select the home retention option that they thought would be best for them. Under what circumstances, if any, should veterans retain opportunities to select from VA loss-mitigation options? How would giving veterans the ability to select from VA loss-mitigation options impact servicers? If VA were to switch to a prescribed order of loss-mitigation options that servicers must follow, what limitations, if any, should be placed on veterans' ability to select from them?

4. During the COVID–19 pandemic, certain loss-mitigation options were offered without the requirement of collecting financial information. Moving beyond the pandemic, under what circumstances should VA require servicers to collect financial information before a loss-mitigation option is selected? Under what circumstances might a trial payment plan serve as a substitute for the collection of financial information?

Questions Related to Loan Deferment, VAPCP, and COVID–19 Refund Modifications

5. How should VA develop a loan deferment option that would assist veterans without placing undue burden on servicers? For example, if VA were to incentivize a hybrid loan deferment/repayment plan in which servicers would defer the missed principal and interest and establish a loan repayment plan for missed taxes and insurance, would that address potential concerns related to short-term lost income from deferring missed mortgage payments? For veterans, what consumer protection concerns should VA be aware of in considering a loan deferment loss-mitigation option?

6. In what way(s), if any, should VA use the VAPCP and/or COVID–19 Refund Modification after the COVID–19 national emergency? VA is particularly interested in data and evidence showing whether the VAPCP and/or COVID–19 Refund Modification programs have assisted veterans, servicers, and taxpayers.

7. What challenges would exist for veterans, servicers, holders, and VA, if VA were to develop a loss-mitigation option similar to the VAPCP, but with a requirement for repayment at a low interest rate (rather than the zero percent interest rate under the VAPCP)? What hurdles might servicers face in executing such loan documents on behalf of VA? What if VA required servicers to service such loans on VA's behalf?

8. Would a low-interest second loan option similar to the VAPCP be more helpful to veterans and/or servicers than a loan deferment loss-mitigation option, and what data and evidence exist to support your response? What sort of financial evaluation would be appropriate to determine whether a low-interest second loan would be an appropriate loss-mitigation option for a veteran, as opposed to VA's existing loss-mitigation options at 38 CFR 36.4319?

9. What, if any, limitations should VA place on a deferment-style loss-mitigation option, including minimum/maximum deferment amounts, lifetime uses, etc.?

Questions Related to Incentive Payments

10. What kind of incentive payment might be appropriate to make loan deferment a more viable option for servicers and VA? What kind of incentive payment might be appropriate for a loss-mitigation option similar to the VAPCP or COVID–19 Refund Modification?

11. How could VA structure an incentive payment that does not encourage servicers to use one of these loss-mitigation options if more financially feasible options are available to assist the veteran?

Questions Related to Investor Requirements

12. What, if any, Government National Mortgage Association (Ginnie Mae) specific investor requirements should VA consider when evaluating changes to VA loss-mitigation options, including the introduction of a deferment-style loss-mitigation option?

Executive Orders 12866 and 13563

Executive Orders 12866 and 13563 direct agencies to assess the costs and benefits of available regulatory alternatives and, when regulation is necessary, to select regulatory approaches that maximize net benefits (including potential economic, environmental, public health and safety effects, and other advantages; distributive impacts; and equity). Executive Order 13563 (Improving Regulation and Regulatory Review) emphasizes the importance of quantifying both costs and benefits, reducing costs, harmonizing rules, and promoting flexibility. The Office of Information and Regulatory Affairs has determined that this rule is a significant regulatory action under Executive Order 12866. The Regulatory Impact Analysis associated with this rulemaking can be found as a supporting document at *www.regulations.gov.*

Signing Authority

Denis McDonough, Secretary of Veterans Affairs, approved this document on October 11, 2022, and authorized the undersigned to sign and submit the document to the Office of the Federal Register for publication electronically as an official document of the Department of Veterans Affairs.

Jeffrey M. Martin,

Assistant Director, Office of Regulation Policy & Management, Office of General Counsel, Department of Veterans Affairs.

[FR Doc. 2022–22414 Filed 10–14–22; 8:45 am]

BILLING CODE 8320–01–P

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Parts 87, 1031, and 1068

[EPA–HQ–OAR–2022–0389; FRL–5934–01–OAR]

RIN 2060–AT10

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

AGENCY: Environmental Protection Agency (EPA).

ACTION: Proposed action.

SUMMARY: In this action, the Administrator is proposing to find that lead air pollution may reasonably be anticipated to endanger the public health and welfare within the meaning of section 231(a) of the Clean Air Act. The Administrator is also proposing 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 public health and welfare under section 231(a) of the Clean Air Act.

DATES:

Comments: Written comments must be received on or before January 17, 2023.

Public Hearing: The EPA plans to hold a virtual public hearing on November 1, 2022. See **SUPPLEMENTARY INFORMATION** for information on registering for a public hearing.

ADDRESSES: You may submit your comments, identified by Docket ID No. EPA–HQ–OAR–2022–0389, by any of the following methods:

- *Federal eRulemaking Portal: https://www.regulations.gov* (our preferred method). Follow the online instructions for submitting comments.
- *Email: a-and-r-docket@epa.gov.* Include Docket ID No. EPA–HQ–OAR–

2022–0389 in the subject line of the message.

- *Mail:* U.S. Environmental Protection Agency, EPA Docket Center, OAR, Docket EPA–HQ–OAR–2022–0389. Mail Code 28221T, 1200 Pennsylvania Avenue NW, Washington, DC 20460.
- *Hand Delivery or Courier (by scheduled appointment only):* EPA Docket Center, WJC West Building, Room 3334, 1301 Constitution Avenue NW, Washington, DC 20004. The Docket Center's hours of operations are 8:30 a.m.–4:30 p.m., Monday–Friday (except federal holidays).

Instructions: All submissions received must include the Docket ID No. for this action. Comments received may be posted without change to *https://www.regulations.gov/,* including any personal information provided. For detailed instructions on sending comments and additional information on the process for this action, see the ''Public Participation'' heading of the **SUPPLEMENTARY INFORMATION** section of this document.

Public Hearing. EPA plans to hold a virtual public hearing for this action. Please refer to Participation in Virtual Public Hearing in the **SUPPLEMENTARY INFORMATION** section of this document for additional information.

FOR FURTHER INFORMATION CONTACT: Marion Hoyer, Office of Transportation and Air Quality, Assessment and Standards Division (ASD), Environmental Protection Agency; Telephone number: (734) 214–4513; Email address: *hoyer.marion@epa.gov.*

SUPPLEMENTARY INFORMATION:

A. Public Participation

Written Comments: Submit your comments, identified by Docket ID No. EPA–HQ–OAR–2022–0389, at *https://www.regulations.gov* (our preferred method), or the other methods identified in the **ADDRESSES** section of this document. Once submitted, comments cannot be edited or withdrawn from the docket. The EPA may publish any comment received to its public docket. Do not submit electronically any information you consider to be Confidential Business Information (CBI), Proprietary Business Information (PBI), or other information whose disclosure is restricted by statute. Multimedia submissions (audio, video, etc.) must be accompanied by a written comment. The written comment is considered the official comment and should include discussion of all points you wish to make. The EPA will generally not consider comments or comment contents located outside of the primary submission (including such content located on the web, cloud, or other file sharing system). For additional submission methods, the full EPA public comment policy, information about CBI, PBI, or multimedia submissions, and general guidance on making effective comments, please visit *https://www.epa.gov/dockets/commenting-epa-dockets.*

Documents to which the EPA refers in this proposed action are available online at *https://www.regulations.gov/* in the docket for this action (Docket EPA–HQ–OAR–2022–0389). To access reference documents in-person and for additional assistance, please refer to the following instructions.

The EPA plans to hold a virtual hearing on November 1, 2022. This hearing will be held using Zoom. In order to attend the virtual public hearing, all attendees (including those who will not be presenting verbal testimony) must register in advance. Upon publication of this document in the **Federal Register**, the EPA will begin registering speakers for the hearing. To register to speak at the virtual hearing, please use the instructions at *https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-lead-emissions-aircraft.* If you have questions regarding registration, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section of this document. The last day to register to speak at the hearing will be October 31, 2022. Prior to the hearing, the EPA will post a general agenda that will list registered speakers in approximate order at: *https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-lead-emissions-aircraft.* The EPA will make every effort to follow the schedule as closely as possible on the day of the hearing; however, please plan for the hearings to run either ahead of schedule or behind schedule.

The EPA anticipates that each commenter will have 5 minutes to provide oral testimony. The EPA recommends submitting the text of your oral testimony as written comments to the docket for this action. The EPA may ask clarifying questions during the oral presentations but will not respond to the presentations at that time. Written statements and supporting information submitted during the comment period will be considered with the same weight as oral testimony and supporting information presented at the public hearing.

If you require the services of a translator or special accommodations such as audio description, please identify these needs when you register for the hearing no later than October 24, 2022. The EPA may not be able to arrange accommodations without advanced notice.

B. General Information

Does this action apply to me?

Regulated Entities: In this action, the EPA is proposing to make endangerment and cause or contribute findings for the lead air pollution and engine emissions of lead from certain aircraft. The classes of aircraft engines and of aircraft relevant to this proposed 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—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.

The proposed findings in this action, if finalized, would not themselves apply new requirements to entities other than the EPA and the Federal Aviation Administration (FAA). Specifically, if the EPA issues final findings that lead emissions from covered aircraft engines cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare, then the EPA would, under section 231 of the Clean Air Act, promulgate aircraft engine emission standards for that air pollutant. In contrast to the findings, those standards would apply to and have an effect on other entities outside the federal government. Entities potentially interested in this proposed action include those that manufacture

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[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.

and sell covered aircraft engines and covered aircraft in the United States and those who own or operate covered aircraft. Categories that may be regulated in 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 potentially regulated entities likely to be interested in this proposed 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 proposed action. If the EPA issues final affirmative findings under section 231(a) of the Clean Air Act regarding lead, the EPA would then undertake a future notice and comment rulemaking to issue emission standards, and the FAA would be required to prescribe regulations to ensure compliance with these emissions standards pursuant to section 232 of the Clean Air Act. Such findings also would trigger the FAA's statutory mandate pursuant to 49 U.S.C. 44714 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 EPA has decided endanger public health or welfare under section 231(a) of the Clean Air Act. 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 proposed action, consult the person listed in the preceding **FOR FURTHER INFORMATION CONTACT** section of this document.

C. Children's Health

Executive Order 13045 [3] requires agencies to identify and assess health and safety risks that may disproportionately affect children and ensure that activities address disproportionate risks to children. Children may be 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 relative to their size than adults do, and consequently 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.[4]

Protecting children's health from environmental risks is fundamental to the EPA's mission. Since the inception of Executive Order 13045, the understanding of children's environmental health has broadened to include conception, infancy, early childhood and through adolescence until 21 years of age.[5] Because behavioral and physiological characteristics can affect children's environmental health risks, childhood and children's health is viewed with an understanding of the concept of ''lifestages,'' which recognize unique growth and developmental periods through which all humans pass.[6]

This document includes discussion and analysis that is focused particularly on children. For example, as described in Sections III.A and V 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.'' [7] 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.[8] The 2013 Lead ISA notes that in epidemiologic studies, postnatal (early childhood) blood lead levels are consistently associated with cognitive function decrements in children and adolescents.[9] 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.

D. Environmental Justice

Executive Order 12898 establishes federal executive policy on environmental justice. It directs federal agencies, to the greatest extent practicable and permitted by law, to make achieving environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects

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[3] E.O. 13045. Protection of Children From Environmental Health Risks and Safety Risks. 62 FR 19885 (April 23, 1997).

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

[5] 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.*

[6] EPA. ''Childhood Lifestages relating to Children's Environmental Health.'' Oct. 25, 2021. Retrieved from *https://www.epa.gov/children/childhood-lifestages-relating-childrens-environmental-health* on Nov. 22, 2021.

[7] 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.*

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

[9] 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.

of their programs, policies, and activities on people of color populations and low-income populations in the United States.[10] The EPA defines 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.[11]

Executive Order 14008 also calls on federal agencies to make achieving environmental justice part of their missions ''by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts.'' [12] It also declares a policy ''to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and under-investment in housing, transportation, water and wastewater infrastructure and health care.'' Under Executive Order 13563, federal agencies may consider equity, human dignity, fairness, and distributional considerations, where appropriate and permitted by law.[13]

The United States has made substantial progress in reducing lead exposure, but disparities remain along racial, ethnic, and socioeconomic lines. For example, blood lead levels in children from low-income households remain higher than those in children from higher income households, and the most exposed Black children still have higher blood lead levels than the most exposed non-Hispanic White children.[14] [15] Depending on the levels and associated risk, such blood lead levels may lead to lifelong health effects and barriers to social and economic well-being.[16]

In this action, the EPA is undertaking an evaluation, under section 231(a)(2)(A) of the Clean Air Act, of whether 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, and therefore, our consideration of environmental justice is focused on describing populations living near airports in the United States. Section II.A.5 of this document, and the Technical Support Document [17] for this action describe the scientific evidence and analyses conducted by the EPA that provide information about the disparity in residential location for some low-income populations, people of color and some indigenous peoples in the United States, particularly Alaska Natives, with regard to their proximity to some airports where covered aircraft operate. The information presented in Section II.A.5 of this document 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 people of color and low-income populations, they could indicate a potential environmental justice concern.

Table of Contents

I. Executive Summary

Pursuant to section 231(a)(2)(A) of the Clean Air Act (CAA or Act), the Administrator proposes to find that

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[10] 59 FR 7629 (Feb. 16, 1994).

[11] 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.'' A potential EJ concern is defined as ''the actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, Tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies.'' See, EPA's Environmental Justice During the Development of an Action. 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.*

[12] 86 FR 7619 (Feb. 1, 2021).

[13] 76 FR 3821 (Jan. 18, 2011).

[14] EPA (2013) ISA for Lead. Section 5.4. ''Summary.'' pp. 5–40 through 5–42. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[15] EPA (2022) ''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.*

[16] EPA (2013) ISA for Lead. Section 1.9.1. ''Public Health Significance.'' p. 1–68; Section 1.9.5. ''Reversibility and Persistence of Neurotoxic Effects of Pb.'' p. 1–76. EPA, Washington, DC, EPA/600/R–10/075F, 2013.

[17] 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.

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 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—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.

For purposes of this action, the EPA is proposing to define 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.[18] In proposing to find 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.[19] [20] [21] [22]

Further, for purposes of this action, the EPA is proposing to define 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.[23] Accordingly, the Administrator is proposing to find 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).

In addition to the proposed findings and the science on which they are based, this document includes an overview and background context helpful to understanding the source sector in the context of this proposal, a brief summary of some of the federal actions focused on reducing lead exposures, and the legal framework for this action.

II. Overview and Context for This Proposal

We summarize here background information that provides additional context for this proposed 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 summary of citizen petitions for rulemaking regarding lead emissions from covered aircraft and the EPA responses.

A. Background Information Helpful to Understanding This Proposal

This proposal 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[24] for lead and the lead NAAQS.[25] 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, the 2013 Lead ISA[26] as well as information summarized in previous assessments, including the 1977, 1986, and 2006 AQCDs.[27] [28] [29]

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.[30] Lead emitted in the past can remain available for environmental or human exposure for extended time in some areas.[31] 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.[32] Lead in the environment today may have been airborne yesterday or emitted to the air long ago.[33] Over time, lead that was initially emitted to air can become less available for environmental circulation by sequestration in soil, sediment and other reservoirs.[34]

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

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[18] As noted in Section IV.A of this notice, the lead air pollution that we are considering in this proposed finding can occur as elemental lead or in lead-containing compounds.

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

[20] EPA (2006) AQC for Lead. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[21] EPA (1986) AQC for Lead. EPA, Washington, DC, EPA–600/8–83/028aF–dF, 1986.

[22] EPA (1977) AQC for Lead. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[23] As noted in Section V.A of this notice, the lead air pollutant we are considering in this proposed finding can occur as elemental lead or in lead-containing compounds.

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

[25] 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.''

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

[27] EPA (1977) AQC for Lead. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[28] EPA (1986) AQC for Lead. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[29] EPA (2006) AQC for Lead. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[30] 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.

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

[32] 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.

[33] 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.

[34] 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.

ambient air.[35] Ambient air inhalation pathways include both inhalation of air outdoors and inhalation of ambient air that has infiltrated into indoor environments.[36] 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.[37] [38] [39] [40] [41] [42] 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,[43] [44] 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.[45]

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—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.

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).[46] Currently, 100LL is the most commonly available and most commonly used type of avgas.[47] Tetraethyl lead was first used in piston-engine aircraft in 1927.[48] 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.[49] [50] 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.,[51] and the FAA provides information on the volume of leaded avgas consumed in the U.S.[52] 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.[53] As described later in this section, while the consumption of leaded avgas is expected to decrease three percent from 2026 to 2041, FAA projects increased activity at some airports and decreased activity at other airports out to 2045.

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[35] 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.

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

[37] 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.

[38] EPA (2006) AQC for Lead. Chapter 3. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[39] EPA (1986) AQC for Lead. Section 1.11.3. EPA, Washington, DC, EPA–600/8–83/028aF-dF (NTIS PB87142386), 1986.

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

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

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

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

[44] 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.

[45] 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.

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

[47] National Academies of Sciences, Engineering, and Medicine (NAS). 2021. Options for Reducing Lead Emissions from Piston-Engine Aircraft. Washington, DC: The National Academies Press. *https://doi.org/10.17226/26050.*

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

[49] 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.*

[50] 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.*

[51] 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.

[52] Department of Transportation (DOT). FAA. Aviation Policy and Plans. FAA Aerospace Forecast Fiscal Years 2009–2025. p. 81. Available at *http://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.

[53] 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.*

The FAA's National Airspace System Resource (NASR)[54] 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.[55] While less aircraft activity occurs at the remaining 15,336 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.[56] The activity by piston-engine aircraft spans a range of purposes, as described further below. In Alaska this fleet of aircraft currently play a critical role in the transportation infrastructure.

As of 2019, there were 171,934 piston-engine aircraft in the U.S.[57] This total includes 128,926 single-engine aircraft, 12,470 twin-engine aircraft, and 3,089 rotorcraft.[58] 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.[59] In 2019, 883 new piston-engine aircraft were manufactured in the U.S. some of which are exported.[60] For the period from 2019 through 2041, the fleet of fixed wing[61] piston-engine aircraft is projected to decrease at an annual average rate of 0.9 percent, and the hours flown by these aircraft is projected to decrease 0.9 percent per year from 2019 to 2041.[62] 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.[63] There were approximately 664,565 pilots certified to fly general aviation aircraft in the U.S. in 2021.[64] This included 197,665 student pilots and 466,900 non-student pilots. In addition, there were more than 301,000 FAA Non-Pilot Certificated mechanics.[65]

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.[66] 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.[67]

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.[68] 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.[69] [70]

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).[71] 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,

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

[55] 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.*

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

[57] 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/.*

[58] 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/.*

[59] 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.*

[60] 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.*

[61] 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.

[62] *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.*

[63] 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.*

[64] 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.

[65] 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.

[66] 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/.*

[67] 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/.*

[68] 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/.*

[69] 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/.*

[70] 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. Available at *https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/2012%20FAA%20Aerospace%20Forecast.pdf.*

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

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.[72] 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.[73] 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.[74] 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).

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.[75] [76] [77] 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. Therefore, 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, 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.[78] 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.[79] In addition to lead bromides, ammonium salts of other lead halides were also emitted by motor vehicles and would be expected in the exhaust of piston-engine aircraft.[80]

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.[81] 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).[82] 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.[83]

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

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[72] 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.

[73] 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.*

[74] 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.*

[75] EPA (1977) AQC for Lead. EPA, Washington, DC, EPA–600/8–77–017 (NTIS PB280411), 1977.

[76] EPA (1986) AQC for Lead. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

[77] 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.

[78] EPA (1986) AQC for Lead. EPA, Washington, DC, EPA–600/8–83/028aF–dF (NTIS PB87142386), 1986.

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

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

[81] 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.

[82] 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.

[83] 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.

measurements of lead.[84] The Swiss FOCA reported the mean particle diameter of particulate matter emitted by one single-engine piston-powered aircraft 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.[85] 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. in recent years, contributing over 50 percent of lead emissions to air starting in 2008 (Table 1).[86] 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.[87] 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 Aviation Gasoline [88] and in the document titled ''Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 National Emissions Inventory.'' [89] 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.[90]

TABLE 1—PISTON-ENGINE EMISSIONS OF LEAD TO AIR

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

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.[91] Among the counties in the U.S. where the EPA estimates engine emissions of lead from covered aircraft, lead inventories range from 0.00005 tons per year to 4.1 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).[92] 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 emission from covered aircraft, the contribution of aircraft engine emissions ranges from 0.0006 to 0.26 tons, comprising 0.0065 to 99.98 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.[93] 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

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[84] 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.*

[85] 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.*

[86] 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.*

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

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

[89] 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).

[90] 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.*

[91] 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.*

[92] 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* 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.

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

estimated to have inventories above 0.1 tons in 2045.[94]

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.[95]

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 concentrations of lead in air from piston-engine aircraft exhaust at, and downwind of, airports where these aircraft are active.[96,97,98,99,100,101] 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.'' [102,103]

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 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 (concentrations for periods of approximately 18 hours to three-month averages).[104,105,106,107,108,109] 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.[110,111,112] 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).[113]

The lead NAAQS was revised in 2008.[114] 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 consecutive three-month average of lead in total suspended particles.[115] 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 now 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

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[94] EPA used the method describe 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.*

[95] 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.

[96] 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.*

[97] 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.

[98] 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.*

[99] 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.

[100] 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.*

[101] 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.

[102] 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).

[103] 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.

[104] These studies report monitored or modeled data for averaging times ranging from approximately 18 hours to three-month averages.

[105] 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.*

[106] 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.*

[107] 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.

[108] 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.*

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

[110] 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.*

[111] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020. EPA responses to peer review comments on the report are available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YIWD.pdf.*

[112] 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.

[113] 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.

[114] 73 FR 66965 (Nov. 12, 2008).

[115] 40 CFR 50.16 (Nov. 12, 2008).

ton or more per year.[116] 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 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. [117] [118]

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

Airport, State	Lead design value,[119] 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.[120]

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.[121]

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 anticipated 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.'' [122] [123] 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.[124] 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 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.[125] This approach for conducting a nationwide analysis of airports was selected due to the impact of piston-engine aircraft run-up

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[116] 75 FR 81226 (Dec. 27, 2010).

[117] 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.*

[118] 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.

[119] 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.

[120] 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.

[121] 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.

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

[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] 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.

[125] 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*).

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.[126]

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 airports with activity ranging from 3,616–26,816 Landing and Take-Off events (LTOs) in a three-month period.[127] 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.[128] Model-extrapolated three-month average lead concentrations from aircraft engine emissions were estimated to extend to 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.[129] 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 were estimated above background extending almost 1,000 meters downwind from the runway.[130]

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 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 invites comment on the approach used in this model-extrapolation analysis.

The EPA's model-extrapolation analysis of lead concentrations from engine emissions resulting from covered aircraft found that the lowest annual airport emissions of lead estimated to result in air lead concentrations approaching or potentially exceeding the NAAQS was 0.1 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.[131] The EPA's estimate of 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 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).[132] 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 anthropogenic and natural sources, including aircraft engine emissions.[133] The 2017 AirToxScreen provides lead concentration estimates in air for 73,449

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[126] 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.

[127] 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.

[128] *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.

[129] 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.

[130] 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.

[131] 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. EPA responses to peer review comments on the report are available here: *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YIWD.pdf.*

[132] *See* EPA's 2017 AirToxScreen. Available at *https://www.epa.gov/AirToxScreen.*

[133] 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.*

census tracts in the U.S.[134] Lead emissions from piston-engine aircraft comprised more than 50 percent of these census block area-weighted lead concentrations 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 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),[135] [136] 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.[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.

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.[139] 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.[140] Tetraethyl lead has an atmospheric residence time ranging from a few hours to a few days. 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.[141]

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.[142] 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.[143]

Studies summarized in the 2013 Lead ISA suggest that soil is a reservoir for contemporary and historical emissions of lead to air.[144] 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.[145] 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.[146] Murphy et al. (2008) reported weekend increases in ambient lead monitored at remote locations in the U.S. that the authors attributed to weekend increases in piston-engine powered general aviation activity.[147]

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 aircraft engine emissions.[148] 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

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[134] 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.

[135] 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.*

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

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

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

[139] EPA (1977) AQC for Lead. Section 6.2.2.1. EPA, Washington, DC, EPA–600/8–77–017, 1977.

[140] EPA (2006) AQC for Lead. Section E.6. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[141] EPA (2006) AQC for Lead. Section 2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[142] 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.

[143] 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.

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

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

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

[147] 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.

[148] 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.*

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.[149] [150] [151] [152] [153] [154] 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.[155] [156] In this way, air lead sources may contribute to dietary exposure pathways.[157] 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.[158] The low flying height is needed to minimize the drift of the fertilizer and pesticide particles away from their intended target. 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,[159] 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.[160] Atmospheric deposition of lead provides a pathway for lead in vegetation as a result of contact with above-ground portions of the plant.[161] [162] [163] 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.[164]

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).[165] Alkyl lead, in particular, has been identified by the EPA as a Persistent, Bioaccumulative, and Toxic (PBT) pollutant.[166] 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.[167] 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 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.[168] Leaded avgas discharged to the ground and water includes other

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

[150] 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.*

[151] 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.*

[152] 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.*

[153] 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.

[154] 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.

[155] 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.

[156] EPA (2006) AQC for Lead. Section 8.2.2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[157] EPA (2006) AQC for Lead. Section 8.2.2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[158] 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.agaviation.org/Files/RelatedEntities/Aerial_Applicators_Manual.pdf.*

[159] 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.

[160] EPA (2006) AQC for Lead. pp. 7–9 and AXZ7–39. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

[161] EPA (2006) AQC for Lead. p. AXZ7–39. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

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

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

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

[165] 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.

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

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

[168] 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.*

hazardous fuel components such as ethylene dibromide.[169]

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. Consideration of EJ implications in the population living near airports is important because blood lead levels in children from low-income households remain higher than those in children from higher income households, and the most exposed Black children still have higher blood lead levels than the most exposed non-Hispanic White children.[170] [171] [172]

Executive Orders 12898 (59 FR 7629, February 16, 1994) and 14008 (86 FR 7619, February 1, 2021) direct Federal agencies, to the greatest extent practicable and permitted by law, to make achieving EJ part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on people of color populations and low-income populations in the United States. The EPA defines 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.

For the reasons described in **SUPPLEMENTARY INFORMATION** Section D, our consideration of EJ implications here is focused on describing conditions relevant to the most recent year for which demographic data are available. 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. Residential proximity to airports implies that there is an increased potential for exposure to lead from covered aircraft engine emissions.[173] 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, two studies have reported increased blood lead levels in children with increasing proximity to airports.[174] [175]

We first summarize here the literature on disparity with regard to those who live in proximity to airports. Then we describe the analyses the EPA has 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 of the population compared with the general population, including near transportation sources.[176] [177] [178] [179] [180] 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.[181] 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.[182] 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.[183]

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

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[169] 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.

[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] 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 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.

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

[175] 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.

[176] 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.*

[177] 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.*

[178] 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.*

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

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

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

[182] 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.

[183] 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.

School Near U.S. Airports.'' [184] 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 on individual days downwind of a runway, depending on aircraft activity and prevailing wind direction.[185] [186] [187]

Because the U.S. has a dense network of airports, many of which have neighboring communities, we first quantified the number of people living and children attending school within 500 meters of the approximately 20,000 airports in the U.S. The results of this analysis are summarized at the national scale in the EPA's report titled ''National Analysis of the Populations Residing Near or Attending School Near U.S. Airports.'' [188] 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 age 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.[189]

In order to identify potential disparities in the near-airport population, we first 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.[190] 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 compared with the percent of these groups in the state population.[191] Results of this analysis are presented in the following tables.[192] 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 living within 500 meters of a runway represent 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	1,000	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).

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[184] EPA (2020) Model-extrapolated Estimates of Airborne Lead Concentrations at U.S. Airports. EPA, Washington, DC, EPA–420–R–20–003, 2020. EPA responses to peer review comments on the report are available at *https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YISM.pdf.*

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

[186] 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.*

[187] 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.

[188] 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.*

[189] 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.*

[190] 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.

[191] 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.

[192] 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.

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

Among Native Americans and Alaska Natives, 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, as anticipated due to the critical nature of air travel for the transportation infrastructure in that state, the disparity in residential proximity to a runway was the largest; 16,000 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 compared with 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.[193] [194] 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

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[193] 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.

[194] 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.

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[a]				
	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 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[195]	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.[196]

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, and their implications discussed in Kamal et.al. (2022).[197]

The data summarized here 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 people of color and low-income populations, they could indicate a potential EJ concern. Given the number of children in close proximity to runways, including those in EJ populations, there is a potential for substantial implications for children's health. The EPA invites comment on the potential EJ impacts of aircraft lead emissions from aircraft engines and on the potential impacts on children in close proximity to runways where piston-engine aircraft operate.

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 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.[198] 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.''[199] 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.[200] The EPA's 2016 **Federal Register** notice describes the Agency's decision to retain the existing Lead

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

[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.

[197] 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.

[198] 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.*

[199] 41 FR 14921 (April 8, 1976). *See also, e.g.,* 81 FR at 71910 (Oct. 18, 2016) for a description of the history of the listing decision for lead under CAA section 108.

[200] 73 FR 66965 (Nov. 12, 2008).

NAAQS.[201] The Lead NAAQS is currently undergoing review.[202]

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 EPA 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. The states, in conjunction with the EPA, also administer the Prevention of Significant Deterioration program for these pollutants.

Additional EPA programs to address lead in the environment include the Federal Motor Vehicle Control program under Title II of the Act, which involves controls for motor vehicles and nonroad engines and equipment; 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 112 and 129. For example, in January 2012, the EPA updated the NESHAP for the secondary lead smelting source category.[203] 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.[204]

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 for potable water applications may not be used in new installations or repairs or introduced into commerce unless it is considered ''lead free'' as defined by that Act.[205] Also under section 1412 of the SDWA, the EPA's 1991 Lead and Copper Rule [206] regulates lead in public drinking water systems through corrosion control and other utility actions which work together to minimize lead levels at the tap.[207] On January 15, 2021, the agency published the Lead and Copper Rule Revisions (LCRR) [208] and subsequently reviewed the rule in accordance with Executive Order 13990.[209] While the LCRR took effect in December 2021, the agency concluded that there are significant opportunities to improve the LCRR.[210] The EPA is developing a new proposed rule, the Lead and Copper Rule Improvements (LCRI),[211] that would 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 ''methods to identify and trigger action in communities that are most at risk of elevated drinking water levels.'' [212] The EPA intends to propose the LCRI and take final action on it prior to October 16, 2024.

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.'' [213] 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.[214] 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

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[201] 81 FR 71912–71913 (Oct. 18, 2016).

[202] 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.*

[203] 77 FR 555 (Jan. 5, 2012).

[204] 78 FR 9112 (Feb. 7, 2013).

[205] 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.*

[206] 40 CFR 141 Subpart I (June 7, 1991).

[207] 40 CFR 141 Subpart I (June 7, 1991).

[208] 86 FR 4198. (Jan. 15, 2021).

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

[210] 86 FR 31939. (Dec. 17, 2021).

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

[212] 86 FR 31939 (Dec. 17, 2021).

[213] 66 FR 1206 (Jan. 5, 2001).

[214] 84 FR 32632 (July 9, 2019).

and windowsills, respectively.[215] The EPA is now reconsidering the 2019 and 2021 rules in accordance with Executive Order 13990 [216] and in response to a May 2021 decision by U.S. Court of Appeals for the Ninth Circuit.

Programs associated with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) [217] and Resource Conservation Recovery Act (RCRA) [218] also implement removal and remedial response programs that reduce exposures to the release or threat of a release of lead and other hazardous substances. The EPA develops and implements protective levels for lead in soil 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 sites. Federal programs, including those implementing RCRA, provide for management of hazardous substances in hazardous and municipal solid waste (*e.g.,* 66 FR 58258, November 20, 2001).

C. History of Lead Endangerment Petitions for Rulemaking and the EPA Responses

The Administrator's proposed 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 here.[219]

In a 2003 letter to the EPA, Friends of the Earth initially raised the issue of the potential for lead emissions from the use of leaded avgas in general aviation aircraft using piston engines to cause or contribute to endangerment of public health or welfare.[220] In 2006, Friends of the Earth filed a petition with the EPA requesting that the Administrator find endangerment or, if there was insufficient information to find endangerment, commence a study of lead emissions from piston-engine aircraft. In 2007, the EPA issued a **Federal Register** notice on the petition requesting comments and information related to a wide range of issues regarding the use of leaded avgas and potential public health and welfare exposure issues.[221] The EPA did not receive new information to inform the evaluation of whether lead emissions from aircraft engines using leaded avgas cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.

In 2010, the EPA further responded to the 2006 petition from Friends of the Earth by issuing an Advance Notice of Proposed Rulemaking on Lead Emissions from Piston-Engine Aircraft Using Leaded Aviation Gasoline (ANPR).[222] In the ANPR, the EPA described information currently available and information being collected that would be used by the Administrator to issue a subsequent proposal regarding whether, in the Administrator's judgment, aircraft lead emissions from aircraft using leaded avgas cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare. After issuing the ANPR, the EPA continued the data collection and evaluation of information that is described in Sections II.A, IV and V of this action.

In 2012, Friends of the Earth, Physicians for Social Responsibility, and Oregon Aviation Watch filed a new petition claiming that, among other things, the EPA had unreasonably delayed in responding to the 2006 petition from Friends of the Earth because it had failed to determine whether emissions of lead from general aviation aircraft engines cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare.[223] The EPA responded to the 2012 petition with our plan for collecting the necessary information and conducting 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. Friends of the Earth, Physicians for Social Responsibility, and Oregon Aviation Watch submitted a petition for reconsideration in 2014 [224] to which the EPA responded in 2015.[225]

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.[226] The EPA responded in 2022 noting our intent to develop this proposal 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.[227]

III. Legal Framework for This Action

In this action, the EPA is proposing to make 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

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[215] 86 FR 983 (Jan. 7, 2021).

[216] 86 FR 7037 (Jan. 20, 2021).

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

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

[219] *See https://www.epa.gov/regulations-emissions-vehicles-and-engines/petitions-and-epa-response-memorandums-related-lead.* Accessed on Dec. 12, 2021.

[220] Friends of the Earth (formerly Bluewater Network) comment dated Dec. 12, 2003, submitted to EPA's 68 FR 56226, published Sept. 30, 2003.

[221] *See* 72 FR 64570 (Nov. 16, 2007).

[222] 75 FR 22440–68 (Apr. 28, 2010).

[223] Petitioners filed a complaint in district court seeking to compel EPA to respond to their 2006 petition for rulemaking and to issue an endangerment finding and promulgate regulations. The EPA then issued its response to the petition, mooting that claim of the complaint. In response to EPA's motion for summary judgment on the remaining claims, the court concluded that making the endangerment determination is not a nondiscretionary act or duty and thus that it lacked jurisdiction to grant the relief requested by plaintiffs. *Friends of the Earth* v. *EPA,* 934 F. Supp. 2d 40, 55 (D.D.C. 2013).

[224] The petition for reconsideration submitted to EPA by Friends of the Earth, Physicians for Social Responsibility, and Oregon Aviation Watch is available at *https://www.epa.gov/sites/default/files/2016-09/documents/avgas-petition-reconsider-04-21-14.pdf.*

[225] The 2015 EPA response to the 2014 petition for reconsideration is available at *https://www.epa.gov/sites/default/files/2016-09/documents/ltr-response-av-ld-foe-psr-oaw-2015-1-23.pdf.*

[226] 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.*

[227] 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.*

provided a detailed explanation of the legal framework for making such findings and the statutory interpretations and caselaw supporting its approach.[228] In this proposal, the Administrator is using the same approach of applying a two-part test under section 231(a)(2)(A) as described in the 2016 Findings and is relying on the same interpretations supporting that approach, which are briefly described in this Section, and set forth in greater detail in the 2016 Findings.[229] This is also 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),[230] which was affirmed by the U.S. Court of Appeals for the D.C. Circuit in 2012.[231] As explained further in the 2016 Findings, the text of the CAA section concerning aircraft emissions in section 231(a)(2)(A) mirrors the text of CAA section 202(a) that was the basis for the 2009 Findings.[232] 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 proposing to act consistently with that framework for purposes of these proposed section 231 findings.[233] As this approach has been previously discussed at length in the 2016 and 2009 Findings, the EPA provides only a brief description in this proposal.

A. Statutory Text and Basis for This Proposal

Section 231(a)(2)(A) of the CAA provides that the ''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.'' [234] In this proposal, 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 and in the 2009 Findings.

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.[235]

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.[236] 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.'' [237] 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.'' [238] 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.[239] Comment has been taken on these proposed findings as part of the notice and comment process for the emission standards.[240] However, there is no requirement that the Administrator propose the endangerment and cause or contribute findings concurrently with proposed standards and, most recently under section 231, the EPA made separate endangerment and cause or contribute findings for GHGs before proceeding to set standards.

The Administrator is applying the rulemaking 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.'' [241] Any subsequent

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[228] FR 54422–54475 (Aug. 15, 2016).

[229] *See e.g.,* 81 FR at 55434–54440 (Aug. 19, 2016).

[230] 74 FR 66496, 66505–10 (Dec. 15, 2009).

[231] *Coalition for Responsible Regulation, Inc.* v. *EPA,* 684 F.3d 102 (D.C. Cir. 2012) (*CRR*) (subsequent history omitted).

[232] 81 FR at 55434 (Aug. 19, 2016).

[233] 81 FR at 55434 (Aug. 19, 2016).

[234] 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.

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

[236] *See* 81 FR at 54435 (Aug. 19, 2016).

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

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

[239] 81 FR at 54425 (Aug. 19, 2016).

[240] *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).

[241] 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).

standard setting rulemaking under CAA section 231 will also be subject to the notice and comment rulemaking 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 proposed findings will be subject to the same procedural requirements that would apply if the proposed 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 proposal, 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.[242]

This analysis entails a scientific judgment by the Administrator about the potential risks posed by lead emissions to public health and welfare. In this proposed action, the EPA is using the same approach in making scientific judgments regarding endangerment as it has previously described in the 2016 Findings, and its analysis is guided by the same five principles that guided the Administrator's analysis in those Findings.[243]

Similarly, the EPA is taking the same approach to the cause or contribute analysis as was previously explained in the 2016 Findings.[244] 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.[245] Moreover, like the CAA section 202(a) language 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.''[246] 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.[247] 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.[248]

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.[249] 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.''[250] 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.''[251] 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).[252] 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.[253] 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.[254]

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.[255]

C. Regulatory Authority for Emission Standards

Though the EPA is not proposing standards in this action, should the EPA finalize these findings, the EPA would then proceed to propose emission standards under CAA section 231. As noted in Section III.A of this document, section 231(a)(2)(A) of the CAA directs the Administrator of the EPA to, from time to time, propose aircraft engine 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 notice and an opportunity for a public hearing on standards, the Administrator shall issue such standards ''with such modifications as he deems appropriate.'' In addition, under CAA section 231(b), the EPA determines, in consultation with the U.S. Department of Transportation (DOT), that the effective date of any standard provides the necessary time to permit the development and application of the requisite technology, giving appropriate consideration to the cost of compliance.

Once the EPA adopts standards, CAA section 232 then directs the Secretary of Transportation 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

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

[243] *See, e.g.,* 81 FR 54422, 54434–55435 (Aug. 15, 2016).

[244] *See, e.g.,* 81 FR at 54437–54438 (September 4, 2013).

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

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

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

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

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

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

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

[252] 81 FR at 54438 (Aug. 15, 2016).

[253] 81 FR at 54438 (Aug. 15, 2016).

[254] 81 FR at 54438 (Aug. 15, 2016).

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

emissions unless such standard is identical to the EPA's standards.[256]

IV. The Proposed Endangerment Finding Under CAA Section 231

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.[257] 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.[258] 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 is proposing to define 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.[259]

2. Health Effects and Lead Air Pollution

As noted in Section II.A of this document, 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 on which the Administrator is proposing to find that lead air pollution is reasonably anticipated to endanger public health and welfare.[260] [261]

As summarized in Section II.A of this document, human exposure to lead that is emitted into the air can occur by multiple pathways. Ambient air inhalation pathways include both inhalation of air outdoors and inhalation of 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. While 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), as described in Section II.A of this document, it is well-documented that exposures to air-related lead can result in increased blood lead levels, particularly for children living near air lead sources, who may have increased blood lead levels due to their proximity to these sources of exposure.[262]

As described in the EPA's 2013 Lead ISA and in prior Criteria Documents, 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.[263] 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,'' or a ''likely to be causal relationship,'' or for which the evidence is ''suggestive of a causal relationship'' between lead exposure and a health effect.[264] 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).[265] 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.[266]

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.[267]

Intelligence quotient is a well-established, widely recognized and rigorously standardized measure of neurocognitive function which has been

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[256] CAA Section 233 (Dec. 31, 1970).

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

[258] 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.

[259] The lead air pollution that we are considering in this proposed finding can occur as elemental lead or in lead-containing compounds, and this proposed 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).

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

[261] EPA (2006) AQC for Lead. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

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

[263] 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.

[264] 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.

[265] 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.

[266] 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.

[267] 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.

used extensively as a measure of the negative effects of exposure to lead.[268] [269] 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.[270]

In summarizing the evidence related to neurocognitive impacts of lead at different childhood lifestages, the 2013 Lead ISA notes that ‘‘in individual studies, postnatal (early childhood and concurrent [with IQ testing]) blood lead levels are also consistently associated with cognitive function decrements in children and adolescents.’’ [271] 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.’’ [272] 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 lead exposures that are part of the effects and blood lead levels observed in epidemiologic studies (uncertainties which are greater in studies of older children and adults than in studies of younger children).[273] 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,[274] potentially affecting lower educational attainment and financial well-being.[275]

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.[276] 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’’.[277] 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.[278]

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 the role of past versus current exposures to lead is unclear.[279]

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.’’ [280] 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.’’ [281] 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.[282] 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.’’ [283] 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.’’ [284]

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.[285]

Additionally, the evidence is suggestive of lead exposure and some additional effects. These include auditory function decrements and

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

[269] EPA (2006) AQC for Lead. Sections 6.2.2 and 8.4.2. EPA, Washington, DC, EPA/600/R–5/144aF, 2006.

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

[271] 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.

[272] 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.

[273] 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.

[274] 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.

[275] 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.

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

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

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

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

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

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

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

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

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

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

subclinical atherosclerosis, reduced kidney function, birth outcomes (*e.g.,* low birth weight, spontaneous abortion), and female reproductive function.[286]

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.[287] 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.'' [288]

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.[289] 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).[290]

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.[291] 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.[292]

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.[293]

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.'' [294]

B. Proposed Endangerment Finding

The Administrator proposes to find, 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 proposal 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.

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

A. Proposed 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

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[286] 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.

[287] 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.

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

[289] 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.

[290] 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.

[291] 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.

[292] 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.

[293] 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.

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

section 231 for greenhouse gases, in making this proposed 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 proposes to define the air pollutant to match the proposed definition of the air pollution, such that the air pollutant analyzed for contribution would mirror the air pollution considered in the endangerment finding. Accordingly, for purposes of this action, the Administrator is proposing to define 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.[295] 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.

Under section 231(a), the Administrator is required to set ''emission standards applicable to the emission of any air pollutant'' from classes of aircraft engines that the Administrator determines causes or contributes to air pollution that may reasonably be anticipated to endanger public health or welfare. If the Administrator makes a final determination under section 231 that the emissions of the lead air pollutant from certain classes of aircraft engines cause or contribute to air pollution that may reasonably be anticipated to endanger public health and welfare, then he is called on to set standards applicable to the emission of this air pollutant. The term ''standards applicable to the emission of any air pollutant'' is not defined, and the Administrator has the discretion to interpret it in a reasonable manner to effectuate the purposes of section 231. We anticipate that the Administrator would consider a variety of factors in determining what approach to take in setting the standard or standards, and the EPA would provide notice and an opportunity to comment on the proposed standards before finalizing them.

B. The Data Used To Evaluate the Proposed 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 is 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 potential future conditions.

As used in this proposal, 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—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.[296] 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 0.0006 to 0.26 tons per year, comprising 0.0065 to 99.98 percent (respectively) of total lead emissions to air in those counties from covered aircraft.[297]

Covered aircraft activity, as measured by the number of hours flown nationwide, increased nine percent in the period from 2012 through 2019.[298] General aviation activity, largely conducted by covered aircraft, increased up to 52 percent at airports that are among the busiest in the U.S.[299] 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.[300] Although there is some uncertainty in these projections, they indicate that lead emissions from covered aircraft may increase at some airports in the future.[301]

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 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

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[295] The lead air pollutant we are considering in this proposed finding 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.

[296] 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.*

[297] 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.

[298] 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/.*

[299] 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.

[300] 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.

[301] 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.*

to lead air pollution, as defined in Section V.A of this document, the EPA also considers 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.[302] [303] 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.[304] [305] [306]

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.[307] [308] 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 (starting on March 10, 2012) and the McClellan-Palomar Airport (starting 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.[309] 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 lead concentration in over half of the census tracts in the U.S.[310]

The EPA also notes that lead emissions from engines in covered aircraft are present 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.[311] [312] 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.

C. Proposed Cause or Contribution Finding for Lead

Taking into consideration the data and information summarized in Section V of this document, the Administrator proposes to find 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 proposed conclusion, the Administrator notes that piston-engine aircraft operate on leaded avgas. That operation emits lead-

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[302] 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.*

[303] 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.*

[304] 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.*

[305] 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.*

[306] 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.

[307] 73 FR 66965 (Nov. 12, 2008).

[308] 75 FR 81226 (Dec. 27, 2010).

[309] 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.*

[310] EPA's 2017 AirToxScreen is available at *https://www.epa.gov/AirToxScreen.*

[311] 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.*

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

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, and present 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 proposed 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, and more recently, in 2017, when approximately 470 tons of lead was emitted by engines in covered aircraft.[313]

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 quality that exceeds 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.[314] 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 add support for the proposed conclusion that lead emissions from engines in covered 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. 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. 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 is proposing to find 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 proposes to conclude 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 13563: Improving Regulation and Regulatory Review

This action is a ''significant regulatory action'' because of the cross-agency nature of this issue. Accordingly, it was submitted to the Office of Management and Budget (OMB) for review under Executive Order 12866. This action proposes 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. Any changes made in response to OMB recommendations have been documented in the docket.

B. Paperwork Reduction Act (PRA)

This action does not impose an information collection burden under the PRA. The proposed 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 proposed 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 proposed 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. Accordingly, this action affords no opportunity for the EPA to fashion for small entities less burdensome compliance or reporting requirements or timetables or exemptions from all or part of the proposal.

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.

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[313] 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.*

[314] 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.*

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 proposed 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 proposed 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.[315] 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

The EPA interprets E.O. 13045 (62 FR 19885, April 23, 1997) as applying only to those regulatory actions that concern health or safety risks, such that the analysis required under section 5–501 of the E.O. has the potential to influence the regulation. This action is not subject to E.O. 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 proposed endangerment and cause or contribute findings under CAA section 231(a)(2)(A), the proposed findings themselves, if finalized, would not impose a standard intended to mitigate those risks. While this action is not subject to Executive Order 13045 in this scenario, the Agency's Policy on Children's Health[316] still applies. The Administrator considered lead exposure risks to children as part of this proposed endangerment finding under CAA section 231(a)(2)(A). This action's discussion of the impacts of lead exposure on public health and welfare is found in Section IV of this document, and specific discussion with regard to children are contained in Supplemental Information Section C, as well as Sections II.A.5, and IV 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 proposed 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 proposed 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

The EPA believes this action will not have potentially disproportionately high and adverse human health or environmental effects on people of color, low-income, or indigenous populations because this action does not affect the level of protection provided to human health or the environment. The Administrator considered the potential for lead exposure risks to people of color, low-income, and indigenous populations as part of this proposed endangerment finding under CAA section 231(a)(2)(A). This action's discussion of lead exposure impacts on public health and welfare is found in Section IV of this document. Specific discussion focused on environmental justice with regard to people of color, low-income, and indigenous populations are found in Supplemental Information Section D, as well as Sections II.A.5, and Section IV of this document. A copy of the documents pertaining to the EPA's analysis of potential environmental justice concerns related to this action have been placed in the public docket for this action (Docket EPA–HQ–OAR–2022–0389).

K. 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).

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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[315] *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.

[316] EPA (2021) EPA Policy on Children's Health. Available at *https://www.epa.gov/system/files/documents/2021-10/2021-policy-on-childrens-health.pdf.*