disorders in children and young adults, internalizing behaviors such as depression, anxiety and withdrawn behavior, auditory function decrements, and fine and gross motor function decrements.[274]

Multiple epidemiologic studies conducted in diverse populations of children consistently demonstrate the harmful effects of lead exposure on cognitive function (as measured by decrements in intelligence quotient [IQ], decreased academic performance, and poorer performance on tests of executive function). These findings are supported by extensively documented toxicological evidence substantiating the plausibility of these findings in the epidemiological literature and provide information on the likely mechanisms underlying these neurotoxic effects.[275]

Intelligence quotient is a well-established, and among the most rigorously standardized, cognitive function measure that has been used extensively as a measure of the negative

[265] EPA (2013) ISA for Lead. Section 2.2. ''Sources of Atmospheric Pb.'' p. 2–1. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[266] EPA (2013) ISA for Lead. Executive Summary. ''Sources, Fate and Transport of Lead in the Environment, and the Resulting Human Exposure and Dose.'' pp. lxxviii-lxxix. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[267] The lead air pollution can occur as elemental lead or in lead-containing compounds, and this definition of the air pollution recognizes that lead in air (whatever form it is found in, including in inorganic and organic compounds containing lead) has the potential to elicit public health and welfare effects. We note, for example, that the 2013 Lead ISA and 2008 AQCD described the toxicokinetics of inorganic and organic forms of lead and studies evaluating lead-related health effects commonly measure total lead level (*i.e.,* all forms of lead in various biomarker tissues such as blood).

[268] EPA (2013) ISA for Lead. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[269] EPA (2006) Air Quality Criteria for Lead. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[270] EPA (2013) ISA for Lead. Section 5.4. ''Summary.'' p. 5–40. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[271] The causal framework draws upon the assessment and integration of evidence from across scientific disciplines, spanning atmospheric chemistry, exposure, dosimetry and health effects studies (*i.e.,* epidemiologic, controlled human exposure, and animal toxicological studies), and assessment of the related uncertainties and limitations that ultimately influence our understanding of the evidence. This framework employs a five-level hierarchy that classifies the overall weight of evidence with respect to the causal nature of relationships between criteria pollutant exposures and health and welfare effects using the following categorizations: causal relationship; likely to be causal relationship; suggestive of, but not sufficient to infer, a causal relationship; inadequate to infer the presence or absence of a causal relationship; and not likely to be a causal relationship. EPA (2013) ISA for Lead. Preamble section. p. xliv. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[272] EPA (2013) ISA for Lead. Table ES–1. ''Summary of causal determinations for the relationship between exposure to Pb and health effects.'' pp. lxxxiii–lxxxvii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[273] EPA (2013) ISA for Lead. Table ES–1. ''Summary of causal determinations for the relationship between exposure to Pb and health effects.'' p. lxxxiii and p. lxxxvi. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[274] EPA (2013) ISA for Lead. Table ES–1. ''Summary of causal determinations for the relationship between exposure to Pb and health effects.'' pp. lxxxiii–lxxxiv. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[275] EPA (2013) ISA for Lead. Executive Summary. ''Effects of Pb Exposure in Children.'' pp. lxxxvii–lxxxviii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

effects of exposure to lead.[276] [277] Examples of other measures of cognitive function negatively associated with lead exposure include measures of intelligence and cognitive development and cognitive abilities, such as learning, memory, and executive functions, as well as academic performance and achievement.[278]

In summarizing the evidence relating neurocognitive effects to lead exposure metrics, the 2013 Lead ISA notes that ''in individual studies, postnatal (early childhood and concurrent) blood [lead] levels are also consistently associated with cognitive function decrements in children and adolescents.'' [279] [280] The 2013 Lead ISA additionally notes that the findings from experimental animal studies indicate that lead exposures during multiple early lifestages and periods are observed to induce impairments in learning, and that these findings ''are consistent with the understanding that the nervous system continues to develop (*i.e.,* synaptogenesis and synaptic pruning remains active) throughout childhood and into adolescence.'' [281] The 2013 Lead ISA further notes that ''it is clear that [lead] exposure in childhood presents a risk; further, there is no evidence of a threshold below which there are no harmful effects on cognition from [lead] exposure,'' and additionally recognizes uncertainty about the patterns of [lead] exposure that contribute to the blood [lead] levels analyzed in epidemiologic studies (uncertainties which are greater in studies of older children and adults than in studies of younger children who do not have lengthy exposure histories).[282] Evidence suggests that while some neurocognitive effects of lead in children may be transient, some lead-related cognitive effects may be irreversible and persist into adulthood,[283] potentially affecting lower educational attainment and financial well-being.[284]

The 2013 Lead ISA concluded that neurodevelopmental effects in children were among the effects best substantiated as occurring at the lowest blood lead levels, and that these categories of effects were clearly of the greatest concern with regard to potential public health impact.[285] For example, in considering population risk, the 2013 Lead ISA notes that ''[s]mall shifts in the population mean IQ can be highly significant from a public health perspective.'' [286] Specifically, if lead-related decrements are manifested uniformly across the range of IQ scores in a population, ''a small shift in the population mean IQ may be significant from a public health perspective because such a shift could yield a larger proportion of individuals functioning in the low range of the IQ distribution, which is associated with increased risk of educational, vocational, and social failure'' as well as a decrease in the proportion with high IQ scores.[287]

With regard to lead effects identified for the adult population, the 2013 Lead ISA concluded that there is a ''causal relationship'' between lead exposure and hypertension and coronary heart disease in adults. The 2013 Lead ISA concluded that cardiovascular effects in adults were those of greatest public health concern for adults because the evidence indicated that these effects occurred at the lowest blood lead levels, compared to other health effects, although it further noted that the role of past versus recent exposures to lead is unclear.[288]

With regard to evidence of cardiovascular effects and other effects of lead on adults, the 2013 Lead ISA notes that ''[a] large body of evidence from both epidemiologic studies of adults and experimental studies in animals demonstrates the effect of long-term [lead] exposure on increased blood pressure and hypertension.'' [289] In addition to its effect on blood pressure, ''[lead] exposure can also lead to coronary heart disease and death from cardiovascular causes and is associated with cognitive function decrements, symptoms of depression and anxiety, and immune effects in adult humans.'' [290] The extent to which the effects of lead on the cardiovascular system are reversible is not well characterized. Additionally, the frequency, timing, level, and duration of lead exposure causing the effects observed in adults has not been pinpointed, and higher exposures earlier in life may play a role in the development of health effects measured later in life.[291] The 2013 Lead ISA states that ''[i]t is clear however, that [lead] exposure can result in harm to the cardiovascular system that is evident in adulthood and may also affect a broad array of organ systems.'' [292] In summarizing the public health significance of lead on the adult population, the 2013 Lead ISA notes that ''small [lead]-associated increases in the population mean blood pressure could result in an increase in the proportion of the population with hypertension that is significant from a public health perspective.'' [293]

In addition to the effects summarized here, the EPA has concluded there is a ''likely to be causal relationship'' between lead exposure and both cognitive function decrements and psychopathological effects in adults. The 2013 Lead ISA also concludes that there is a ''causal relationship'' between lead exposure and decreased red blood cell survival and function, altered heme synthesis, and male reproductive function. The EPA has also concluded there is a ''likely to be causal relationship'' between lead exposure and decreased host resistance, resulting in increased susceptibility to bacterial infection and suppressed delayed type hypersensitivity, and cancer.[294]

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[276] EPA (2013) ISA for Lead. Section 4.3.2. ''Cognitive Function.'' p. 4–59. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[277] EPA (2006) Air Quality Criteria for Lead. Sections 6.2.2 and 8.4.2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[278] EPA (2013) ISA for Lead. Section 4.3.2. ''Cognitive Function.'' p. 4–59. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[279] In this statement, the term ''concurrent'' is referring to blood lead measurements that were taken concurrently with the neurocognitive testing.

[280] EPA (2013) ISA for Lead. Section 1.9.4. ''Pb Exposure and Neurodevelopmental Deficits in Children.'' p. 1–76. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[281] EPA (2013) ISA for Lead. Section 1.9.4. ''Pb Exposure and Neurodevelopmental Deficits in Children.'' p. 1–76. EPA/600/R–10/075F, 2013.

[282] EPA (2013) ISA for Lead. Executive Summary. ''Effects of Pb Exposure in Children.'' pp. lxxxvii–lxxxviii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[283] EPA (2013) ISA for Lead. Section 1.9.5. ''Reversibility and Persistence of Neurotoxic Effects of Pb.'' p. 1–76. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[284] EPA (2013) ISA for Lead. Section 4.3.14. ''Public Health Significance of Associations between Pb Biomarkers and Neurodevelopmental Effects.'' p. 4–279. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[285] EPA (2013) ISA for Lead. Section 1.9.1. ''Public Health Significance.'' p. 1–68. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[286] EPA (2013) ISA for Lead. Executive Summary. ''Public Health Significance.'' p. xciii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[287] EPA (2013) ISA for Lead. Section 1.9.1. ''Public Health Significance.'' p. 1–68. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[288] EPA (2013) ISA for Lead. Section 1.9.1. ''Public Health Significance.'' p. 1–68. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[289] EPA (2013) ISA for Lead. Executive Summary. ''Effects of Pb Exposure in Adults.'' p. lxxxviii. EPA/600/R–10/075F, 2013.

[290] EPA (2013) ISA for Lead. Executive Summary. ''Effects of Pb Exposure in Adults.'' p. lxxxviii. EPA/600/R–10/075F, 2013.

[291] EPA (2013) ISA for Lead. Executive Summary. ''Effects of Pb Exposure in Adults.'' p. lxxxviii. EPA/600/R–10/075F, 2013.

[292] EPA (2013) ISA for Lead. Executive Summary. ''Effects of Pb Exposure in Adults.'' p. lxxxviii. EPA/600/R–10/075F, 2013.

[293] EPA (2013) ISA for Lead. Executive Summary. ''Public Health Significance.'' p. xciii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[294] EPA (2013) ISA for Lead. Table ES–1. ''Summary of causal determinations for the relationship between exposure to Pb and health

Additionally, in 2013 EPA concluded that the evidence is ''suggestive of a causal relationship'' between lead exposure and some additional effects. These include auditory function decrements in adults and subclinical atherosclerosis, reduced kidney function, birth outcomes (*e.g.,* low birth weight, spontaneous abortion), and female reproductive function.[295]

The EPA has identified factors that may increase the risk of health effects of lead exposure due to susceptibility and/or vulnerability; these are termed ''at-risk'' factors. The 2013 Lead ISA describes the systematic approach the EPA uses to evaluate the coherence of evidence to determine the biological plausibility of associations between at-risk factors and increased vulnerability and/or susceptibility. An overall weight of evidence is used to determine whether a specific factor results in a population being at increased risk of lead-related health effects.[296] The 2013 Lead ISA concludes that ''there is adequate evidence that several factors—childhood, race/ethnicity, nutrition, residential factors, and proximity to [lead] sources—confer increased risk of lead-related health effects.''[297]

3. Welfare Effects and Lead Air Pollution

The 2013 Lead ISA characterizes the causal nature of relationships between lead exposure and welfare effects using a five-level hierarchy that classifies the overall weight of evidence.[298] We summarize here the welfare effects for which the EPA has concluded that the evidence supports a determination of either a ''causal relationship,'' or a ''likely to be causal relationship,'' with exposure to lead, or that the evidence is ''suggestive of a causal relationship'' with lead exposure. The discussion that follows is organized to first provide a summary of the effects of lead in the terrestrial environment, followed by a summary of effects of lead in freshwater and saltwater ecosystems. The 2013 Lead ISA further describes the scales or levels at which these determinations between lead exposure and effects on plants, invertebrates, and vertebrates were made (*i.e.,* community-level, ecosystem-level, population-level, organism-level or sub-organism level).[299]

In terrestrial environments, the EPA determined that ''causal relationships'' exist between lead exposure and reproductive and developmental effects in vertebrates and invertebrates, growth in plants, survival for invertebrates, hematological effects in vertebrates, and physiological stress in plants.[300] The EPA also determined that there were ''likely to be causal relationships'' between lead exposure and community and ecosystem effects, growth in invertebrates, survival in vertebrates, neurobehavioral effects in invertebrates and vertebrates, and physiological stress in invertebrates and vertebrates.

In freshwater environments, the EPA found that ''causal relationships'' exist between lead exposure and reproductive and developmental effects in vertebrates and invertebrates, growth in invertebrates, survival for vertebrates and invertebrates, and hematological effects in vertebrates. The EPA also determined that there were ''likely to be causal relationships'' between lead exposure and community and ecosystem effects, growth in plants, neurobehavioral effects in invertebrates and vertebrates, hematological effects in invertebrates, and physiological stress in plants, invertebrates, and vertebrates.[301]

The EPA also determined that the evidence for saltwater ecosystems was ''suggestive of a causal relationship'' between lead exposure and reproductive and developmental effects in invertebrates, hematological effects in vertebrates, and physiological stress in invertebrates.[302]

The 2013 Lead ISA concludes, ''With regard to the ecological effects of [lead], uptake of [lead] into fauna and subsequent effects on reproduction, growth and survival are established and are further supported by more recent evidence. These may lead to effects at the population, community, and ecosystem level of biological organization. In both terrestrial and aquatic organisms, gradients in response are observed with increasing concentration of [lead] and some studies report effects within the range of [lead] detected in environmental media over the past several decades. Specifically, effects on reproduction, growth, and survival in sensitive freshwater invertebrates are well-characterized from controlled studies at concentrations at or near [lead] concentrations occasionally encountered in U.S. fresh surface waters. Hematological and stress related responses in some terrestrial and aquatic species were also associated with elevated [lead] levels in polluted areas. However, in natural environments, modifying factors affect [lead] bioavailability and toxicity and there are considerable uncertainties associated with generalizing effects observed in controlled studies to effects at higher levels of biological organization. Furthermore, available studies on community and ecosystem-level effects are usually from contaminated areas where [lead] concentrations are much higher than typically encountered in the environment. The contribution of atmospheric [lead] to specific sites is not clear and the connection between air concentration of [lead] and ecosystem exposure continues to be poorly characterized.''[303]

B. Final Endangerment Finding

The Administrator finds, for purposes of CAA section 231(a)(2)(A), that lead air pollution may reasonably be anticipated to endanger the public health and welfare. This finding is based on consideration of the extensive scientific evidence, described in this section, that has been amassed over decades and rigorously peer reviewed by CASAC, as well as consideration of public comments on the proposal.

V. The Final Cause or Contribute Finding Under CAA Section 231

In this action, the Administrator finds that engine emissions of lead from

effects.'' pp. lxxxiv–lxxxvii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[295] EPA (2013) ISA for Lead. Table ES–1. ''Summary of causal determinations for the relationship between exposure to Pb and health effects.'' pp. lxxxiv–lxxxvi. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[296] EPA (2013) ISA for Lead. Chapter 5. ''Approach to Classifying Potential At-Risk Factors.'' p. 5–2. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[297] EPA (2013) ISA for Lead. Section 5.4. ''Summary.'' p. 5–44. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[298] Causal determinations for ecological effects were based on integration of information on biogeochemistry, bioavailability, biological effects, and exposure-response relationships of lead in terrestrial, freshwater, and saltwater environments. This framework employs a five-level hierarchy that classifies the overall weight of evidence with respect to the causal nature of relationships between criteria pollutant exposures and health and welfare effects using the categorizations described in the 2013 Lead NAAQS.

[299] EPA (2013) ISA for Lead. Table ES–2. ''Schematic representation of the relationships between the various MOAs by which Pb exerts its effects.'' p. lxxxii. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[300] EPA (2013) ISA for Lead. Table ES–2. ''Summary of causal determinations for the relationship between Pb exposure and effects on plants, invertebrates, and vertebrates.'' p. xc. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[301] EPA (2013) ISA for Lead. Table ES–2. ''Summary of causal determinations for the relationship between Pb exposure and effects on plants, invertebrates, and vertebrates.'' p. xc. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[302] EPA (2013) ISA for Lead. Table ES–2. ''Summary of causal determinations for the relationship between Pb exposure and effects on plants, invertebrates, and vertebrates.'' p. xc. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[303] EPA (2013) ISA for Lead. ''Summary.'' p. xcvi. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

certain aircraft cause or contribute to the lead air pollution that may reasonably be anticipated to endanger public health and welfare under section 231(a)(2)(A) of the Clean Air Act. This section describes the definition of the air pollutant and the data and information supporting the Administrator's final determination. Public comments on the cause or contribute finding were largely supportive of the EPA's proposal, though some commenters opposed finalizing the finding. After consideration of the comments on this topic, the EPA concludes that the scientific evidence supports finalizing the finding as proposed. The Agency's responses to certain public comments on the cause or contribute finding can be found in section V.C. of this document, and responses to additional comments on the cause or contribute finding can be found in the Response to Comments document for this action.

A. Definition of the Air Pollutant

Under section 231, the Administrator is to determine whether emissions of any air pollutant from any class or classes of aircraft engines cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. As in the 2016 Findings that the EPA made under section 231 for greenhouse gases, in making this cause or contribute finding under section 231(a)(2), the Administrator first defines the air pollutant being evaluated. The Administrator has reasonably and logically considered the relationship between the lead air pollution and the air pollutant when considering emissions of lead from engines used in covered aircraft. The Administrator defines the air pollutant to match the definition of the air pollution, such that the air pollutant analyzed for contribution mirrors the air pollution considered in the endangerment finding. Accordingly, for purposes of this action, the Administrator defines the ''air pollutant'' referred to in section 231(a)(2)(A) as lead, which we also refer to as the lead air pollutant in this document.[304] As noted in section II.A.2. of this document, lead emitted to the air from covered aircraft engines is predominantly in particulate form as lead dibromide; however, some chemical compounds of lead that are expected in the exhaust from these engines, including alkyl lead compounds, would occur in the air in gaseous form.

B. The Data and Information Used To Evaluate the Final Cause or Contribute Finding

The Administrator's assessment of whether emissions from the engines used in covered aircraft cause or contribute to lead air pollution was informed by estimates of lead emissions from the covered aircraft, lead concentrations in air at and near airports that are attributable to lead emissions from piston engines used in covered aircraft, and projected future conditions.

As used in this final action, the term ''covered aircraft'' refers to all aircraft and ultralight vehicles equipped with covered engines which, in this context, means any aircraft engine that is capable of using leaded avgas. Examples of covered aircraft would include smaller piston-powered aircraft such as the Cessna 172 (single-engine aircraft) and the Beechcraft Baron G58 (twin-engine aircraft), as well as the largest piston-engine aircraft such as the Curtiss C–46 and the Douglas DC–6. Other examples of covered aircraft would include rotorcraft, such as the Robinson R44 helicopter, light-sport aircraft, and ultralight vehicles equipped with piston engines. The vast majority of covered aircraft are piston-engine powered.

In recent years, covered aircraft are estimated to be the largest single source of lead to air in the U.S. Since 2008, as described in section II.A.2.b. of this document, lead emissions from covered aircraft are estimated to have contributed over 50 percent of all lead emitted to the air nationally. The EPA estimates 470 tons of lead were emitted by covered aircraft in 2017, comprising 70 percent of lead emitted to air nationally that year.[305] [306] In approximately 1,000 counties in the U.S., the EPA's emissions inventory identifies covered aircraft as the sole source of lead emissions. Among the 1,872 counties in the U.S. for which the inventory identifies multiple sources of lead emissions, including engine emissions from covered aircraft, the contribution of aircraft engine emissions ranges from 0.00005 to 4.3 tons per year, comprising 0.15 to 98 percent (respectively) of total lead emissions to air in those counties.[307]

Covered aircraft activity, as measured by the number of hours flown nationwide, increased nine percent in the period from 2012 through 2019.[308] General aviation activity, largely conducted by covered aircraft, increased up to 52 percent at airports that are among the busiest in the U.S.[309] In future years, while piston-engine aircraft activity overall is projected to decrease slightly, this change in activity is not projected to occur uniformly across airports in the U.S.; some airports are forecast to have increased activity by general aviation aircraft, the majority of which is conducted by piston-engine aircraft.[310] Although there is some uncertainty in these projections, they indicate that lead emissions from covered aircraft may increase at some airports in the future.[311]

Additionally, engine emissions of lead from covered aircraft may deposit in the local environment and, due to the small size of the lead-bearing particles emitted by engines in covered aircraft, these particles may disperse widely in

[304] The lead air pollutant can occur as elemental lead or in lead-containing compounds, and this definition of the air pollutant recognizes the range of chemical forms of lead emitted by engines in covered aircraft.

[305] The lead inventories for 2008, 2011 and 2014 are provided in the EPA (2018b) Report on the Environment Exhibit 2. Anthropogenic lead emissions in the U.S. Available at *https://cfpub.epa.gov/roe/indicator.cfm?i=13#2.* The lead inventories for 2017 are available at *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data#dataq.*

[306] As described in section II.A.2., the EPA estimates 427 tons of lead were emitted by aircraft engines operating on leaded fuel in 2020. Due to the Covid–19 pandemic, a substantial decrease in activity by aircraft occurred in 2020, impacting the total lead emissions for this year. The 2020 NEI is available at: *https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data.*

[307] Airport lead annual emissions data used were reported in the 2017 NEI. Available at *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data.* In addition to the triennial NEI, the EPA collects from state, local, and Tribal air agencies point source data for larger sources every year (see *https://www.epa.gov/air-emissions-inventories/air-emissions-reporting-requirements-aerr* for specific emissions thresholds). While these data are not typically published as a new NEI, they are available publicly upon request and are also included in *https://www.epa.gov/air-emissions-modeling/emissions-modeling-platforms,* which are created for years other than the triennial NEI years. County estimates of lead emissions from non-aircraft sources used in this action are from the 2019 inventory. There are 3,012 counties and statistical equivalent areas where EPA estimates engine emissions of lead occur.

[308] FAA. General Aviation and Part 135 Activity Surveys—CY 2019. Chapter 3: Primary and Actual Use. Table 1.3—General Aviation and Part 135 Total Hours Flown by Aircraft Type 2008–2019 (Hours in Thousands). Retrieved on Dec., 27, 2021 at *https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.*

[309] Geidosch. Memorandum to Docket EPA–HQ–OAR–2022–0389. Past Trends and Future Projections in General Aviation Activity and Emissions. June 1, 2022. Docket ID EPA–HQ–2022–0389.

[310] Geidosch. Memorandum to Docket EPA–HQ–OAR–2022–0389. Past Trends and Future Projections in General Aviation Activity and Emissions. June 1, 2022. Docket ID EPA–HQ–2022–0389.

[311] FAA TAF Fiscal Years 2020–2045 describes the forecast method, data sources, and review process for the TAF estimates. The documentation for the TAF is available at *https://taf.faa.gov/Downloads/TAFSummaryFY2020–2045.pdf.*

the environment. Therefore, because lead is a persistent pollutant in the environment, we anticipate current and future emissions of lead from covered aircraft engines may contribute to exposures and uptake by humans and biota into the future.

In evaluating the contributions of engine emissions from covered aircraft to the lead air pollution, as defined in section IV.A. of this document, the EPA also considered three types of information about lead concentrations in the ambient air: monitored concentrations, modeled concentrations, and model-extrapolated estimates of lead concentrations. Lead concentrations monitored in the ambient air typically quantify lead compounds collected as suspended particulate matter. The information gained from air monitoring and air quality modeling provides insight into how lead emissions from piston engines used in covered aircraft can affect lead concentrations in air.

As described in section II.A.3. of this document, the EPA has conducted air quality modeling at two airports and extrapolated modeled estimates of lead concentrations to 13,000 airports with piston-engine aircraft activity. These studies indicate that over a three-month averaging time (the averaging time for the Lead NAAQS), the engine emissions of lead from covered aircraft are estimated to contribute to air lead concentrations to a distance of at least 500 meters downwind from a runway.[312 313] Additional studies have reported that lead emissions from covered aircraft may have increased concentrations of lead in air by one to two orders of magnitude at locations proximate to aircraft emissions compared to nearby locations not impacted by a source of lead air emissions.[314 315 316]

In 2008 and 2010, the EPA enhanced the lead monitoring network by requiring monitors to be placed in areas with sources such as industrial facilities and airports, as described further in section II.A.3. of this document.[317 318] As part of this 2010 requirement to expand lead monitoring nationally, the EPA required a 1-year monitoring study of 15 additional airports with estimated lead emissions between 0.50 and 1.0 ton per year in an effort to better understand how these emissions affect concentrations of lead in the air at and near airports. Further, to help evaluate airport characteristics that could lead to ambient lead concentrations that approach or exceed the lead NAAQS, airports for this 1-year monitoring study were selected based on factors such as the level of activity of covered aircraft and the predominant use of one runway due to wind patterns. Monitored lead concentrations in ambient air are highly sensitive to monitor location relative to the location of the run-up areas for piston-engine aircraft and other localized areas of elevated lead concentrations relative to the air monitor locations.

The lead monitoring study at airports began in 2011. In 2012, air monitors were placed in close proximity to the run-up areas at the San Carlos Airport (measurements started on March 10, 2012) and the McClellan-Palomar Airport (measurements started on March 16, 2012). The concentrations of lead measured at both of these airports in 2012 were above the level of the lead NAAQS, with the highest measured levels of lead in total suspended particles over a rolling three-month average of 0.33 micrograms per cubic meter of air at the San Carlos Airport and 0.17 micrograms per cubic meter of air at the McClellan-Palomar Airport. These concentrations violate the primary and secondary lead NAAQS, which are set at a level of 0.15 micrograms per cubic meter of air measured in total suspended particles, as an average of three consecutive monthly concentrations.

In recognition of the potential for lead concentrations to exceed the lead NAAQS in ambient air near the area of maximum concentration at airports, the EPA further conducted an assessment of airports nationwide, titled ''Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports'' and described in section II.A.3. of this document.[319] The model-extrapolated lead concentrations estimated in this study are attributable solely to emissions from engines in covered aircraft operating at the airports evaluated and did not include other sources of lead emissions to air. The EPA identified four airports with the potential for lead concentrations above the lead NAAQS due to lead emissions from engines used in covered aircraft.

Additional information regarding the contribution of engine emissions of lead from covered aircraft to lead air pollution is provided by the EPA's Air Toxics Screening Assessment. As described and summarized in section II.A.3. of this document, the EPA's Air Toxics Screening Assessment estimates that piston engines used in aircraft contribute more than 50 percent of the estimated lead concentrations in over half of the census tracts in the U.S.[320]

The EPA also notes that lead is emitted from engines in covered aircraft in three of the ten areas in the U.S. currently designated as nonattainment for the 2008 lead NAAQS. These areas are Arecibo, PR, and Hayden, AZ, each of which include one airport servicing covered aircraft, and the Los Angeles County-South Coast Air Basin, CA, which contains at least 22 airports within its nonattainment area boundary.[321 322] Although the lead emissions from aircraft are not the predominant source of airborne lead in these areas, the emissions from covered aircraft may increase ambient air lead concentrations in these areas.

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[312] Carr et al., 2011. Development and evaluation of an air quality modeling approach to assess near-field impacts of lead emissions from piston-engine aircraft operating on leaded aviation gasoline. *Atmospheric Environment,* 45 (32), 5795–5804. DOI: *https://dx.doi.org/10.1016/j.atmosenv.2011.07.017.*

[313] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. Table 6. EPA–420–R–20–003, 2020. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf.*

[314] Carr et al., 2011. Development and evaluation of an air quality modeling approach to assess near-field impacts of lead emissions from piston-engine aircraft operating on leaded aviation gasoline. *Atmospheric Environment,* 45 (32), 5795–5804. DOI: *https://dx.doi.org/10.1016/j.atmosenv.2011.07.017.*

[315] Heiken et al., 2014. Quantifying Aircraft Lead Emissions at Airports. ACRP Report 133. Available at *https://www.nap.edu/catalog/22142/quantifying-aircraft-lead-emissions-at-airports.*

[316] Hudda et al., 2022. Substantial Near-Field Air Quality Improvements at a General Aviation Airport Following a Runway Shortening. *Environmental Science & Technology.* DOI: 10.1021/acs.est.1c06765.

[317] 73 FR 66965 (Nov. 12, 2008).

[318] 75 FR 81126 (Dec. 27, 2010).

[319] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports Table 6. EPA–420–R–20–003, 2020. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf.*

[320] EPA's 2019 AirToxScreen is available at *https://www.epa.gov/AirToxScreen/2019-airtoxscreen.*

[321] South Coast Air Quality Management District (2012) Adoption of 2012 Lead SIP Los Angeles County by South Coast Governing Board, p.3–11, Table 3–3. Available at *https://www.aqmd.gov/home/air-quality/clean-air-plans/lead-state-implementation-plan.* The South Coast Air Quality Management District identified 22 airports in the Los Angeles County-South Coast Air Basin nonattainment area; the Whiteman Airport is among those in the nonattainment area and the EPA estimated activity at this airport may increase lead concentrations to levels above the lead NAAQS in the report, Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. Table 7. EPA, Washington, DC, EPA–420–R–20–003, 2020. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf.*

[322] EPA provides updated information regarding nonattainment areas at this website: *https://www.epa.gov/green-book/green-book-lead-2008-area-information.*

C. Response to Certain Comments on the Cause or Contribute Finding

The EPA received comments related to the contribution of lead emissions from engines in covered aircraft to lead air pollution. Commenters provided both support for and opposition to the EPA's proposed cause or contribute finding, with specific comments regarding the amount of lead emitted by aircraft operating on leaded fuel and the contribution of aircraft engine emissions to lead concentrations in the air.

Numerous commenters state their support for the proposed cause or contribute finding, in some cases noting that ample evidence supports this finding and highlighting the important role that lead emissions from covered aircraft engines have in local environments in many areas of the U.S. Additional commenters express concern regarding monitored lead concentrations that exceed the NAAQS at some airports. The comments expressing support for the proposed cause or contribute finding and EPA's responses are described in greater detail in the Response to Comment document for this action. We acknowledge these comments and the support expressed for the EPA's cause or contribute finding, and we agree with the commenters that lead emissions from engines in covered aircraft contribute to lead air pollution.

Commenters stating opposition to the cause or contribute finding based on the amount of lead emitted by aircraft operating on leaded fuel, assert that lead emissions today are 425 times less than lead emissions of the 1970s or that the emissions of lead from aircraft are less than one quarter of one percent of the emissions from cars in the 1970s. Some commenters also state that it only stands to reason that covered aircraft engine emissions of lead represent a high percentage of current lead emissions because lead is no longer being emitted by motor vehicles. At least one additional commenter states that given the number of hours flown by covered aircraft, they do not contribute enough lead to affect air pollution.

Commenters stating opposition to the cause or contribute finding based on the concentrations of lead in air from engine emissions by covered aircraft state that concentrations of lead exceeding the lead NAAQS are rare, representing two of 17 airports studied. One commenter also notes that Table 2 (in section II.A.3. of this document) does not address the localized conditions of the airports studied and that the airports where lead concentrations violated the lead NAAQS may have unique conditions that resulted in the concentrations measured. Additionally, some commenters state that there is no evidence that engine emissions of lead are creating a hazard, and that the lead emitted is not toxic in the small amount emitted by aircraft engines.

In response to commenters comparing emissions of lead from covered aircraft to lead emitted by motor vehicles in the 1970s, the EPA acknowledges that more lead was emitted by motor vehicles in the 1970s than is emitted by covered aircraft engines currently. This cause or contribute finding is focused on emissions of lead from covered aircraft engines, a different category of mobile sources from motor vehicles, and the commenters do not explain why the fact that historical emissions were higher from a different source category means that current emissions from covered aircraft engines are not contributing to the existing lead air pollution. Similarly, the historical contributions of lead emitted by motor vehicles is not germane to the present-day analysis of the contribution of lead emissions from covered aircraft engines to the total lead released to the air annually in the U.S. Indeed, nothing in CAA section 231(a) precludes EPA from making a cause or contribute finding for emissions from aircraft engines where such a finding is warranted, even if emissions from other sources regulated elsewhere in the CAA or under other Federal programs may also contribute to that air pollution or have historically contributed to it. *See Massachusetts* v. *E.P.A.,* 549 U.S. 497, 533 (2007) (the alleged efficacy of other ''Executive Branch programs'' in addressing the air pollution problem is not a valid reason for declining to make an endangerment finding). As noted previously, in making a cause or contribute finding, CAA section 231 does not require the EPA to find that the contribution from the relevant source category is ''significant,'' let alone the sole or major cause of the endangering air pollution. As described in section V.B., the lead emissions from engines used in covered aircraft clearly contribute to the endangering lead air pollution, as these emissions contributed over 50 percent of lead emissions to air starting in 2008, when approximately 560 tons of lead were emitted by engines in covered aircraft, and more recently, in 2017, when approximately 470 tons of lead were emitted by engines in covered aircraft. In the EPA's view, both the quantity and percentage of lead emitted by covered aircraft engines amply demonstrate that this source contributes to lead air pollution in the U.S.

In response to commenters stating that the number of hours flown by covered aircraft do not contribute enough lead to affect air pollution, the EPA notes that the commenters made a conclusory allegation and did not provide data or analysis supporting their claim. The EPA disagrees with this comment, and we present data in section V.B. of this document demonstrating that the activity by covered aircraft, which includes the number of hours flown, contributes to lead air pollution as described in the preceding paragraph.

In response to commenters asserting that concentrations of lead exceeding the lead NAAQS are rare, representing two of 17 airports studied, as an initial matter, the EPA notes that nothing in section 231(a) of the CAA premises the cause or contribute finding on emissions from the relevant classes of aircraft engines contributing to such exceedances in a minimum number of air quality regions. More importantly, the EPA notes that the purpose of this airport monitoring study was not to determine the frequency with which potential violations of the lead NAAQS occur at or near airports, but to understand the potential range in lead concentrations at a small sample of airports and the factors that influence those concentrations. As described in section II.A.3. of this document, the concentrations of lead monitored at and near highly active general aviation airports is largely determined by the placement of the monitor relative to the run-up area, and monitor placement relative to the run-up area was not uniform across the airports studied. The EPA fully explains the basis on which the Administrator finds that emissions of lead from covered aircraft engine emissions cause or contribute to lead air pollution. The data that support this finding are presented in section V.B. and, as articulated in section V.D., where, among other data, the Administrator takes into account the fact that in some situations lead emissions from covered aircraft have contributed and may continue to contribute to air concentrations that exceed the lead NAAQS. Given that the lead NAAQS are established to provide requisite protection of public health and welfare, the Administrator expresses particular concern with contributions to concentrations that exceed the lead NAAQS, and those contributions are part of the support for the conclusion that lead emissions from engines in covered aircraft cause or contribute to the endangering air pollution.

In response to the comment regarding the assertion that the two airports where lead concentrations violated the lead NAAQS may have unique conditions that resulted in the concentrations measured, the EPA notes that the commenter did not specify or explain what localized conditions might lead to this result; nor did they provide supporting evidence for localized conditions occurring in these areas that could explain these lead concentrations presented in Table 2 of this document. The EPA describes in section II.A.3. of this document that at both of these airports, monitors were located in close proximity to the area at the end of the runway most frequently used for pre-flight safety checks (*i.e.,* run-up), and monitor placement relative to the run-up area is a key factor in evaluating the maximum impact location attributable to lead emissions from piston-engine aircraft. Additionally, as described in section II.A.3. of this document, air lead concentrations at and downwind from airports can be influenced by factors such as the use of more than one run-up area, wind speed, and the number of operations conducted by single- versus twin-engine aircraft.[323] At the two airports at which concentrations of lead violated the lead NAAQS, the EPA observed a similar fleet composition of single- versus twin-engine aircraft compared with other airports where on-site measurements were taken; wind speeds, which are inversely proportional to lead concentration, were not lower at the airports with lead concentrations violating the lead NAAQS compared with other airports; and these airports were not unique in that the activity by piston-engine aircraft was in the range of activity by these aircraft at the majority of airports where monitors were located.[324] The EPA thus concludes that these two airports do not have unique conditions responsible for the concentrations of lead that violated the lead NAAQS.

In response to the comments that there is no evidence that engine emissions of lead are creating a hazard,[325] and that the lead emitted is not toxic in the small amount emitted by aircraft engines, we note that these comments conflate the endangerment and cause or contribute steps of the analysis. The text in section 231(a)(2) provides for the EPA to make a finding based on a determination that emissions of the air pollutant from the covered aircraft engine ''causes, or contributes to'' the air pollution. In making a cause or contribute finding, the EPA need not additionally and separately make a determination as to whether the emissions from covered aircraft engines alone cause endangerment. In section IV. of this document, the EPA explained why the Administrator is finding that the lead air pollution endangers public health and welfare. The only remaining issue at the second step of the analysis is whether emissions from the analyzed class or classes of aircraft engines cause or contribute to the air pollution that may reasonably be anticipated to endanger public health and welfare. For the reasons described in section V. of this document, in the Administrator's judgment, emissions of the lead air pollutant from engines in the covered aircraft cause or contribute to the lead air pollution.

Additional comments were submitted to the EPA regarding the emissions, deposition, transport, and fate of lead emitted by covered aircraft engines. The EPA responds to these comments in the Response to Comments Document for this action.

D. Final Cause or Contribute Finding for Lead

Taking into consideration the data and information summarized in section V. of this document, and the public comments received on the proposed finding, the Administrator finds that engine emissions of the lead air pollutant from covered aircraft cause or contribute to the lead air pollution that may reasonably be anticipated to endanger public health and welfare. In reaching this conclusion, the Administrator noted that piston-engine aircraft operate on leaded avgas. That operation emits lead-containing compounds into the air, contributing to lead air pollution in the environment. As explained in section II.A. of this document, once emitted from covered aircraft, lead may be transported and distributed to other environmental media, where it presents the potential for human exposure through air and non-air pathways before the lead is removed to deeper soils or waterbody sediments. In reaching this final finding, the Administrator takes into consideration different air quality scenarios in which emissions of the lead air pollutant from engines in covered aircraft may cause or contribute to lead air pollution. Among these considerations, he places weight on the fact that current lead emissions from covered aircraft are an important source of air-related lead in the environment and that engine emissions of lead from covered aircraft are the largest single source of lead to air in the U.S. in recent years. In this regard, he notes that these emissions contributed over 50 percent of lead emissions to air starting in 2008, when approximately 560 tons of lead was emitted by engines in covered aircraft (of the total 950 tons of lead) and, more recently, in 2017, when approximately 470 tons of lead was emitted by engines in covered aircraft (of the total 670 tons of lead).[326]

Additionally, he takes into account the fact that in some situations lead emissions from covered aircraft have contributed and may continue to contribute to air concentrations that exceed the lead NAAQS. The NAAQS are standards that have been set to protect public health, including the health of sensitive groups, with an adequate margin of safety and to protect public welfare from any known or anticipated adverse effects associated with the presence of the pollutant in the ambient air. For example, the EPA's monitoring data show that lead concentrations at two airports, McClellan-Palomar and San Carlos, violated the lead NAAQS. The EPA's model-extrapolated estimates of lead also indicate that some U.S. airports may have air lead concentrations above the NAAQS in the area of maximum impact from operation of covered aircraft.[327] Given that the lead NAAQS are established to protect public health and welfare, contributions to concentrations that exceed the lead NAAQS are of particular concern to the Administrator and are persuasive support for the conclusion that lead emissions from engines in covered

[323] The data in Table 2 represent concentrations measured at one location at each airport and monitors were not consistently placed in close proximity to the run-up areas. As described in section II.A.3., monitored concentrations of lead in air near airports are highly influenced by proximity of the monitor to the run-up area. In addition to monitor placement, there are individual airport factors that can influence lead concentrations (*e.g.,* the use of multiple run-up areas at an airport, fleet composition, and wind speed). The monitoring data reported in Table 2 reflect a range of lead concentrations indicative of the location at which measurements were made and the specific operations at an airport.

[324] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports Appendix B, Table B–2. EPA–420–R–20–003, 2020. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf.*

[325] While the comment does not clearly explain what it is referring to with the phrase ''creating a hazard,'' we understand that phrase to align with the ''cause'' portion of the cause or contribute findings.

[326] The lead inventories for 2008, 2011 and 2014 are provided in the U.S. EPA (2018b) Report on the Environment Exhibit 2. Anthropogenic lead emissions in the U.S. Available at *https://cfpub.epa.gov/roe/indicator.cfm?i=13#2.* The lead inventories for 2017 are available at *https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data#dataq.*

[327] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports Table 7. EPA–420–R–20–003, 2020. Available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG52.pdf.*

aircraft cause or contribute to the endangering air pollution.

The Administrator is also concerned about the likelihood for these emissions to continue to be an important source of air-related lead in the environment in the future, if uncontrolled. While recognizing that national consumption of leaded avgas is forecast to decrease slightly from 2026 to 2041 commensurate with overall piston-engine aircraft activity, the Administrator also notes that these changes are not expected to occur uniformly across the U.S.[328] For example, he takes note of the FAA forecasts for airport-specific aircraft activity out to 2045 that project decreases in activity by general aviation at some airports, while projecting increases at other airports.[329] Although there is some uncertainty in these projections, they indicate that lead emissions from covered aircraft may increase at some airports in the future. Thus, even assuming that consumption of leaded avgas and general aviation activity decrease somewhat overall, as projected, the Administrator anticipates that current concerns about these sources of air-related lead will continue into the future, without controls. Accordingly, the Administrator is considering both current levels of emissions and anticipated future levels of emissions from covered aircraft. In doing so, the Administrator finds that current levels cause or contribute to pollution that may reasonably be anticipated to endanger public health and welfare. He also is taking into consideration the projections that some airports may see increases in activity while others see decreases, as well as the uncertainties in these predictions. The Administrator therefore considers all this information and data collectively to inform his judgment on whether lead emissions from covered aircraft cause or contribute to endangering air pollution.

Accordingly, for all the reasons described, the Administrator concludes that emissions of the lead air pollutant from engines in covered aircraft cause or contribute to the lead air pollution that may reasonably be anticipated to endanger public health and welfare.

VI. Statutory Authority and Executive Order Reviews

Additional information about these statutes and Executive Orders can be found at *https://www2.epa.gov/laws-regulations/laws-and-executive-orders.*

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 14094: Modernizing Regulatory Review

This action is a ''significant regulatory action'' as defined in Executive Order 12866, as amended by Executive Order 14094. Accordingly, EPA submitted this action to the Office of Management and Budget (OMB) for Executive Order 12866 review. Documentation of any changes made in response to the Executive Order 12866 review is available in the docket. This action finalizes a finding that emissions of the lead air pollutant from engines in covered aircraft cause or contribute to the lead air pollution that may be reasonably anticipated to endanger public health and welfare.

B. Paperwork Reduction Act (PRA)

This action does not impose an information collection burden under the PRA. The final endangerment and cause or contribute findings under CAA section 231(a)(2)(A) do not contain any information collection activities.

C. Regulatory Flexibility Act (RFA)

I certify that this action will not have a significant economic impact on a substantial number of small entities under the RFA. This action will not impose any requirements on small entities. The final endangerment and cause or contribute findings under CAA section 231(a)(2)(A) do not in-and-of-themselves impose any new requirements on any regulated entities but rather set forth the Administrator's finding that emissions of the lead air pollutant from engines in covered aircraft cause or contribute to lead air pollution that may be reasonably anticipated to endanger public health and welfare.

D. Unfunded Mandates Reform Act (UMRA)

This action does not contain any unfunded mandate as described in UMRA, 2 U.S.C. 1531–1538 and does not significantly or uniquely affect small governments. The action imposes no enforceable duty on any state, local or Tribal governments or the private sector.

E. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

F. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have Tribal implications as specified in Executive Order 13175. The final endangerment and cause or contribute findings under CAA section 231(a)(2)(A) do not in-and-of-themselves impose any new requirements but rather set forth the Administrator's final finding that emissions of the lead air pollutant from engines in covered aircraft cause or contribute to lead air pollution that may be reasonably anticipated to endanger public health and welfare. Thus, Executive Order 13175 does not apply to this action.

Tribes have previously submitted comments to the EPA noting their concerns regarding potential impacts of lead emitted by piston-engine aircraft operating on leaded avgas at airports on, and near, their Reservation Land.[330] The EPA plans to continue engaging with Tribal stakeholders on this issue and will offer a government-to-government consultation upon request.

G. Executive Order 13045: Protection of Children From Environmental Health Risks and Safety Risks

Executive Order 13045 (62 FR 19885, April 23, 1997) directs Federal agencies to include an evaluation of the health and safety effects on children of a planned regulation in setting Federal health and safety standards. This action is not subject to Executive Order 13045 because it does not propose to establish an environmental standard intended to mitigate health or safety risks. Although the Administrator considered health and safety risks as part of the endangerment and cause or contribute findings under CAA section 231(a)(2)(A), the findings themselves do not impose a standard intended to mitigate those risks. However, the EPA's Policy on Children's Health applies to this action. Consistent with this policy,

[328] FAA Terminal Area Forecast provides projections of aircraft activity at airports. The forecast is available at *https://taf.faa.gov* and the FAA Terminal Area Forecast for Fiscal Years 2020–2045 describes the forecast method, data sources, and review process for the TAF estimates, available at: *https://taf.faa.gov/Downloads/TAFSummaryFY2020-2045.pdf.*

[329] Geidosch. Memorandum to Docket EPA–HQ–OAR–2022–0389. Past Trends and Future Projections in General Aviation Activity and Emissions. June 1, 2022. Docket ID EPA–HQ–2022–0389.

[330] *See* Docket ID Number EPA–HQ–OAR–2006–0735. The Tribes that submitted comments were: The Bad River Band of Lake Superior Tribe of Chippewa Indians, The Quapaw Tribe of Oklahoma, The Leech Lake Band of Ojibwe, The Lone Pine Paiute-Shoshone Reservation, The Fond du Lac Band of Lake Superior Chippewa, and The Mille Lacs Band of Ojibwe.

the Administrator considered lead exposure risks to children as part of this final endangerment finding under CAA section 231(a)(2)(A). Information on how the Policy was applied is available under ''Children's Environmental Health'' in the **SUPPLEMENTARY INFORMATION** section B. of this document. A copy of the documents pertaining to the impacts on children's health from emissions of lead from piston-engine aircraft that the EPA references in this action have been placed in the public docket for this action (Docket EPA–HQ–OAR–2022–0389).

H. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use

This action is not a ''significant energy action'' because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. Further, we have concluded that this action is not likely to have any adverse energy effects because the final endangerment and cause or contribute findings under section 231(a)(2)(A) do not in-and-of themselves impose any new requirements but rather set forth the Administrator's finding that emissions of the lead air pollutant from engines in covered aircraft cause or contribute to lead air pollution that may be reasonably anticipated to endanger public health and welfare.

I. National Technology Transfer and Advancement Act (NTTAA)

This action does not involve technical standards.

J. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations; Executive Order 14096: Revitalizing Our Nation's Commitment to Environmental Justice for All

The EPA believes that the human health or environmental conditions that exist prior to this action result in or have the potential to result in disproportionate and adverse human health or environmental effects on communities with environmental justice concerns. The EPA conducted an analysis of people living within 500 meters or one kilometer of airports and found that there is a greater prevalence of people of color and of low-income populations within 500 meters or one kilometer of some airports compared with people living more distant. The EPA provides a summary of the evidence for potentially disproportionate and adverse effects among people of color and low-income populations residing near airports in section II.A.5. of this document. A copy of the documents pertaining to the EPA's analysis of potential environmental justice concerns regarding populations who live in close proximity to airports has been placed in the public docket for this action (Docket EPA–HQ–OAR–2022–0389).

The EPA believes that this action will not change existing disproportionate and adverse effects on communities with environmental justice concerns. In this action, the EPA finds, under section 231(a)(2)(A) of the Clean Air Act, that emissions of lead from engines in covered aircraft may cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare. We are not proposing emission standards at this time.

The EPA additionally promoted fair treatment and meaningful involvement for the public, including for communities with environmental justice concerns, in this action by briefing Tribal members on this action and providing information on our website in both Spanish and English, as well as providing access to Spanish translation during the public hearing.

K. Congressional Review Act (CRA)

The EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is not a ''major rule'' as defined by 5 U.S.C. 804(2).

L. Determination Under Section 307(d)

Section 307(d)(1)(V) of the CAA provides that the provisions of section 307(d) apply to ''such other actions as the administrator may determine.'' Pursuant to section 307(d)(1)(V), the Administrator determines that this action is subject to the provisions of section 307(d).

M. Judicial Review

Section 307(b)(1) of the CAA governs judicial review of final actions by the EPA. This section provides, in part, that petitions for review must be filed in the D.C. Circuit: (i) when the agency action consists of ''nationally applicable regulations promulgated, or final actions taken, by the Administrator,'' or (ii) when such action is locally or regionally applicable, but ''such action is based on a determination of nationwide scope or effect and if in taking such action the Administrator finds and publishes that such action is based on such a determination.'' For locally or regionally applicable final actions, the CAA reserves to the EPA complete discretion whether to invoke the exception in (ii) described in the preceding sentence.[331]

This action is ''nationally applicable'' within the meaning of CAA section 307(b)(1) because in issuing these final findings, the EPA becomes subject to a statutory duty to propose and promulgate aircraft engine emission standards under CAA section 231(a), which are nationally applicable regulations for which judicial review is available only in the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit) pursuant to CAA section 307(b)(1). Further, these emission standards would apply to covered aircraft, wherever in the nation they are located. We note also that similar actions, including the 2016 Endangerment and Cause or Contribute Findings under CAA section 231 for greenhouse gases and the 2009 Endangerment and Cause or Contribute Findings under CAA section 202(a) for greenhouse gases, were also nationally applicable[332] and were challenged in the D.C. Circuit.[333]

In the alternative, to the extent a court finds this final action to be locally or regionally applicable, the Administrator is exercising the complete discretion afforded to him under the CAA to make and publish a finding that this action is based on a determination of ''nationwide scope or effect'' within the meaning of CAA section 307(b)(1).[334] In issuing these final findings, the EPA becomes subject to a statutory duty to propose and promulgate emissions standards under CAA section 231(a), which would apply nationwide to covered aircraft that travel and operate within multiple judicial circuits. As described in section III. of this document, in making these findings, the EPA is applying the same analytical framework that the Agency applied in the 2016 Endangerment and Cause or

[331] *Sierra Club* v. *EPA,* 47 F.4th 738, 745 (D.C. Cir. 2022) (''EPA's decision whether to make and publish a finding of nationwide scope or effect is committed to the agency's discretion and thus is unreviewable''); *Texas* v. *EPA,* 983 F.3d 826, 834–35 (5th Cir. 2020).

[332] 81 FR 54422 (Aug. 15, 2016) (2016 Findings); 74 FR 66496 (2009 Findings).

[333] *Coalition for Responsible Regulation, Inc.* v. *EPA,* 684 F.3d 102 (D.C. Cir. 2012) (subsequent history omitted) (affirming 2009 Findings); *Biogenic CO2 Coalition* v. *EPA* (Doc. No. 1932392, No. 16–1358, D.C. Cir., January 26, 2022) (granting petitioner's motion to voluntarily dismiss petition for review of 2016 Findings).

[334] In deciding whether to invoke the exception by making and publishing a finding that an action is based on a determination of nationwide scope or effect, the Administrator takes into account a number of policy considerations, including his judgment balancing the benefit of obtaining the D.C. Circuit's authoritative centralized review versus allowing development of the issue in other contexts and the best use of agency resources.

Contribute Findings under CAA section 231 for greenhouse gases and the 2009 Endangerment and Cause or Contribute Findings under CAA section 202(a) for greenhouse gases, both of which were challenged in the D.C. Circuit, as noted above.

The Administrator finds that this is a matter on which national uniformity in judicial resolution of any petitions for review is desirable, to take advantage of the D.C. Circuit's administrative law expertise, and to facilitate the orderly development of the law under the Act. The Administrator also finds that consolidated review of this action in the D.C. Circuit will avoid piecemeal litigation in the regional circuits, further judicial economy, and eliminate the risk of inconsistent results, and that a nationally consistent approach to the CAA's provisions related to making endangerment and cause or contribute findings under section 231 of the CAA, including for lead air pollution and emissions of lead from engines in covered aircraft as here, constitutes the best use of agency resources.

For these reasons, this final action is nationally applicable or, alternatively, the Administrator is exercising the complete discretion afforded to him by the CAA and finds that this final action is based on a determination of nationwide scope or effect for purposes of CAA section 307(b)(1) and is publishing that finding in the **Federal Register**. Under section 307(b)(1) of the CAA, petitions for judicial review of this action must be filed in the United States Court of Appeals for the District of Columbia Circuit by December 19, 2023.

VII. Statutory Provisions and Legal Authority

Statutory authority for this action comes from 42 U.S.C. 7571, 7601 and 7607.

List of Subjects

40 CFR Parts 87 and 1031

Environmental protection, Air pollution control, Aircraft, Aircraft engines.

40 CFR Part 1068

Environmental protection, Administrative practice and procedure, Confidential business information, Imports, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements, Warranties.

Michael S. Regan,

Administrator.

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