CALIFORNIA
AIR RESOURCES BOARD

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October 19, 2020

Administrator Andrew Wheeler
U.S. Environmental Protection Agency
Air and Radiation Docket and Information Center
1200 Pennsylvania Avenue, NW
Washington, DC 20460
Attention: Docket ID No. EPA–HQ–OAR–2018–0276

Comments submitted electronically via https://www.regulations.gov.

Re: Proposed Rulemaking for Control of Air Pollution From Airplanes and Airplane Engines: GHG Emission Standards and Test Procedures; 85 Fed. Reg. 51,556 (August 20, 2020).

Dear Administrator Wheeler:

The California Air Resources Board (CARB) submits the following comments on the United States Environmental Protection Agency's (EPA) Proposed Rulemaking for Control of Air Pollution from Airplanes and Airplane Engines: GHG Emission Standards and Test Procedures, 85 Fed. Reg. 51,556 (August 20, 2020). These comments supplement the comments submitted jointly today by CARB, California Attorney General Xavier Becerra, and the States of Connecticut, Illinois, Maryland, Minnesota, New Jersey, New York, Oregon, Vermont, and Washington, the Commonwealth of Massachusetts, and the District of Columbia (hereinafter, "Multistate Comment").

California and the world need real limits on aviation emissions, and there are effective ways to cut this pollution; yet, as this letter and the Multistate Comment explain, EPA's proposal dramatically misses the mark. EPA has previously recognized its authority to regulate factors influencing fuel consumption and greenhouse gas (GHG) emissions from the whole aircraft, including engine emissions, aerodynamics, and aircraft weight.[1] EPA also acknowledged its obligation to control aircraft GHG emissions as a result of its 2016 finding that these emissions contribute to pollution endangering public health and welfare.[2] Nonetheless, EPA has proposed a standard that, on its own admission, does nothing to cut pollution from aircraft, even though the agency acknowledges that this pollution is dangerous. Because real reductions are available, and the Clean Air Act obligates EPA to take action, the wholly ineffective proposed standards are illegal and arbitrary. The proposal must be withdrawn, and EPA must instead propose standards reflecting the controls needed.

California regularly experiences the burden of aircraft emissions, both because it is particularly vulnerable to air quality and climate challenges, and because it is home to two of the nation's 10 busiest airports by passengers and three of the 11 busiest by cargo weight.[3] According to 2019 Federal Aviation Administration (FAA)

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[1] EPA, Proposed Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare and Advance Notice of Proposed Rulemaking, 80 Fed. Reg. 37,758, 37,768-69 (July 1, 2015).
[2] EPA, Finding That Greenhouse Gas Emissions From Aircraft Cause or Contribute to Air Pollution That May Reasonably Be Anticipated To Endanger Public Health and Welfare, 81 Fed. Reg. 54,422 (Aug. 15, 2016).
[3] FAA, Passenger Boarding (Enplanement) and All-Cargo Data for U.S. Airports, updated Sept. 29, 2020, available at https://www.faa.gov/airports/planning_capacity/passenger_allcargo_stats/passenger/ (ranking Los Angeles International as #2 and San Francisco International as #7 by passengers, and Los Angeles International as #5, Ontario International as #10, and Metropolitan Oakland

data, the State's total commercial passenger trips represented 12.9 percent of U.S. commercial passengers, and airports in the state handled 11.1 percent of all U.S. cargo.[4] These statistics reflect California's status as the fifth-largest economy in the world, as well as a major tourism destination. In 2017, these flights emitted more GHGs than California's energy use for the residential and commercial sectors combined.[5] Aircraft also emit significant criteria and hazardous air pollutants that impede attainment of air quality standards and disproportionately affect disadvantaged and low-income communities nearest the airports.[6]

International as #11 by cargo weight).

[4] *Ibid.* California's airports processed 120,652,743 of 935,693,377 calendar year 2019 enplanements and 20,151,532,213 of 181,574,937,105 calendar year 2019 landed pounds at U.S. airports.

[5] In 2017, California's intrastate, interstate, and international flights emitted about 48.5 million metric tons (MMT) of carbon dioxide equivalent (CO2e), while residential and commercial energy use generated about 41 MMT CO2e. CARB, California Greenhouse Gas Emission Inventory for 2000 to 2017 (2019 edition), available at https://ww2.arb.ca.gov/ghg-inventory-data. The 2019 California GHG inventory includes only emissions from intrastate flights, which represented 1.1 percent of included statewide emissions in 2017. CARB, California Greenhouse Gas Emissions for 2000 to 2017: Trends of Emissions and other Indicators (2019 edition), at 6-7, available at https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2017/ghg_inventory_trends_00-17.pdf.

[6] *See* CARB, 2020 Mobile Source Strategy: Workshop Discussion Draft (Sept. 30, 2020), p. 101 *et seq.,* available at https://ww2.arb.ca.gov/sites/default/files/2020-09/Workshop_Discussion_Draft_2020_Mobile_Source_Strategy.pdf; South Coast Air Quality Management District (SCAQMD), Draft Aircraft Emissions Inventory (Aug. 2016), available at http://www.aqmd.gov/docs/default-source/planning/fbmsm-docs/aircraft-emissions-

The public health, environmental, economic, and social impacts of uncontrolled GHG emissions from aircraft necessitate real and significant control of these emissions. Instead, EPA proposes to simply codify an approach that, at the time of its adoption by the International Civil Aviation Organization (ICAO) four years ago, explicitly considered and incorporated only technologies that were "flight-ready" at that time.[7] The International Council on Clean Transportation (ICCT) estimates that the proposed rule lags existing manufacturer efforts by more than 10 years.[8] The incorporated technologies were limited even further by ICAO policies preventing consideration of existing and effective GHG reduction strategies such as weight reductions and sustainable aviation fuels.[9] The proposed standard is worse than business-as-usual.

In its proposal to merely ratify ICAO's limited and already-outdated standard, EPA has arbitrarily failed to consider a variety of demonstrated and in-development emissions-reducing technologies, measures, and policies, and refused to regulate emissions from in-service and smaller aircraft, which comprise major portions of the

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inventory-for-the-south-coast-air-quality-management-district.pdf. These emissions are discussed in detail in Section I.d. below.

[7] 85 Fed. Reg. at 51,585 (ICAO used Technology Readiness Level 8, defined as "actual system completed and 'flight qualified' through test and demonstration.").

[8] Sola Zheng and Daniel Rutherford, ICCT, "Fuel burn of new commercial jet aircraft: 1960 to 2019" (Sept. 8, 2020), available at https://theicct.org/publications/fuel-burn-new-comm-aircraft-1960-2019-sept2020.

[9] 85 Fed. Reg. at 51,564; while ICAO's GHG standard does not include sustainable aviation fuels, ICAO considers these fuels through Carbon Offsetting and Reduction for International Aviation (CORSIA), as discussed below. ICAO, Sustainable Aviation Fuels, https://www.icao.int/environmental-protection/pages/SAF.aspx.

aviation sector. Clean Air Act section 231 requires EPA, having made an endangerment finding for aircraft GHG emissions, to appropriately control these emissions, including consideration of potential controls' technological feasibility.[10] EPA's failure to consider and incorporate the existing and in-development technologies and measures described below is "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law."[11] EPA must strengthen the standards and incorporate these technologies, measures, and sources to fulfill its obligations and its mission to protect public health and the environment.

I. The standard must incorporate additional demonstrated and in-development technologies and measures.

EPA failed to consider a wide variety of existing and in-development technologies and measures. These include engine designs; aircraft designs; sustainable aviation fuels; partial or total electrification; measures for landing and takeoff; ground measures regarding taxiing, idling, and auxiliary power units (APU); and, potentially, offsets.

a. The standard must incorporate additional engine designs and aerodynamic improvements, including weight-reducing technologies.

Congress and federal agencies have recognized the need for emissions-reducing technologies and supported their development and use. The result is that

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[10] 42 U.S.C. § 7571; *see National Association of Clean Air Agencies v. EPA*, 489 F.3d 1221, 1230 (D.C. Cir. 2007) (explaining that section 231 "confer[s] broad discretion to the Administrator to weigh various factors in arriving at appropriate standards.").
[11] Clean Air Act § 307(d)(9), 42 U.S.C. § 7607(d)(9).

many technologies are actively advancing. EPA must account for and incorporate potential reductions from these technologies into its standards.

The FAA Reauthorization Act of 2018 requires FAA, in coordination with the National Aeronautics and Space Administration (NASA), to "conduct a review of current and planned research on the use of advanced aircraft technologies, innovative materials, alternative fuels, additive manufacturing, and novel aircraft designs, to increase aircraft fuel efficiency[,]" and to report its findings to Congress.[12] FAA and NASA programs are demonstrating the effectiveness and current and near-term viability of engine, aerodynamics, and weight-reducing technologies that EPA inexplicably failed to consider.

NASA programs, including the Advanced Air Vehicles Program and the Integrated Aviation System Research Program, research new vehicle technologies that are anticipated to significantly reduce emissions. NASA's Environmentally Responsible Aviation Project, designed to halve fuel burn for subsonic passenger and cargo transport aircraft by 2020, has developed technologies to reduce fuel burn and emissions, including tail enhancements and surface coatings to reduce weight and drag, and lighter-weight structures.[13] The 2015 U.S. Aviation GHG Emissions Reduction Plan submitted to ICAO notes, "Typically five to ten years after the conclusion of a NASA program, industry will build on NASA's research results and integrate the associated knowledge into commercial products."[14]

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[12] FAA Reauthorization Act of 2018, Pub.L. 115-254, 115th Congress, 132 Stat. 3413, § 742.
[13] U.S. Aviation Greenhouse Gas Emissions Reduction Plan (June 2015), available at https://www.icao.int/environmental-protection/Lists/ActionPlan/Attachments/30/UnitedStates_Action_Plan-2015.pdf.
[14] *Id.* at 13.

FAA's Continuous Lower Emissions, Energy, and Noise (CLEEN) program, launched in 2010, is a cost-sharing program in which participants match or exceed federal awards to accelerate the development and commercialization of new certifiable aircraft technologies and sustainable aviation fuels. Congress codified the program into statute in 2018.[15] During the CLEEN program's first phase, from 2010 to 2015, it provided 125 million dollars to help aircraft and components companies develop and demonstrate technologies to reduce aircraft fuel burn by 33 percent, with a target entry into service date of 2018.[16] In the second phase, from 2015 to 2020, FAA provided another 100 million dollars to develop technologies that would reduce aircraft fuel burn by 40 percent, with a target entry into service date of 2026.[17] Emissions-reducing technologies successfully developed through the

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[15] FAA Reauthorization Act of 2018, Pub.L. 115-254, 115th Congress, 132 Stat. 3413, adding 49 U.S.C. § 47511.

[16] Chris Dorbian, FAA Office of Environment & Energy, CLEEN Program Overview (March 3, 2020), available at https://anesymposium.aqrc.ucdavis.edu/sites/g/files/dgvnsk3916/files/inline-files/20200303%20UC%20Davis%20ANE%20Symposium%20-%20CLEEN%20Overview%20%28Dorbian%29.pdf. CLEEN Phase I Recipients include Boeing, General Electric, Honeywell, Pratt & Whitney, and Rolls-Royce. FAA, Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, updated June 19, 2020, https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/.

[17] *Id.* CLEEN Phase II Recipients include Aurora Flight Sciences, Boeing, Collins Aerospace, Delta Tech Ops/MDS Coating Technologies, General Electric, Honeywell, Pratt & Whitney, and Rolls-Royce. FAA, Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, updated June 19, 2020,

program include composite airframe technologies; advanced wing technologies; and advanced fan systems, among many others.[18] Several of technologies developed through CLEEN are now commercially available.[19]

Analyses conducted by the Georgia Institute of Technology, Purdue University, Stanford University, and Massachusetts Institute of Technology (institutions designated as FAA Centers of Excellence) show that the technologies developed through CLEEN Phases I and II could achieve cumulative savings of 22 billion gallons of jet fuel between 2025 and 2050.[20] Sister agencies and Congress have helped to develop, demonstrate, and analyze these emissions-reducing technologies, but EPA has ignored them in considering and proposing emissions standards.

In particular, EPA baselessly refused to consider weight-reducing technologies, which are the focus of many federal and industry research efforts. The proposed

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https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/.

[18] FAA, CLEEN Phase I and II Projects, Feb. 27, 2020, available at https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/media/CLEENI_CLEENII_Projects.pdf.

[19] *Ibid.*

[20] ASCENT, Project 010 Aircraft Technology Modeling and Assessment (July 2018), available at https://ascent.aero/documents/2018/07/ascent-010-2015-annual-report.pdf/; PARTNER, Environmental Design Space Assessment of Continuous Lower Energy Emissions Noise (CLEEN) Technologies (March 2016), available at http://partner.mit.edu/sites/partner.mit.edu/files/PARTNER-Project-36-final-report.pdf. The third phase of the CLEEN Program is currently under development. *See* FAA, Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, updated June 19, 2020, https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/.

rule's Technical Support Document (TSD) includes an analysis of engine and airframe technologies conducted by a third-party contractor, ICF Inc. (The TSD recognizes that many of these technologies have already entered service since ICF's analysis was first performed in 2015.[21]) The TSD provides an analysis of airframe and engine technologies applicable to fuel burn reductions, but explicitly omits critical weight-reducing technologies that can increase fuel efficiency and thereby reduce GHG emissions. This exclusion eliminates about one-third of the technologies identified by ICF that could achieve emissions reductions.[22] EPA explains that it did not consider weight-reducing technologies because they are not credited by ICAO.[23] EPA concludes that "even though weight reducing technologies increase the airplane fuel efficiency, this improvement in efficiency frequently would not be reflected in operation[,]" because, "while weight reduction technologies can be used to improve airplane fuel efficiency, they may also be used to allow increases in payload, equipage, and fuel load."[24]

Yet adopting weight-reducing technologies does not inherently mean an increase in capacity to add weight elsewhere. A study conducted by Tecolote Research demonstrates this in an evaluation of composite material fractions by assuming that "the volume of the parts remains the same with the composites substituted for aluminum."[25] In this example, a reduction in weight does not change

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[21] Proposal TSD at 32.

[22] *Ibid.*

[23] 85 Fed. Reg. at 51,564-65.

[24] *Ibid.*

[25] Tecolote Research, Final Report - Aviation Fuel Efficiency Technology (2015) Assessment, available at

the volume. Any load that would be constrained by volume requirements would remain the same, reducing the operating weight of the aircraft and thus the emissions.

Technology under development by Boeing and funded by CLEEN Phase II, known as the Structurally Efficient Wing (SEW), provides large weight reductions through new manufacturing techniques and advanced composite material technology. It is estimated that this technology could avoid approximately 660 million tons of CO_2 emissions over a twenty-year period.[26] These are non-trivial reductions that EPA should incorporate and must consider.

b. The standard must incorporate sustainable aviation fuels.

In addition to improvements in engine specifications and standards, the rule could achieve significant reductions in GHG emissions and criteria pollutants by mandating or incentivizing the increased use of sustainable aviation fuels (SAFs), drop-in substitutes of petroleum jet fuels that are derived from renewable feedstock, such as vegetable- or waste-based oils. A drop-in jet fuel blend is "completely interchangeable and compatible with conventional jet fuel when blended with conventional jet fuel," and thus drop-in SAF would "not require adaption of the aircraft/engine fuel system or the fuel distribution network, and can be used 'as is'

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https://theicct.org/sites/default/files/publications/Aviation%20Fuel%20Efficiency%20Technology%20Assessment%20(AFETA)%202015%20Final%20Report%2018Jan2016.pdf, at 82.

[26] FAA, CLEEN Phase I and II Projects (Feb. 27, 2020), available at https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/media/CLEENI_CLEENII_Projects.pdf, at 2.

on currently flying turbine-powered aircraft."[27] The FAA's CLEEN program and other initiatives fund development and demonstration of "drop-in" SAFs that "require no modifications to aircraft or fuel supply infrastructure."[28]

SAFs are described by ICAO as "one element of the ICAO basket of measures to reduce aviation emissions, which also includes technology and standards, operational improvements, and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)."[29] In fact, use of SAFs reduces an aircraft operator's CORSIA offsetting requirement and thus requiring or incentivizing the use of SAFs will enable airline operators to meet CORSIA's requirements with less reliance on offsets projects. According to FAA, SAFs "also can help to expand jet fuel supplies beyond petroleum, improving jet fuel price stability, enhancing supply security, and contributing to economic development."[30] And in 2019, the ICAO Assembly adopted a resolution "[r]ecognizing that the technological feasibility of drop-in

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[27] ICAO, Sustainable Aviation Fuels Guide (Dec. 2018), available at https://www.icao.int/environmental-protection/Documents/Sustainable%20Aviation%20Fuels%20Guide_100519.pdf.

[28] FAA, Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, updated June 19, 2020, https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/; U.S. Department of Transportation, FAA Top Policy Issues, updated Jan. 27, 2017, available at https://www.transportation.gov/transition/FAA/Top-Policy-Issues.

[29] ICAO, 2019 Environmental Report: Aviation and Environment, available at https://www.icao.int/environmental-protection/Documents/ICAO-ENV-Report2019-F1-WEB%20(1).pdf.

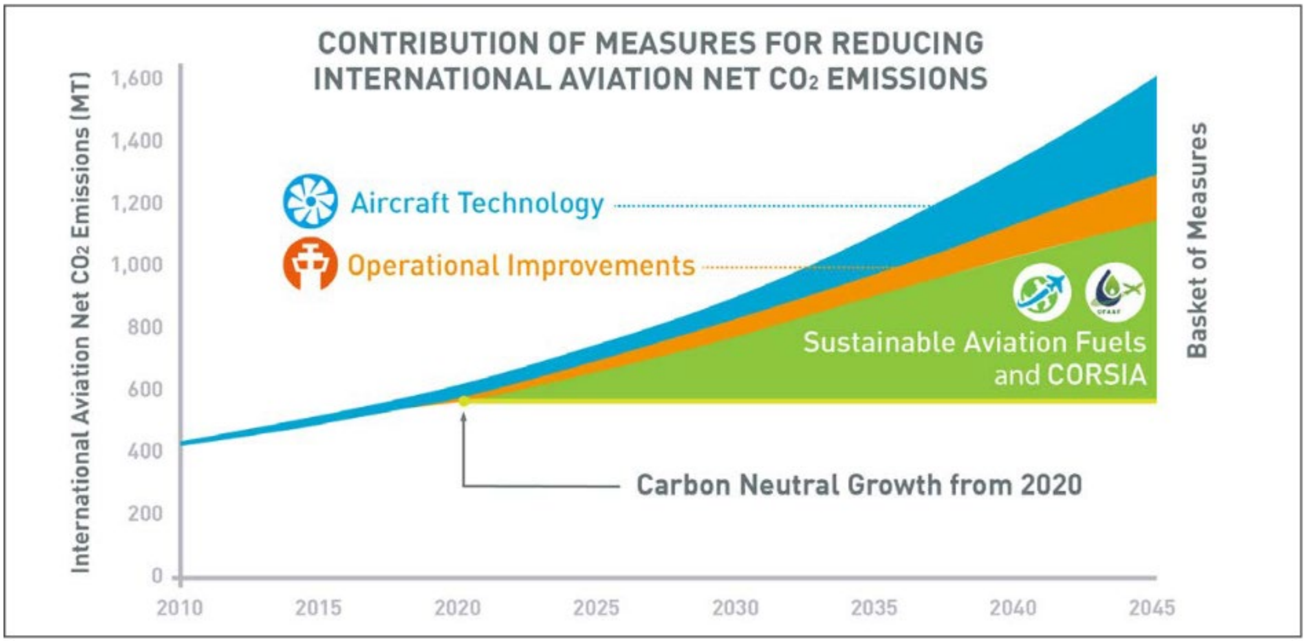
[30] U.S. Department of Transportation, FAA Top Policy Issues, updated Jan. 27, 2017, available at https://www.transportation.gov/transition/FAA/Top-Policy-Issues.

sustainable aviation fuels is proven and that the introduction of appropriate policies and incentives to create a long-term market perspective is required[.]"[31]

To achieve ICAO and industry commitments for carbon neutral growth by 2020 (a goal shared by FAA),[32] ICAO's 2019 environmental report envisions a significant increase in the use of SAFs, as Figure 1 shows.[33] The industry's commitment to achieving 50 percent GHG emissions reduction relative to a 2005 baseline by 2050 necessitates even more stringent reductions, and highlights the necessity of developing a robust SAF industry to supply increasing quantities of alternative fuels to airline operators.

[31] ICAO Assembly, Resolution A40-18, available at https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A40-18_Climate_Change.pdf.
[32] FAA, Aviation Environmental and Energy Policy Statement (July 2012), available at https://www.faa.gov/about/office_org/headquarters_offices/apl/environ_policy_guidance/policy/media/FAA_EE_Policy_Statement.pdf; ICAO Assembly, Resolution A40-18, available at https://www.icao.int/environmental-protection/Documents/Assembly/Resolution_A40-18_Climate_Change.pdf; *International Air Transport Association*, Working Toward Ambitious Targets, https://www.iata.org/en/programs/environment/climate-change/.
[33] ICAO, 2019 Environmental Report: Aviation and Environment, available at https://www.icao.int/environmental-protection/Documents/ICAO-ENV-Report2019-F1-WEB%20(1).pdf.

FIGURE 1: ICAO Global Environmental Trends on CO_2 Emissions and Contribution of Measures for Reducing International Aviation Net CO_2 Emissions



CARB's Low Carbon Fuel Standard (LCFS) program has demonstrated in a short period of time that, with the appropriate economic incentive, SAFs are economically attractive products for fuel producers in the United States. Starting in 2019, the LCFS program allowed SAFs to opt-in the program and generate credits for replacing jet fuels in trips departing from California. Currently, the LCFS provides an incentive of around $1.50/gallon of SAF,[34] and in 2019 more than 1.9 million gallons of SAF were reported to the program, generating more than 11,000 credits.

Two facilities have registered to introduce SAFs into the program, including Altair's facility in Paramount, California, repurposing a refinery from producing fossil

[34] Calculation is based on the following assumptions: $200/LCFS credit, and SAF's carbon intensity of 30 gCO_2e/MJ.

fuel-based petroleum products to producing SAFs for use in the State.[35] Moreover, several California refineries have announced similar plans to convert existing refineries to produce SAFs and renewable diesel products, including Phillip 66's Rodeo refinery,[36] Marathon's Martinez refinery,[37] and Alon's Bakersfield refinery.[38] This demonstrates how SAF use can contribute to the sustainable transition of assets in the oil and gas sector, and maintaining jobs in these communities.

A national aviation fuel standard would provide a much larger positive effect on the SAF production and use in the United States than state programs, meaning that the costs of such fuels would likely drop further were EPA to act, and their use would be more extensive.[39] First, the U.S. market is much larger than the California market, and an adoption of a national program would result in larger quantities of

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[35] "World Energy acquires AltAir biojet, renewable diesel assets," *Biodiesel Magazine* (March 20, 2018), available at http://www.biodieselmagazine.com/articles/2516317/world-energy-acquires-altair-biojet-renewable-diesel-asset.

[36] Janet McGurty, "Phillips 66 to convert San Francisco-area refinery to produce renewable fuels," SP Global, (Aug. 12, 2020), available at https://www.spglobal.com/platts/en/market-insights/latest-news/oil/081220-phillips-66-to-convert-san-francisco-area-refinery-to-produce-renewable-fuels.

[37] Annie Sciacca, "Marathon refinery closure could signal big transition for Bay Area refineries," *Mercury News* (Aug. 8, 2020), available at https://www.mercurynews.com/2020/08/08/marathon-refinery-closure-could-signal-big-transition-for-area-refineries/.

[38] Joseph Luiz, "Alon Bakersfield Refinery sold, to be used to produce renewable fuel," KGET (May 8, 2020), available at https://www.kget.com/news/alon-bakersfield-refinery-sold-to-be-used-to-produce-renewable-fuel/.

[39] While a national aviation fuel standard may require a joint rulemaking with FAA, 49 U.S.C. § 44714, EPA should consider and incorporate the reductions achievable through use of SAFs in setting its GHG emission standard.

SAF being utilized, potentially resulting in decreased costs to scale and learning effects. Second, adopting a national standard would also allow the United States to potentially harmonize such programs with upcoming programs in other jurisdictions (such as the Canadian Clean Fuel Standard and the European Union Emissions Trading System (EU-ETS)) in regulating the GHG emissions from international travel between these regions.

c. EPA must consider electrification and hydrogen.

EPA must also consider zero-emissions and hybrid aircraft technologies that have shown promise in recent years. In a 2019 report, ICAO highlighted the promise of electric and hybrid technologies, noting that "a number of ongoing projects have been identified globally, [including] general aviation or recreational aircraft, business and regional aircraft, [and] large commercial aircraft. . . . Most of them target an entry-in-service date between 2020 and 2030, and some are already commercially available."[40]

In June 2020, a private company successfully flew a commercial-grade plane powered by a hydrogen-electric powertrain.[41] The company anticipates making

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[40] ICAO, Introduction to the ICAO Basket of Measures to Mitigate Climate Change, Climate Change Mitigation: Technology and Operations, Ch. 4 (2019), at 113, available at https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg111-115.pdf.

[41] Ilana Marcus, "Can Airplanes Go Green?," *Washington Post* (July 31, 2020), available at https://www.washingtonpost.com/climate-solutions/2020/07/31/electric-airplane/; Anmar Frangoul, "A battery-electric plane takes to skies over England in latest example of 'zero-emission' flight," *CNBC* (June 24, 2020), available at

retrofitted zero-emission aircraft commercially available as soon as the end of 2023.[42] Airbus recently announced three types of zero-emission hydrogen-fueled commercial aircraft that the company intends to introduce into service by 2035.[43] Collectively termed "ZEROe," the aircraft include a turbofan design with a range of over 2,000 nautical miles and a 120-200 passenger capacity, a turboprop design with a range of over 1,000 nautical miles and a 100 passenger capacity, and a "blended-wing design" with a 200 passenger capacity. These zero-emission aircrafts are anticipated to be able to execute short-haul and transcontinental flights.

It is evident that hydrogen-powered, electric, and hybrid aircraft will soon be a viable option. EPA should take these technologies and designs into consideration in promulgating its emissions standard.

d. EPA should consider measures to reduce GHG emissions and co-pollutants from landing and takeoff, taxi, and APUs.

EPA failed to consider potential emissions reductions from measures for landing and takeoff,[44] taxi, and idling, including from APUs. Along with GHG

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https://www.cnbc.com/2020/06/24/battery-electric-zero-emission-plane-takes-to-skies-over-england.html.

[42] *Ibid.*; Charles Alcock, "ZeroAvia Hydrogen Flight Paves Way to 2023 Service Entry," *AINonline* (Sept. 25, 2020), available at https://www.ainonline.com/aviation-news/air-transport/2020-09-25/zeroavia-hydrogen-flight-paves-way-2023-service-entry.

[43] Airbus, "Airbus reveals new zero-emission concept aircraft" (Sept. 21, 2020), available at https://www.airbus.com/newsroom/press-releases/en/2020/09/airbus-reveals-new-zeroemission-concept-aircraft.html.

[44] The landing takeoff cycle is comprised of taxi-out, take-off, climb-out, approach, landing, and taxi-in modes, and does not include climb, cruise, and descent operation for aircraft

emissions, operational measures generally reduce co-pollutant emissions, which significantly affect air quality surrounding airports during near-ground and ground-based operations like landing and takeoff, taxi, and idling. Aviation is a large and growing source of criteria emissions in California, making it more challenging for the State and local air districts to meet the National Ambient Air Quality Standards (NAAQS). The air quality challenges across California, and especially in the South Coast Air Basin, necessitate federal control of large source categories for which states and localities are preempted from establishing distinct standards, including aircraft engine emissions.[45] EPA's failure to consider these measures, given their likely co-benefits for NAAQS attainment and public health, highlights the arbitrariness of EPA's proposal.

Statewide, more than 28 million Californians live in areas that exceed the federal health-based ozone and fine particulate (PM2.5) standards. Today, in the South Coast Air Basin, over 12 million people are exposed to elevated ozone and PM2.5 air pollution. The most significant air quality challenge in the Basin is to reduce nitrogen oxide (NOx) emissions sufficiently to meet the upcoming ozone standard deadlines. Based on the emissions inventory and modeling results, 522 tons per day (tpd) of total Basin NOx emissions in 2012 are projected to drop to 255 tpd and 214 tpd in the 8-hour ozone attainment years of 2023 and 2031 respectively, due to continued implementation of already adopted regulatory

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above 3,000 feet. CARB, 2020 Mobile Source Strategy: Workshop Discussion Draft (Sept. 30, 2020), at 103, available at https://ww2.arb.ca.gov/sites/default/files/2020-09/Workshop_Discussion_Draft_2020_Mobile_Source_Strategy.pdf.

[45] Clean Air Act § 233, 42 U.S.C. § 7573.

actions.[46] The analysis suggests that total Basin emissions of NOx must be reduced to approximately 141 tpd in 2023 and 96 tpd in 2031 to attain the 8-hour ozone standards.[47] This represents an additional 45 percent reduction in NOx in 2023, and an additional 55 percent NOx reduction beyond 2031 levels. In the South Coast Air Basin, aircraft presently contribute about 16.2 tpd of NOx emissions and are forecasted to contribute 20.5 tpd of NOx emissions in 2031.[48] This is more than 20 percent of the South Coast Air Basin NOx carrying capacity of 96 tpd[49] and would make aircraft the third-largest source of NOx emissions in the Air Basin.[50]

As shown in Figure 2, the communities located nearest large airports bear the brunt of the near-ground and ground emissions. In California, communities within 10 miles of international airports are also disproportionately low-income and people

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[46] CEPAM 2016 SIP – Standard Emission Tool (v1.05), updated July 18, 2018, available at https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php.

[47] SCAQMD Air Quality Management Plan (2016), available at https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2016-air-quality-management-plan/final-2016-aqmp/final2016aqmp.pdf?sfvrsn=15.

[48] CEPAM 2016 SIP – Standard Emission Tool (v1.05), updated July 18, 2018, available at https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php.

[49] CARB, 2020 Mobile Source Strategy: Workshop Discussion Draft (Sept. 30, 2020), at 101 *et seq.,* available at https://ww2.arb.ca.gov/sites/default/files/2020-09/Workshop_Discussion_Draft_2020_Mobile_Source_Strategy.pdf.

[50] *See* CARB, CEPAM 2016 SIP – Standard Emission Tool (v1.05), last updated July 18, 2018, available at https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php. In 2030, aircraft are projected to emit 20.045 tons of per day (tpd) of NO_x, behind only off-road equipment (29.919 tpd) and heavy heavy duty diesel trucks (29.798 tpd). *Ibid.*

of color.[51] Many low-income and disadvantaged communities experience criteria pollutant levels that significantly exceed the NAAQS, as well as exposure to hazardous air pollutants, which can have immediate and long-term detrimental health effects.[52] Recent evidence associates air pollution exposure burdens in

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[51] Julian D. Marshall, "Environmental inequality: air pollution exposures in California's South Coast Air Basin," *Atmos. Environ.* 42:5499-5503 (Feb. 4, 2008), https://doi.org/10.1016/j.atmosenv.2008.02.005; Julian D. Marshall *et al.*, "Prioritizing Environmental Justice and Equality: Diesel Emissions in Southern California," *Envtl. Sci. Tech.* 48:4063-4068 (Feb. 21, 2014), available at https://doi.org/10.1021/es405167f; Jason G. Su *et al.*, "Inequalities in cumulative environmental burdens among three urbanized counties in California," *Environment Int'l* 40:79-87 (Jan. 3, 2012), available at https://superfund.berkeley.edu/pdf/402.pdf; Jason G. Su *et al.*, "An index for assessing demographic inequalities in cumulative environmental hazards with application to Los Angeles, California," *Envtl. Sci. Tech.* 43:7626-7634 (Sept. 21, 2009), available at https://doi.org/10.1021/es901041p; Wonsik Choi *et al.*, *Neighborhood-Scale Air Quality Impacts of Emissions From Motor Vehicles and Aircraft,* 80 ATMOSPHERIC ENV'T 310, 316 (2013), DOI:10.1016/j.atmosenv.2013.07.043; Joshua Apte, "A Tool to Prioritize Sources for Reducing High PM2.5 Exposures in Environmental Justice Communities in California" (Nov. 2019), available at https://ww3.arb.ca.gov/research/single-project.php?row_id=67021.

[52] *E.g.,* American Lung Association, Disparities in the Impact of Air Pollution, updated April 20, 2020, https://www.lung.org/clean-air/outdoors/who-is-at-risk/disparities; Y.-Y. Meng *et al.*, "Are frequent asthma symptoms among low-income individuals related to heavy traffic near homes, vulnerabilities, or both?," 18:343-350 *Annals of Epidemiology* (2008); RB Gunier *et al.*, "Traffic density in California: socioeconomic and ethnic differences among potentially exposed children," *Journal of Exposure Science and Environmental Epidemiology* (2003), 13(3): pp. 240-246; A. Carlson, "The Clean Air Act's Blind Spot: Microclimates and Hotspot Pollution," 65 UCLA L. Rev. 1036 (2018); R.J. Delfino *et al.*, "Asthma Symptoms in Hispanic Children and Daily Ambient Exposures to Toxic and Criteria Air Pollutants," *Environmental*

disadvantaged communities with higher COVID-19 cases and poor health outcomes.[53] This research underscores what air quality experts have stated for decades: improved air quality is essential to supporting the long-term health of individuals, the economy, and communities.[54] Strong federal action on aviation GHGs that reduces criteria pollutants will also further the ultimate goals of the Clean Air Act to protect public health by alleviating negative health impacts associated with aircraft emissions that disproportionately impact low-income, minority, and disadvantaged communities in California. EPA has stated its commitment to addressing the environmental and public health concerns of minority, low-income, and tribal and indigenous communities[55]; amending this rulemaking as recommended herein is an opportunity to implement that commitment.

Health Perspectives vol. 111 number 4 (April 2003); W.J. Gauderman *et al.*, "The effect of air pollution on lung development from 10 to 18 years of age," *New England Journal of Medicine* 351(11): 1057-1067 (2004), Erratum in: New England Journal of Medicine 2005 352(12):1276.

[53] Xiao Wu *et al.*, "Exposure to Air Pollution and COVID-19 mortality in the United States: A Nationwide Cross-Sectional Study," available at https://www.medrxiv.org/content/10.1101/2020.04.05.20054502v2; X. Wu *et al.*, "Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis," *Science Advances*, 6, p.eabd4049 (2020).

[54] *E.g.*, W.J. Gauderman *et al.*, "Association of improved air quality with lung development in children" New England Journal of Medicine 372(10):905-913 (2015); K. Berhane *et al.*, "Association of changes in air quality with bronchitic symptoms in children in California, 1993-2012," *Journal of the American Medical Association*, 315(14):1491-1501 (2016).

[55] EPA, Memorandum on EPA's Environmental Justice and Community Revitalization Priorities (Feb. 23, 2018) available at https://www.epa.gov/sites/production/files/2018-02/documents/epa_ej_memo_02.23.2018.pdf.

There are multiple feasible technologies that would achieve these goals for EPA to consider. In the Revised 2016 Strategy for the State Implementation Plan, CARB discussed aircraft as a growing emissions source that needed to be addressed, and identified potential EPA actions to achieve those emissions reductions.[56] To date, EPA has failed to meet its obligation to effectively limit emissions from aircraft, making it more challenging for California and local air districts to meet federal air quality standards and reduce air pollution that harms public health.

While NOx emissions standards do exist at the federal and international level for new aircraft, these standards do not reflect the current state of technology. As a result, emissions from these categories have not decreased at the same pace as those for other mobile sources in California,[57] or at the pace needed to protect Californians. Achieving the magnitude of emission reductions necessary from this category requires strong federal action.[58]

While EPA must consider these technology developments for the next generation of NOx aircraft standard, it is also critical for the agency to consider

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[56] CARB, Revised 2016 State Strategy for the State Implementation Plan (March 7, 2017), available at https://ww3.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf.

[57] CARB, Mobile Source Strategy (May 2016), available at https://ww3.arb.ca.gov/planning/sip/ 2016sip/2016mobsrc.pdf.

[58] The other technologies and measures described in this supplemental comment generally would also reduce NOx and other criteria and hazardous air emissions from aircraft. FAA's CLEEN program also develops and demonstrates technologies and measures designed to achieve NOx reductions from landing and takeoff, along with reductions related to fuel efficiency. FAA, Continuous Lower Energy, Emissions, and Noise (CLEEN) Program, updated June 19, 2020, https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/.

measures that reduce both GHG and criteria emissions during the landing and take-off (cycle, as well as through the use of APUs. ICAO's metric value, used to establish its GHG standard for new aircraft, only takes into account the cruise performance and does not directly evaluate performance of other flight phases such as landing, takeoff, and climb. As with most other aspects of EPA's proposal, the agency proposed to adopt this ICAO policy without considering its merits or any alternatives. EPA should also consider strategies that improve the current air traffic operation and transition APUs toward zero-emission technologies.

Such strategies include:

- *De-Rated Take Off:* Aircraft are designed to take off safely without full thrust. By not applying full thrust during take-off, aircraft reduce emissions as well as the level of noise. A 2017 study by Koudis et al. has shown that using reduced thrust takeoff reduces fuel consumption, NOx, and black carbon emissions by 1.0 to 23.2 percent, 10.7 to 47.7 percent, and 49.0 to 71.7 percent, respectively, depending on aircraft-engine combinations relative to 100 percent thrust takeoff.[59] Additionally, a study by Electronic Navigation Research Institute of Japan has

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[59] G.S. Koudis *et al.,* "Airport emissions reductions from reduced thrust takeoff operations," *Transportation Research Part D: Transport and Environment*, 52, 15-28 (2017). *See also* M. King and I. Waitz, "Assessment of the Effects of Operational Procedures and Derated Thrust on American Airlines B777 Emissions from London's Heathrow and Gatwick Airports," Partner, Cambridge, MA (2005) (showing that each 1 percent of derate can approximately reduce NOx emissions by 0.7 percent below 3000 feet while slightly increasing the fuel burn).

indicated that reduced thrust near the top of the climb can result in fuel saving.[60] The engine derate can also extend engine life and reduce maintenance cost.[61]

- *Reduced Power during Taxiing:* Most commercial aircraft are equipped with two to four engines. Aircraft engines, even at idle or minimal power settings, are used to taxi the aircraft while on the ground. Because of this, taxi-in, idle and even taxi-out can be completed with one or more of those engines not operating. Shutting down an engine during the taxi-in, until the aircraft is in an advanced stage of the taxi-out for takeoff, has the potential to reduce emissions.[62]

- *Improved Taxi Time:* Minimizing taxi time, when the aircraft is taxi-in or taxi-out, reduces emissions. Such a control measure would require real-time optimization of air traffic with constant feedback from all associated airports.

- *Reduced Usage of APUs:* The typical aircraft APU is a small turbine engine that starts the aircraft main engines and powers the electrical systems on the aircraft when the main engines are off. Switching to the on-board rechargeable batteries as the power supply would reduce the usage of the gas turbine APU and hence emissions.

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[60] R. Mori, "Fuel-Saving Climb Procedure by Reduced Thrust near Top of Climb," *Journal of Aircraft* (2020), at 1-7.

[61] R. Donaldson *et al.,* "Economic Impact of Derated Climb on Large Commercial Engines," *Proceedings of the Performance and Flight Operations Engineering Conference* (2007).

[62] Sustainable Aviation, "Aircraft on the Ground CO_2 Reduction Programme," UK's Airport Operators Association.

These are a few of the strategies that EPA should consider for reducing near-ground GHG, criteria, and hazardous air pollutants.[63] These strategies, along with more stringent standards, would make major contributions to California and local air districts' ability to meet federal air quality standards and climate goals.

Such reductions could potentially be secured via work practice standards, flexible compliance mechanisms within a Clean Air Act standard, or collaborative work with the airlines and airports and other regulators. Moreover, such operational modes demonstrate that aircraft GHG emissions can be reduced in multiple ways, creating room for stringent but flexible standards. EPA must consider an emissions-per-flight (in addition to a per-kilometer) metric, which includes ground emissions and is set low enough to reflect all the potential reductions ground operation measures can achieve. The availability of these options highlights the unreasonableness of EPA's refusal to require any reductions at all. Indeed, given EPA's duties to both reduce GHGs and criteria pollutants, it is particularly arbitrary that EPA has neglected to consider measures that would fulfill both obligations.

e. EPA should consider limited use of offsets, to the extent allowed by statute.

[63] Congress has also recognized the potential for these measures to increase fuel efficiency and reduce emissions. The FAA Reauthorization Act of 2018 requires FAA, in coordination with NASA, to review and report to Congress on technologies and measures to increase aircraft fuel efficiency, including "the potential for novel flight pattern planning and communications systems to reduce aircraft taxiing and airport circling." FAA Reauthorization Act of 2018, Pub.L. 115-254, 115th Congress, 132 Stat. 3413, § 742. FAA does not appear to have completed its report. *See* https://www.faa.gov/about/plans_reports/congress/.

As explained above and in the Multistate Comment, EPA must establish a meaningful aircraft GHG standard based on existing and in-development technologies and measures for engines, aerodynamics, weight reduction, and SAFs. To the extent allowed by statute, EPA should additionally consider aligning standards for the aviation sector with the latest science by increasing ambition, while providing further flexibility for compliance and cost-containment, through the limited use of domestic offsets. The design of an offsets mechanism can allow for other sectors, such as the agricultural sector, to voluntarily take action to reduce GHGs, and be paid for those actions by the airlines that utilize offsets for compliance. The design of such a mechanism must ensure that the offsets are real, additional, permanent, verifiable, not double-counted, and developed with robust quantification methodologies.

There are existing programs where robust methodologies exist. Examples of quantification methodologies include the California Cap-and-Trade Program,[64] California Climate Investments,[65] and the U.S. Department of Agriculture's CarbOn Management Evaluation Tool (*COMET*).[66] The agricultural sector is just one area in which limited and high-quality offsets can create financial incentives to reduce GHGs.

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[64] CARB, Compliance Offset Program, https://ww2.arb.ca.gov/our-work/programs/compliance-offset-program.

[65] CARB, California Climate Investments, https://ww2.arb.ca.gov/our-work/programs/california-climate-investments.

[66] U.S. Dept. of Agriculture, COMET CarbOn Management Evaluation Tool, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/co/air/quality/?cid=nrcseprd605406.

II. EPA should regulate stages and categories of aircraft omitted from the ICAO standard.

The proposed rule would apply the proposed in-production standards only to airplanes built on or after January 1, 2028, along with in-production airplanes that have any modification that triggers the change criteria after January 1, 2023.[67] Incorporating the technologies and measures described above would make more stringent standards eminently achievable for both new type designs and in-production

aircraft.[68] Because aircraft have average service lives of 25 to 27 years,[69] EPA's failure to consider or propose requirements for in-service aircraft is a significant omission.

EPA should add requirements for in-service aircraft types. Without any need for retrofit, these could include drop-in SAFs and measures to reduce emissions from landing, takeoff, taxi, and idling, which could be bolstered by limited offsets to

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[67] 85 Fed. Reg. at 51,558.

[68] Similarly, EPA should strengthen the new type design rule by creating a more stringent emissions standard. However, "New type designs are infrequent, and it is not unusual for new type designs to take 8-10 years to develop, from preliminary design to entry into service." 85 Fed. Reg. at 51,566. With a more stringent standard, CARB also recommends EPA reassess the implementation timeline to give manufacturers adequate time to comply.

[69] U.S. Dept. of Transportation, Bureau of Transportation Statistics, Average Age of Aircraft 2019, available at https://www.bts.gov/average-age-aircraft-2019; D. Forsberg, "Aircraft Retirement And Storage Trends," Aviation Report (2015), available at https://aviation.report/Resources/Whitepapers/c7ca1e8f-fd11-4a96-9500-85609082abf7_whitepaper%201.pdf.

the extent allowed by law. Incorporating retrofits adds significant additional reduction opportunities. Retrofits generally achieve CO_2 metric value reductions of 3 to 5 percent via a combination of wingtip devices and engine performance improvement packages.[70] However, some retrofit wingtip devices alone can provide the emissions reductions associated with fuel savings of 4 to 6 percent, and an alternative design dubbed "spiroid winglets" reduces fuel consumption by over 10 percent.[71] Airframe retrofits, including wingtip devices, riblets (coatings or etchings that reduce drag), and lightweight cabin furnishings, reduce jet fuel burn by 6 to 12 percent.[72]

EPA excluded a variety of aircraft from the proposed standard, because ICAO excludes them.[73] These include small turboprop planes, small business jets, small piston engines, and helicopters, along with military equipment. As EPA acknowledges, these categories of aircraft comprise 11 percent of total U.S. aircraft GHG emissions.[74] Using TSD data regarding 2015 U.S.-operated flights, CARB calculated that roughly 22.4 percent of flights originating in the U.S. were excluded

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[70] Brandon Graver and Dan Rutherford, ICCT, "U.S. Passenger Jets Under ICAO's CO2 Standard, 2018-2038" (Oct. 2, 2018), available at https://theicct.org/sites/default/files/publications/Aircraft_CO2_Standard_US_20181002.pdf.
[71] NASA, "Winglets Save Billions of Dollars in Fuel Costs" (2010), https://spinoff.nasa.gov/Spinoff2010/t_5.html.
[72] IATA, Technology Roadmap for Environmental Improvement, Fact Sheet (Dec. 2019), available at https://www.iata.org/contentassets/8d19e716636a47c184e7221c77563c93/fact-sheet-technology-roadmap-environment.pdf.
[73] 85 Fed. Reg. at 51,565.
[74] *Id.* at 51,563.

from EPA's consideration.[75] While the proposal preamble notes, accurately, that EPA's 2016 endangerment finding for aircraft GHG emissions did not make a contribution finding for these aircraft,[76] the endangerment finding also states, "[T]his final action does not restrict the EPA's future discretion to address GHG emissions from aircraft that are not included in the scope of this finding, or prejudge how the Agency would respond to a petition to address those GHG emissions should one be submitted in the future."[77] While exceptions to the GHG standards for military aircraft and firefighting may be appropriate, EPA should consider appropriate standards for the remaining categories of smaller aircraft. Moreover, rather than categorically excluding aircraft based on potential use, EPA should consider exemptions based on actual use. For instance, helicopters may be used for aerial firefighting as well as other purposes, such as tourism or general transportation. These vehicles should be subject to emissions standards.

EPA should also consider additional regulatory designs and policy levers. For example, more stringent pass/fail phase-out for individual in-service aircraft would accelerate the retirement of non-compliant aircraft. The agency should consider a declining fleet average standard to increase potential reductions in aircraft GHG emissions each year. Such a standard could incorporate additional tiers to the pass/fail standards, which require an increased portion of a fleet's aircraft to meet more stringent emission reduction requirements over time.[78] If EPA incorporates an averaging, banking, and trading program into its standard, even using a portion of

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[75] Proposal TSD at 83.

[76] 85 Fed. Reg. at 51,562.

[77] 81 Fed. Reg. at 54,469.

[78] Dan Rutherford, ICCT, "Standards to Promote Airline Fuel Efficiency" (May 2020), available at https://theicct.org/sites/default/files/publications/Airline-fuel-efficiency-standard-2020.pdf.

these aircraft will reduce fleetwide emissions, with far more significant reductions than the proposed do-nothing standard.

III. EPA must consider and evaluate these technologies objectively.

As detailed in the Multistate Comment, EPA both proposed an explicitly "no cost-no benefit" standard and utterly abdicated its responsibility to consider regulatory options that would actually reduce emissions. If and when EPA fulfills its obligation to consider regulatory options that produce both costs and benefits, it must evaluate these options using objective and appropriate tools and metrics. This excludes use of the arbitrary "interim" domestic social cost of carbon values that EPA applied to this proposal,[79] like many other proposals and rules over the last three and-a-half years.[80] It also necessitates the application of discount rates that are appropriate to the intergenerational nature of climate impacts.

Beginning in 2009, the President's Council of Economic Advisors and the U.S. Office of Management and Budget (OMB) convened the Interagency Working Group

[79] Proposal TSD at 137 *et seq*.

[80] *See, e.g.,* CARB comments on Notices of Proposed rulemaking: "Safer Affordable Fuel-Efficient Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks," 83 Fed. Reg. 53,204 (Oct. 22, 2018), Docket ID No. EPA-HQ-OAR-2018-0283, submitted Oct. 26, 2018; "Affordable Clean Energy Rule," 83 Fed. Reg. 44,746 (Aug. 31, 2018), Docket ID No. EPA-HQ-OAR-2017-0355, submitted Oct. 31, 2018; "Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review," 84 Fed. Reg. 50,244 (Sept. 24, 2019), Docket ID No. EPA-HQ-OAR-2017-0757, submitted Nov. 25, 2019; "Increasing Consistency and Transparency in Considering Costs and Benefits in the Clean Air Act Rulemaking Process," 85 Fed. Reg. 35,612 (June 11, 2020), EPA–HQ–OAR–2020–00044, submitted August 3, 2020.

(IWG) on the Social Cost of GHGs (SC-GHGs) to develop a methodology for estimating the social cost of carbon and other GHGs. The IWG, comprised of scientific and economic experts, recommended the use of SC-GHG values based on models developed over decades of global peer-reviewed research.[81] These models and methodologies have been modified and updated since first being utilized, and represent the best available science in the field.

EPA's interim domestic SC-GHGs are a fraction of the IWG values – which well may be EPA's intent. But given the interconnectedness of the global economy and security, climatic damages outside U.S. borders have both direct and indirect domestic impacts.[82] These include impacts to U.S. citizens (including U.S. military service members) who live abroad and/or have significant investments abroad; potential impacts to trade flows and global commodity markets that affect the U.S. economy; impacts to U.S. military sites abroad; and other risks to national security

[81] *See* IWG, "Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide" (Aug. 2016), available at https://www.epa.gov/sites/production/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf.

[82] National Academies of Science, Engineering, and Medicine, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide (2017), available at http://www.nap.edu/24651, conclusion 2-4 ("It is important to consider what constitutes a domestic impact in the case of a global pollutant that could have international implications that impact the United States. More thoroughly estimating a domestic [social cost of carbon dioxide] would therefore need to consider the potential implications of climate impacts on, and actions by, other countries, which also have impacts on the United States.").

with significant potential costs.[83] As a federal court recently affirmed, a purported estimate of the domestic social costs of GHGs that omits these impacts on the U.S. violates the APA by "failing to consider … important aspect[s] of the problem" and "run[ning] counter to the evidence before the agency."[84]

Although Executive Order 13783 withdrew the IWG reports as no longer representative of federal governmental policy in March 2017,[85] "[T]he President did not alter by fiat what constitutes the best available science. The Executive Order in and of itself has no legal impact on the consensus that IWG's estimates constitute the best available science about monetizing the impacts of greenhouse gas emissions."[86] As a federal court recently admonished, "An agency simply cannot construct a model that confirms a preordained outcome while ignoring a model that reflects the best science available."[87]

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83 Public Law 115-91, Defense Authorization Act of 2018, December 12, 2017, 131 Stat. 1283, § 335.

84 *California v. Bernhardt,* No. 18-5712, —— F.Supp.3d ——, 2020 WL 4001480 (N.D. Cal. July 15, 2020) at *27, appeal pending, No. 20-16794 (filed Sept. 16, 2020), citing *Motor Vehicle Mfrs. Ass'n of U.S., Inc. v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983).

85 E.O. 13783, March 28, 2017, § 5(b).

86 *California v. Bernhardt* at *25, citing *State Farm*, 463 U.S. at 43.

87 *Id.* at *28, citing *Center for Biological Diversity v. NHTSA*, 538 F.3d 1172, 1198-1201 (9th Cir. 2008) (agency "cannot put a thumb on the scale by undervaluing the benefits and overvaluing the costs of more stringent standards" by failing to "monetize or quantify the value of carbon emissions reduction"); *Zero Zone, Inc. v. United States Dep't of Energy*, 832 F.3d 654, 677-79 (7th Cir. 2016) (agency reasonably relied on IWG's estimates to calculate global benefits of greenhouse gas reductions from energy efficiency rules).

Moreover, a variety of experts, including the National Academies of Sciences, have concluded that no appropriate domestic-only social cost of GHGs estimate exists.[88] A recent U.S. Government Accountability Office report affirms that EPA's domestic SC-GHGs does not account for the best available science, in violation of Executive Orders 12688 and 13783, and OMB Circular A-4, which EPA identifies as justification for its interim domestic values.[89] Because updated IWG reports continue to be the best available science, and no appropriate, peer-reviewed domestic-only social cost of GHGs exists, use of domestic-only social cost of GHG values is arbitrary and capricious.[90]

Furthermore, the TSD incorporates only discount rates of 3 and 7 percent, which it asserts, incorrectly, complies with OMB Circular A-4.[91] Circular A-4 suggests

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[88] National Academies of Science, Engineering, and Medicine, Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide, 2017, at 12, available at http://www.nap.edu/24651; *California v. Bernhardt* at *27 (noting that "focusing solely on domestic effects has been soundly rejected by economists as improper and unsupported by science.").

[89] U.S. Government Accountability Office, "Social Cost of Carbon: Identifying a Federal Entity to Address the National Academies' Recommendations Could Strengthen Regulatory Analysis," GAO-20-254 (June 2020), at 29 ("The rulemakings we reviewed used the current federal estimates, which were based on EPA's interim estimates; therefore, the federal government may not be well positioned to ensure agencies' future regulatory analyses are using the best available science until the agencies finalize federal estimates that consider the National Academies' implemented recommendations.").

[90] *California v. Bernhardt* at *28.

[91] Proposal TSD at 140. The TSD appends an alternate cost-benefit analysis using a different SC-GHGs that purports to incorporate global effects, inadequately, with a 2.5 percent discount rate. Proposal TSD at 147-154.

that utilizing discount rates of 3 and 7 percent is likely appropriate, at minimum and in general. However, regarding costs and benefits that arise across generations—the type of intergenerational discounting at play in analysis and consideration of climate impacts—Circular A-4 suggests that discount rates ranging from 1 to 3 percent are more appropriate.[92] Other experts also reject a 7 percent approach, with IWG recommending discount rates of 2.5, 3, and 5 percent,[93] and surveyed experts almost-unanimously recommending a long-term social discount rate between 1 and 3 percent.[94] Like the interim domestic SC-GHGs, EPA's inappropriate discount rates undermine the agency's valuation of GHG reductions.

IV. EPA should require more robust reporting.

EPA should require the proposed data reporting, and should expand its proposed reporting requirements to include the criteria and toxic pollutants emitted by aircraft during cruise cycle. Additionally, the proposed rule omits data reporting from smaller aircraft such as subsonic jets with maximum takeoff mass (MTOM)

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[92] OMB Circular A-4 (Sept. 2003).

[93] IWG, "Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide" (Aug. 2016), available at https://www.epa.gov/sites/production/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf.

[94] In a recent peer-reviewed report, researchers surveyed 197 experts on the long-term social discount rates. While there was much variation, the median preferred social discount rate is 2 percent, and 92 percent of experts surveyed prefer a social discount rate between 1 and 3 percent. Moritz Drupp *et al.*, "Discounting Disentangled," *American Economic Journal: Economic Policy*, 10 (4): 109-34 (2018), available at https://www.aeaweb.org/articles?id=10.1257/pol.20160240&&from=f.

below 5,700 kg and subsonic propeller-driven aircraft with MTOM below 8,618 kg. Considering that these smaller aircraft contribute to about 11 percent of industry GHGs emissions,[95] EPA should consider including data reporting requirements for these aircrafts as well.

The proposed rulemaking indicates that the EPA does not expect a full dataset on all in-production airplanes until after the in-production applicability date of January 1, 2028.[96] EPA should consider an earlier reporting requirement for in-production airplanes, as the information would be essential to support emissions inventory development, technology assessment, and policy development. Similarly, EPA should consider requiring reporting for in-service aircraft. The reported data should be made available to other government agencies and the general public as well.

V. Conclusion.

To meet its legal obligations and adequately protect public health and welfare, EPA must incorporate the technologies and procedures identified in this supplemental comment into its aircraft GHG emissions standard. In its proposed rule, EPA has ostensibly prioritized industry competitiveness by proposing to codify ICAO's do-nothing standard.[97] Yet a robust standard would significantly benefit the industry as well. Airbus notes that the success of its hydrogen-fueled commercial aircraft will depend on airlines' incentive to retire older, dirtier aircraft, and calls on

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[95] 85 Fed. Reg. at 51,563.

[96] *Id. at* 51,576-77.

[97] Proposal TSD at 118.

governments to create this incentive.[98] ICCT concludes that "fuel consumption of new aircraft designs can be reduced by approximately 25% in 2024 and 40% in 2034 compared with today's aircraft by deploying emerging cost-effective technologies, providing net savings to operators over a seven-year time frame."[99] These fuel savings could make airlines both more profitable and more competitive, as ICCT found that "airlines could reduce their fuel spending over the 2025 to 2050 time frame by 19% compared with the baseline case," which, if passed on to consumers, could "lower ticket prices by up to $20 for short-haul flights and $105 for long-haul flights."[100]

EPA's meager rationale for refusing to substantively regulate aircraft GHG emissions thus falls flat. EPA must withdraw its worse than business-as-usual proposal and propose an aircraft GHG standard that would meaningfully reduce emissions, as the law and the climate crisis demand.

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[98] Charlotte Ryan, "Airbus unveils hydrogen designs for zero-emission flight," *Energywire* (Sept. 22, 2020), https://www.eenews.net/energywire/stories/1063714307.
[99] Anastasia Kharina and Daniel Rutherford, ICCT, "Cost Assessment of Near and Mid-term Technologies to Improve New Aircraft Fuel Efficiency" (2016), at 35, available at https://theicct.org/sites/default/files/publications/ICCT%20aircraft%20fuel%20efficiency%20cost%20assessment_final_09272016.pdf.
[100] *Ibid.*

Sincerely,

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