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Federal Aviation Administration (FAA) Reauthorization Issues for the 118th Congress

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Federal Aviation Administration (FAA) reauthorization refers to a periodic process through which Congress develops legislation to renew authorizing statutes as well as revise and update relevant laws governing civil aviation programs and functions primarily carried out by the FAA. In addition to funding and operations of the FAA, some aviation programs administered by other components of the Department of Transportation (DOT) are also considered in the context of FAA reauthorization.

The last multiyear FAA reauthorization measure, the FAA Reauthorization Act of 2018 (P.L. 115-254), was enacted in October 2018. It extended civil aviation taxes and fees and FAA program funding authorities through the end of FY2023. Key civil aviation authorizations, including Airport and Airway Trust Fund (AATF) revenue collections and certain FAA expenditure authorities, will thus expire at the end of FY2023, prompting an FAA reauthorization process to develop and debate authorizing legislation, which has begun during the first session of the 118th Congress.

Congress established the AATF in the Airport and Airway Revenue Act of 1970 (P.L. 91-258) to provide a dedicated source of federal funding for the aviation system in the United States. Since then, the AATF has been the primary funding source for all FAA major accounts that fund federal aviation programs, with the remainder coming from general fund appropriations. Both the authority to collect aviation excise taxes and the authority to spend from the trust fund must be reauthorized periodically by Congress. Besides AATF revenue collections, which cannot continue without reauthorization, grant expenditure authority for federal support of airport improvement projects must also be reauthorized to prevent a halt in airport infrastructure projects.

In addition to authorizing revenue collections and setting spending levels, FAA reauthorization acts typically set policy and establish various statutory requirements pertaining to a broad array of pertinent civil aviation issues, including

- airport development and financing;
- FAA management and organizational issues, including FAA workforce hiring, retention, and training;
- air navigation services and air traffic control modernization;
- the integration of drones, commercial space activities, and new technologies into the national airspace system;
- aviation safety, including potential expansion of requirements to implement safety management across the aviation industry;
- airline industry issues, including air service to small communities and airline consumer service;
- the commercial aviation workforce, including the future supply of airline pilots and aviation maintenance workers; and
- aviation and the environment, including initiatives to reduce aircraft noise and emissions and dependence on fossil fuels.

SUMMARY

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The last multiyear FAA reauthorization measure, the FAA Reauthorization Act of 2018 (P.L. 115-254, also referred to hereinafter as the 2018 FAA reauthorization act), was enacted in October 2018 and extended most FAA revenue collection and program funding authorities, including federal grant expenditure authority for airport projects, through the end of FY2023. As a result, Congress would need to enact legislation to reauthorize or extend these authorities before September 30, 2023.

The Airport and Airway Trust Fund[1]

Congress established the Airport and Airway Trust Fund (AATF) in the Airport and Airway Revenue Act of 1970 (Title II of P.L. 91-258) to provide a dedicated source of federal funding for the aviation system in the United States. Since then, the AATF has been the primary funding source for all major FAA accounts that fund federal aviation programs, with the remainder coming from general fund appropriations. Both the authority to collect aviation excise taxes and to spend from the trust fund must be periodically reauthorized by Congress. Temporary suspension of tax collections also needs congressional authorization, such as the suspension of aviation excise taxes in late March 2020 through the end of calendar year 2020, as authorized by Section 4007 of the CARES Act (P.L. 116-136).

AATF revenue comes from a variety of excise taxes paid by users of the national airspace system, which includes airline ticket taxes, segment fees, air cargo fees, and fuel taxes paid by commercial airline passengers and general aviation aircraft operators (see **Table 1**). The trust fund also accrues interest on its cash balance.

In addition to excise taxes deposited into the trust fund, the FAA imposes air traffic service fees on flights that transit U.S.-controlled airspace but do not take off from or land in the United States. These overflight fees partially fund the Essential Air Service program.[2]

Most FAA spending, including most spending from the AATF, requires annual appropriations by Congress. Approximately 20% of the FAA's total funds are disbursed as contract authority for the Airport Improvement Program (AIP) and may be committed prior to annual appropriations.[3] The rest may be spent only with a congressional appropriation.

[1] See CRS Report R44749, *The Airport and Airway Trust Fund (AATF): An Overview*, by Rachel Y. Tang and Bart Elias.

[2] See CRS Report R44176, *Essential Air Service (EAS)*, by Rachel Y. Tang.

[3] Contract authority is a type of budget authority that allows the federal government to incur an obligation in advance of an appropriation. Liquidating authority is needed eventually to pay off the obligations incurred using contract authority. The annual obligation limitation is analogous to an appropriation. In effect, limitations of obligations restrict the amount of contract authority that may be committed under the Airport Improvement Program (AIP).

Table 1. Aviation Taxes and Fees

(CY2023 rates)

Tax or Fee	Rate
Passenger ticket tax (on domestic ticket purchases and frequent flyer awards)	7.5%
Flight segment tax (domestic, indexed annually to Consumer Price Index)	$4.80
Cargo waybill tax	6.25%
Frequent flyer tax	7.5%
General aviation gasoline[a]	19.3 cents/gallon
General aviation jet fuel[a] (kerosene)	21.8 cents/gallon
Commercial jet fuel[a] (kerosene)	4.3 cents/gallon
International departure/arrivals tax (indexed annually to Consumer Price Index) (prorated Alaska/Hawaii to/from mainland United States)	$21.10 (Alaska/Hawaii = $10.60)
Fractional ownership surtax on general aviation jet fuel	14.1 cents/gallon

Source: CRS update using tax rates published in Internal Revenue Service, 26 C.F.R. §601.602: Tax forms and instructions, Rev. Proc. 2022-38.

a. Fuel tax rates do not include 0.1 cents/gallon for the Leaking Underground Storage Tank (LUST) trust fund.

Trust fund revenue can be volatile, as external factors affect demand for air travel. For example, when the terrorist attacks of September 11, 2001, substantially reduced demand for air travel, trust fund revenues plummeted. The Coronavirus Disease 2019 (COVID-19) pandemic had a similar negative effect. The decline in air travel and the suspended aviation tax collection through calendar year 2020 resulted in a sharp decline in FY2020 trust fund revenue to about $8 billion, nearly a 47% decrease from the $15 billion collected in FY2019.[4]

The aviation trust fund appears to have bounced back from the pandemic-related decreases and is likely to have additional funds to support extra airport capital investment, as projected by the Congressional Budget Office (CBO) in February 2023 (**Table 2**).

CBO's May 2023 projections show the trust fund would have over $17 billion in excise tax revenues in FY2023, with an end-of-year cash balance of over $13 billion. At the end of FY2022, the AATF uncommitted balance was down to $229 million, but it is projected to recover to $831 million by the end of FY2023 and further grow to over $13 billion in the next five years.

The financial vitality of the trust fund can be evaluated by looking at its uncommitted balance and the cash balance, but there are considerable differences between the two indicators. The FAA considers the committed balance of the trust fund to include the appropriated amounts from the trust fund plus obligated AIP contract authority for the year. The uncommitted balance, which is the revenue that would remain in the trust fund after subtracting the committed balance, is often used to evaluate the FAA's ability to enter into future commitments as provided in authorization and appropriations acts.

With a projected end-of-year FY2028 uncommitted balance of $13 billion, Congress would have around $10 billion above projected baseline spending available for civil aviation spending and still be able to maintain an uncommitted balance of several billion dollars.

[4] Congressional Budget Office (CBO), "Budget and Economic Data: 10-year Trust Fund Projections," at https://www.cbo.gov/data/budget-economic-data.

Table 2. Airport and Airway Trust Fund Baseline Projections

(dollars in millions)

	FY2023	FY2024	FY2025	FY2026	FY2027	FY2028
Cash Balances[a]						
Start-of-Year Balance	12,337	13,013	14,789	16,916	19,296	21,941
Excise Tax Revenues	17,245	18,853	19,690	20,483	21,270	22,047
Interest	256	395	437	419	441	501
Outlays	16,825	17,472	18,000	18,522	19,066	19,588
End-of-Year Balance	13,013	14,789	16,916	19,296	21,941	24,901
Uncommitted Balances						
Start-of-Year Balance	229	831	2,561	4,698	7,135	9,900
Change in Balance[b]	602	1,730	2,137	2,437	2,765	3,112
End-of-Year Balance	831	2,561	4,698	7,135	9,900	13,012

Source: Congressional Budget Office, Baseline Projections: Airport and Airway Trust Fund, May 2023.

Notes:

a. Trust fund cash balance amounts exclude the effects of general fund appropriations for the Airport Improvement Program.

b. The change in uncommitted balances equals excise tax revenues plus transfers and interest minus total spending authority.

Federal Aviation Administration Funding

FAA funding is divided among four major accounts. Operations and Maintenance (O&M) receives approximately 60% of total FAA appropriations. The O&M account, funded by the trust fund as well as by general fund contributions, principally funds air traffic operations and aviation safety programs. The AIP provides federal grants-in-aid for projects such as new runways and taxiways; runway lengthening, rehabilitation, and repair; and noise mitigation near airports. The Facilities and Equipment (F&E) account provides funding for the acquisition and maintenance of air traffic facilities and equipment and for engineering, development, testing, and evaluation of technologies related to the federal air traffic system. The Research, Engineering, and Development account finances research on improving aviation safety and operational efficiency and reducing environmental impacts of aviation operations.

Authorized levels and actual funding for these accounts are shown in **Table 3**. Aside from the annual funding for FAA accounts Congress addressed the financial impact of the pandemic in three separate laws in 2020 and 2021 that appropriated a total of $20 billion from the general fund to eligible U.S. airports as COVID-19 relief measures.[5] These funds were not included in funding

[5] The Coronavirus Aid, Relief, and Economic Security Act (CARES Act; P.L. 116-136, enacted on March 27, 2020), which provided $10 billion as economic relief to eligible airports affected by the COVID-19 pandemic; the Consolidated Appropriations Act, 2021 (P.L. 116-260, enacted on December 27, 2020), which provided $2 billion in economic relief to eligible U.S. airports, including $200 million to operators of eligible airport concessions, such as on-airport parking and car rental as well as in-terminal concessions; and the American Rescue Plan Act of 2021 (P.L. 117-
(continued...)

for the four major accounts in **Table 3**, as they were not part of the FAA reauthorization or annual FAA appropriations.

Table 3. Funding Levels for Major FAA Accounts

(dollars in millions)

Account	FY2018	FY2019	FY2020	FY2021	FY2022	FY2023
Operations and Maintenance (O&M)						
Authorized Levels	10,247	10,486	10,732	11,000	11,269	11,537
Actual/Enacted Levels	10,212	10,411	10,630	11,002	11,414	11,915
Airport Improvement Program (AIP)						
Authorized Levels	3,350	3,350	3,350	3,350	3,350	3,350
Additional General Fund Authorization		1,020	1,041	1,064	1,087	1,110
Actual/Enacted Levels	4,350	3,850	3,750	3,750	3,904	3,909
Facilities and Equipment (F&E)						
Authorized Levels	3,330	3,398	3,469	3,547	3,624	3,701
Actual/Enacted Levels	3,250	3,000	3,045	3,015	2,893	2,945
Research, Engineering, and Development (RE&D)						
Authorized Levels	189	194	199	204	209	214
Actual/Enacted Levels	189	191	193	198	249	255
Totals						
Authorized Levels	17,116	18,448	18,791	19,165	19,539	19,912
Actual/Enacted Levels	18,000	17,452	17,618	17,965	18,460	19,024

Sources: FAA Reauthorization Act of 2018 **(**P.L. 115-254); Federal Aviation Administration (FAA), "Airport and Airway Trust Fund (AATF) Fact Sheet," July 2022; FAA FY2024 Budget Estimates.

Furthermore, the Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58), enacted on November 15, 2021, appropriated $25 billion from the general fund over a five-year period (FY2022-FY2026) for airport and air traffic control projects. This aviation funding includes $15 billion in grants for airport infrastructure projects that increase safety and expand capacity; $5 billion in competitive grants for airport terminals, including replacing aging terminals and airport-owned control towers; and $5 billion to improve the physical condition of FAA air traffic control facilities. The IIJA provides money for aviation projects that previously were not eligible to receive federal funding (e.g., airport terminal projects that have previously been financed with airports' own funds); this funding did not fall under the existing major FAA accounts, so it was not included in the major accounts' funding levels.

These significant general fund injections, though not permanent, depart from the usual practice of funding civil aviation infrastructure in the United States largely from user taxes and fees. Lawmakers may face decisions related to whether the civil aviation infrastructure and programs

2, enacted on March 11, 2021), which provided $8 billion for eligible airports to cover costs of operations, personnel, and cleaning, including a set-aside for rent relief and other costs of airport concessionaires.

are to be funded predominantly by the trust fund, or if they are also to rely on short-term additions appropriated from the general fund, such as with IIJA funding.

Airport Development and Financing[6]

The federal government supports the development of airport infrastructure in three ways:

1. the AIP provides federal grants to airports for planning and development, mainly of capital projects related to aircraft operations such as runways and taxiways;
2. Congress has authorized airports to assess a local passenger facility charge (PFC) on each boarding passenger, subject to specific federal approval (PFC revenues can be used for a broader range of projects than AIP funds, including landside projects, such as passenger terminals and ground access improvements); and
3. preferential income tax treatment for investors on interest income from bonds issued by state and local governments for airport improvements (subject to compliance with federal rules).

Airports may also draw on state and local funds and on operating revenues, such as lease payments and landing fees.

Different airports use different combinations of AIP funding, PFCs, tax-exempt bonds, state and local grants, and airport revenues to finance particular projects. Small airports are more likely to be dependent on AIP grants than large or medium-sized airports. Large airports are more likely to issue tax-exempt bonds or finance capital projects with the proceeds of PFCs. Each of these funding sources places various legislative, regulatory, or contractual constraints on the airports that use it. The availability and conditions of one source of funding may also influence the availability and terms of other funding sources.

Airport Improvement Program

The AIP provides federal grants to airports for airport development and planning. Participants range from large, publicly owned commercial airports to small, general aviation airports that may be privately owned but are available for public use.[7] AIP funding is usually limited to construction of improvements related to aircraft operations, such as runways and taxiways (also known as airside projects). Landside projects, including commercial revenue-producing facilities such as parking facilities generally are not eligible for AIP, nor are operating costs.[8] The structure of AIP funds distribution reflects congressional priorities and the objectives of assuring airport safety and security, increasing capacity, reducing congestion, helping fund noise and environmental mitigation, and financing small state and community airports.

The main financial advantage of the AIP to airports is that as a grant program, it can provide funds for capital projects without the financial burden of debt financing, although airports are required to provide a relatively modest local match to the federal funds. Limitations on the use of

[6] See CRS Report R43327, *Financing Airport Improvements*, by Rachel Y. Tang.

[7] General aviation airports do not serve military (with a few Air National Guard exceptions) or scheduled commercial service aircraft but typically do support one or more of the following: business/corporate, personal, instructional flying; agricultural spraying; air ambulances; on-demand air taxies; charter aircraft.

[8] For detailed guidance on allowable costs under the AIP, see Chapter 3 of FAA, *Airport Improvement Program Handbook*, at http://www.faa.gov/airports/resources/publications/orders/media/aip_5100_38c.pdf.

AIP grants include the range of projects that the AIP can fund and the requirement that recipients adhere to all program regulations and grant assurances.

Federal law requires the Secretary of Transportation to publish a national plan for the development of public-use airports in the United States. This appears as a biannual FAA publication called the *National Plan of Integrated Airport Systems (NPIAS)*.[9] For an airport to receive AIP funds, it must be listed in the NPIAS.

The Federal Share of Airport Improvement Program Matching Funds

For AIP-funded projects, the federal government share differs depending on the type of airport.[10] The federal share is generally 75% for large and medium airports and 90% for other airports, with some exceptions. Certain economically distressed communities receiving subsidized air service may be eligible for up to a 95% federal share of project costs. This cost-share structure means that smaller airports pay a lower share of AIP-funded project costs than larger airports.[11]

Funding Distribution

The distribution system for AIP grants is complex. It is based on a combination of formula grants (also referred to as apportionments or entitlements) and discretionary funds.[12] Each year, the entitlements are first apportioned by formula to specific airports or types of airports. Once the entitlements are satisfied, the remaining funds are defined as discretionary funds. Airports apply for discretionary funds for projects in their airport master plans. Formula grants and discretionary funds are not mutually exclusive in the sense that airports receiving formula funds may also apply for and receive discretionary funds. Grants generally are awarded directly to airports.

Policy Issues

The airport improvement questions Congress generally faces in the context of FAA reauthorization include the following:

- Should airport development funding be increased or decreased? How might significant multiyear general fund appropriations, such as IIJA, fit into the overall airport development and finance in the long run?
- Could the AIP be restructured to address congestion and capacity at the busiest U.S. airports, or should a large share of AIP resources continue to go to noncommercial airports that lack other sources of funding?
- Should Congress consider setting tighter limits on the purposes for which AIP and PFC funds may be spent?

[9] According to the Federal Aviation Administration (FAA), 3,287 of the 19,853 airports in the United States are listed in the National Plan of Integrated Airport Systems (NPIAS) report, 2023-2027, at https://www.faa.gov/airports/planning_capacity/npias/current.

[10] The federal government's share of project costs is statutorily defined in 49 U.S.C. §47109.

[11] Higher federal shares are available to airports in states with large amounts of federal land; see 49 U.S.C. §47109(b).

[12] See 49 U.S.C. Chapter 471; and FAA, *Airport Improvement Program Handbook*, at http://www.faa.gov/airports/resources/publications/orders/media/aip_5100_38D.pdf.

Airport Resilience and Sustainability Programs

Airport planning and projects related to resilience and sustainability concerns, including emission reduction efforts and energy efficiency and reliability projects, are eligible for federal funding from AIP discretionary funds. Eligible projects under these programs include the following:[13]

- Voluntary Airport Low Emissions (VALE):[14] gate electrification, charging stations for electrical ground support vehicles, geothermal systems, low-emission vehicles, and solar hot water systems.
- Zero Emission Vehicle (ZEV):[15] replacement or conversion of on-road vehicles for zero-emission vehicles.
- Sustainability Planning:[16] development of sustainability plans that address environmental and energy planning involving recycling, energy efficiency, renewable energy, water quality, and climate resiliency.[17]
- Energy Efficiency Program:[18] energy assessments for heating and cooling, base load, backup power, and power for on-road vehicles and ground support equipment. Typical projects include LED lighting, renewable energy systems, and HVAC upgrades.

The FAA also provides discretionary funds for its airport energy supply, redundancy, and microgrids program. This airport program targets improving reliability and efficiency of the power supply, preventing power disruptions, acquiring and installing electrical generators, separating the main power supply, and constructing or modifying facilities to install microgrids.

Aside from AIP funds, IIJA funds are available for eligible sustainability planning and aviation projects:

- $15 billion ($3 billion per year for five years) in airport infrastructure funding can be used for runways, taxiways, safety and sustainability projects, as well as terminal, airport-transit connections, and roadway projects;
- $5 billion ($1 billion per year for five years) in competitive grants for airport terminal development projects may fund safe, sustainable, and accessible airport terminals, as well as on-airport rail access projects and airport-owned airport traffic control towers (projects may also include multimodal development); and
- $5 billion ($1 billion per year for five years) to update and improve the physical condition of FAA air traffic control facilities.

The FAA announced on April 20, 2023, that it had selected a sustainable design for new air traffic control towers that will be used primarily at municipal and smaller airports. The design

[13] For additional information of these programs and eligibility requirements at AIP eligible airports, see FAA, "FY2022 Competitive Funding Opportunity: Airport Improvement Program Supplemental Discretionary Grants," 87 *Federal Register* 80248, December 29, 2022, at https://www.govinfo.gov/content/pkg/FR-2022-12-29/pdf/2022-28285.pdf.

[14] FAA, "Voluntary Airport Low Emissions Program (VALE)," at https://www.faa.gov/airports/environmental/vale.

[15] FAA, "Airport Zero Emissions Vehicle and Infrastructure Pilot Program," at https://www.faa.gov/airports/environmental/zero_emissions_vehicles.

[16] FAA, "Airport Sustainability," at https://www.faa.gov/airports/environmental/sustainability.

[17] FAA is conducting research to provide airports guidance and assistance on improving airport resilience to climate change and severe weather. For more information, see https://www.faa.gov/sites/faa.gov/files/2022-09/Airport_Resilience_Factsheet_2022_09.pdf.

[18] See Chapter 6, §7 of the *Airport Improvement Program Handbook* at https://www.faa.gov/airports/aip/aip_handbook/.

incorporates some sustainability elements, such as all-electric building systems and thermally efficient facades.[19]

Passenger Facility Charges

The Aviation Safety and Capacity Expansion Act of 1990 allowed the Secretary of Transportation to authorize public agencies that control commercial airports to impose a PFC on each paying passenger boarding an aircraft at their airports to supplement their AIP grants.[20] The PFC is a state, local, or port authority fee and is not deposited into the U.S. Treasury.[21]

To impose a PFC above $3, an airport has to show that the funded projects will make significant improvements in air safety, increase competition, or reduce congestion or noise impacts on communities and that these projects could not be fully funded by AIP funds. Unlike AIP grants that fund airside projects, PFC funds may be used to pay for a broader range of "capacity enhancing" projects, including for landside projects such as terminals and transit systems on airport property and for interest payments servicing debt incurred to carry out projects.[22]

Large and medium hub airports imposing PFCs above the $3 level forgo 75% of their AIP formula funds. Because of the complementary relationship between the AIP and PFCs, PFC provisions are generally folded into FAA reauthorization legislation dealing with the AIP. Initially, there was a $3 cap on each airport's PFC and a $12 limit on the total PFCs that a passenger could be charged per round trip. The Wendell H. Ford Aviation Investment and Reform Act for the 21st Century of 2000 (P.L. 106-181) raised the PFC ceiling to $4.50, with an $18 limit on the total PFCs that a passenger can be charged per round trip.

According to FAA statistics, as of March 2023, 360 airports collect PFCs among which 350 airports charge at the maximum rate of $4.50. PFC collections in 2022 were over $3.32 billion, about the same as the authorized level of AIP funding. [23]

The central legislative issue related to PFCs remains whether to raise or eliminate the $4.50 per enplaned passenger ceiling. In general, airports complain about the diminishing purchase power of PFCs and argue for increasing or eliminating the ceiling, whereas most air carriers and some passenger advocates oppose a higher PFC ceiling.

The permissible uses of revenues are another ongoing point of contention. Airport operators, in particular, would like more freedom to use PFC funds for off-airport projects, such as transportation access projects, and want the process of obtaining FAA approval to impose PFCs to be streamlined. Carriers, on the other hand, often complain that airports tend to use PFC funds to finance lower-priority projects that may not offer meaningful safety or capacity enhancements. The major air carriers are also unhappy with their limited influence over project decisions, as

[19] FAA, "FAA Selects Sustainable Design for New Control Towers at Municipal, Smaller Airports," at https://www.faa.gov/newsroom/faa-selects-sustainable-design-new-control-towers-municipal-smaller-airports.

[20] P.L. 101-508, Omnibus Budget Reconciliation Act of 1990, Title IX.

[21] Air carriers collect the passenger facility charges (PFCs) for airports and are paid a small administrative fee.

[22] 49 U.S.C. §40117.

[23] FAA, "Key Passenger Facility Charge Statistics as of March 31, 2023," at https://www.faa.gov/airports/pfc/monthlyreports/key-passenger-facility-charge-statistics-31-march-2023.

airports are required, by PFC program guidance and procedures,[24] to consult with resident air carriers but do not need to get their agreement on PFC-funded projects.[25]

FAA Management and Organizational Issues

The FAA is a large organization with a staff of about 44,000. More than 31,000 of these employees are in the Air Traffic Organization (ATO), including approximately 14,500 air traffic controllers, 5,000 air traffic supervisors and managers, and 7,800 engineers and maintenance technicians. The ATO was established under Executive Order 13180 (December 7, 2000) as a functional unit within the FAA but with a completely separate management and organizational structure and a mandate to employ a business-like approach emphasizing defined performance goals and metrics related to operational safety and system efficiency. Separate from the ATO, about 7,200 aviation safety inspectors and other staff comprise the Office of Aviation Safety (AVS), which has primary responsibility for the FAA's safety regulatory and oversight functions. Together, the ATO and AVS comprise the large majority of the FAA workforce. Additionally, other FAA personnel administer contracts and agreements for FAA facilities and equipment, manage the AIP grant program, and are involved in civil aviation research, engineering, and development activities to support the FAA's operational and safety functions. Key organizational issues for FAA center on the selection, retention, training, and job resources to support its highly skilled workforce of controllers, engineers, technicians, and aviation safety inspectors.

Air Traffic Controller Staffing

The FAA is presently facing a shortage of fully qualified controllers. The FAA reduced its air traffic controller hiring during the COVID-19 pandemic in response to the significant drop in air traffic volumes.[26] Subsequently, the FAA accelerated air traffic controller hiring and training to address air traffic activity that rebounded more quickly than forecast. While the FAA hired about 500 new controllers in FY2021 compared with 920 in FY2020, it increased the number of newly hired controllers to just over 1,000 in FY2022. In FY2023, the FAA plans to hire and train about 1,500 controllers, and it has requested funds to hire and provide initial training to about 1,800 new controllers in FY2024.[27] Although the FAA is hiring more controllers and has developed a plan to address a backlog in initial and on-the-job training, the lengthy process to fully certify controllers presents near-term challenges at some air traffic facilities. The issue is most prevalent at larger, more complex facilities with lengthy on-the-job training requirements.

The New York City area Terminal Radar Approach Control (TRACON) facility, in particular, currently does not have sufficient numbers of fully certified air traffic controllers, known as Certified Professional Controllers (CPCs) by FAA standards. Controllers do not attain CPC status until they demonstrate operational proficiency at all positions within a facility. For large facilities with a large number of positions and complex airspace and air traffic patterns, such as the New

[24] See FAA Order 5500.1, *Passenger Facility Charge*, at https://www.faa.gov/regulations_policies/orders_notices/index.cfm/go/document.information/documentID/12947.

[25] Airlines for America, "A4A Statement for the Record Opposing Airport Tax Hikes on Travelers," March 26, 2019, at https://www.airlines.org/news/a4a-statement-for-the-record-opposing-airport-tax-hikes-on-travelers/; Travel Weekly, "PFC redux: Airport and airlines lobbyists resume the fight," March 26, 2019, at https://www.travelweekly.com/Travel-News/Airline-News/PFC-redux.

[26] FAA, *The Air Traffic Controller Workforce Plan, 2023-2032,* at https://www.faa.gov/about/office_org/headquarters_offices/afn/offices/finance/offices/office-financial-labor-analysis/plans/controller-workforce.

[27] Ibid.; U.S. Department of Transportation, *Budget Estimates, Fiscal Year 2024, Federal Aviation Administration*, at https://www.transportation.gov/sites/dot.gov/files/2023-03/FAA_FY_2024_President_Budget_508.pdf.

York TRACON, the on-the-job training process to attain CPC qualification is lengthy. Controllers in this on-the-job training phase are known as "developmentals." The FAA strives to keep the percentage of developmentals at or below 35%; system wide, it currently stands at 21%-22%.[28] However, the FAA has reported that developmentals make up about 46% of the controller workforce at the New York TRACON.[29] The FAA warns that this situation will reduce efficiency and result in delays.[30] Backlogs in hiring and training due to the COVID-19 pandemic have exacerbated this situation, according to the FAA.

One stopgap measure to address this situation is that the FAA offers incentives to controllers to relocate to facilities with acute staffing needs. The FAA has frequently used such incentives to address staffing needs in understaffed air traffic facilities. However, transferring CPCs would need to familiarize themselves with all the positions in the facility they transfer into and are considered "in training" (CPC-IT) until they do so (although they usually can complete this training phase faster than developmentals). The FAA has issued a notice relaxing requirements for airlines to utilize their slot allocations at the New York area airports and at Washington Reagan National Airport during the summer months of 2023, in hopes that airlines will reduce schedules at these locations to avoid delays.[31] However, airlines are forecasting high travel demand for the summer of 2023, which may make it unlikely that they would voluntarily reduce schedules and may instead increase flight operations, potentially placing additional strain on air traffic control operations at New York and Washington area facilities.

The FAA Extension, Safety, and Security Act of 2016 (P.L. 114-190) required the FAA to give hiring preference to veterans with aviation experience, applicants with prior experience at Department of Defense (DOD) air traffic facilities, and graduates of controller training programs endorsed by the FAA under its Collegiate Training Initiative (CTI). Provisions in the National Defense Authorization Act for Fiscal Year 2020 (P.L. 116-92) modified these requirements to broaden the criteria for eligibility for additional applicants with military backgrounds. It also required the FAA to track applicants given hiring preference separately from applicants that respond to public announcements for air traffic controller jobs and to assess attrition rates for both groups and the costs to hire and train air traffic controllers. Initial findings from 2020 found that both preferred applicants and applicants selected from broad hiring announcements had high success rates for completing basic training at the FAA Academy and similar attrition rates of around 2%.[32] In 2021, while attrition rates remained similar for both groups, they increased considerably to about 20%.[33] The FAA did not provide analysis or explanation for the increase, but that level of attrition could present challenges for maintaining future air traffic controller staffing levels. According to the FAA, the per student cost for the air traffic basics training at the FAA Academy is about $7,500, while initial qualification costs roughly $83,000 per controller for terminal facilities and $122,000 per controller at en route facilities.[34] En route facilities

[28] FAA, *The Air Traffic Controller Workforce Plan, 2022-2031*, at https://www.faa.gov/about/office_org/headquarters_offices/afn/offices/finance/offices/office-financial-labor-analysis/plans/controller-workforce.

[29] FAA, "Staffing Related Relief Concerning Operations at Ronald Reagan Washington National Airport, John F. Kennedy International Airport, LaGuardia Airport, and Newark Liberty International Airport, May 15, 2023, Through September 15, 2023," 88 *Federal Register* 18032-18034, March 27, 2023.

[30] Ibid.

[31] Ibid.

[32] FAA, *Report to Congress: Air Traffic Controller Hiring Reform*, June 9, 2021, at https://www.faa.gov/sites/faa.gov/files/2021-11/FY20_NDAA_Section_1134_Air_Traffic_Control_Hiring_Reform.pdf.

[33] FAA, *Report to Congress: Air Traffic Controller Hiring Reform*, February 8, 2022, at https://www.faa.gov/sites/faa.gov/files/2022-02/PL_116-92_Sec_1134_Air_Traffic_Control_Hiring_Reform.pdf.

[34] Ibid.

encompass larger, more complex facilities that handle larger volumes of airspace encompassing both low-altitude and high-altitude aircraft flying between origins and destinations. It generally takes longer and costs more to train controllers at such facilities compared to most TRACONs that strictly handle airport arrivals and departures. However, among TRACONS, more complex facilities whose coverage includes larger geographic areas and busy airports—like the New York TRACON, the Potomac Consolidated TRACON in the Washington, DC area, and the Southern California and Northern California TRACONs on the west coast—require extensive training for controllers that is more similar to en route facilities in terms of training costs and the time needed to meet initial qualification standards.

FAA Inspector Workforce Training and Resources

The FAA also faces ongoing challenges in recruiting, retaining, and training its workforce of aviation safety inspectors that oversee airlines, other aircraft operators (including unmanned aircraft operators), repair stations, pilots and other safety critical personnel, and aviation manufacturers. These functions are carried out by the FAA's Office of Aviation Safety (AVS), which has a staff of about 7,200 safety inspectors, technicians, and support staff. Over 4,000 of these staff are aviation safety inspectors, and an additional 2,500 are considered safety-critical or safety-technical positions. The FAA is required to submit annual aviation safety workforce plans. Its most recent plan points to hiring, retention, and training challenges for the FAA's aviation safety workforce. The AVS workforce is somewhat older than other FAA components: the average age at hire among AVS employees is 46, and the current average employee age is 55.[35] There is no mandatory retirement age for aviation safety inspectors, and attrition among AVS staff has been historically low, averaging roughly 4%-5% annually. Nonetheless, the FAA anticipates that the AVS workforce would need to grow by about 13%-14% over the next decade to keep pace with expansion of the civil aviation industry and the increasing complexity of aviation technologies.

The FAA Reauthorization Act of 2018 (P.L. 115-254) mandated that the FAA develop a workforce training strategy for its safety workforce. Since 2021, the FAA's aviation safety workforce plan has included strategic objectives driving workforce skill needs and a strategy for effective use of resources. Resources primarily are focused on various capabilities to improve risk-based analysis and decisionmaking to prioritize and make the most efficient use of limited human capital and available resources. The FAA's strategic objectives include improving aerospace safety; setting a "gold standard" of safety by excelling domestically to influence globally; excelling operationally by improving the effectiveness, efficiency, and standardization of safety management; and focusing on people to improve hiring, retention, and training opportunities.[36]

Air Navigation Services

The term *air navigation services* refers broadly to air traffic services, including surveillance and separation of aircraft and safe management of the airspace, as well as aviation weather and aeronautical information services provided to users of the airspace. The FAA is the largest air navigation service provider in the world. In addition to its responsibilities for operating the national airspace system within the United States, the FAA is engaged in numerous initiatives to modernize the facilities, equipment, and technologies that it relies on to carry out this mission,

[35] FAA, *Aviation Safety Workforce Plan, FY2023-FY2032,* at https://www.faa.gov/sites/faa.gov/files/2023_Aviation_Safety_Workforce_Plan_0.pdf.

[36] Ibid.

including through the use of annual facilities and equipment appropriations and through additional IIJA funds designated for modernization of FAA facilities and infrastructure.

Air Traffic Control Infrastructure

The airspace overlying the United States and the overwater areas for which the FAA has operational responsibility is the busiest in the world. On a typical day, the FAA handles about 45,000 flights. The FAA operates 139 stand-alone air traffic control towers at airports, mostly at large airports. Another 262 towers, located at small airports that primarily serve general aviation aircraft, are operated by contractors under the FAA federal contract tower (FCT) program. At 124 mostly mid-sized airports, the FAA operates combined tower and TRACON facilities that provide radar guidance and separation to arriving and departing aircraft as well as tower control of runway and taxiway surface movement operations. In 25 larger regions—such as the airspace around New York City, Washington, DC, and Southern California—the FAA has consolidated radar surveillance at stand-alone consolidated TRACON facilities. En route traffic control and radar surveillance outside of areas covered by the TRACONs are handled by the FAA's 25 Air Route Traffic Control Centers (ARTCCs) and combined control facilities.[37]

The age and condition of these facilities vary significantly. Some are relatively new, but other towers and radar facilities are several decades old, with some more than 70 years old. A portion of the FAA's F&E account funds upkeep, rehabilitation, and replacement of these facilities. In addition, the IIJA included funding of $5 billion—$1 billion each fiscal year from FY2022 through FY2026—to improve the FAA's air traffic facilities. The FAA is using this funding to renovate and replace towers and radar control facilities; update power systems; overhaul and replace radar equipment sites; improve sustainability of navigation, weather, and tracking equipment; and enhance facility security.[38]

In addition to its network of surveillance radars to provide aircraft tracking capabilities to the FAA's TRACONS, ARTCCs, and combined control facilities, the FAA maintains an elaborate network of navigational aids (NAVAIDS), primarily ground-based radio beacons used by aircraft for guidance. While the FAA is transitioning to satellite-based navigation and tracking, it currently maintains over 12,000 NAVAIDS, primarily very high frequency omnidirectional range (VOR) transmitters, used for both en route navigation and non-precision instrument approaches, and instrument landing systems (ILSs), used for precision approach guidance to selected runways, especially at commercial service airports. Some of this ground-based infrastructure will be decommissioned in the coming years as the FAA transitions to the Next Generation Air Transportation System (NextGen), but some will remain operational to provide for backup navigational and surveillance capabilities. A minimum operational network of VORs will be retained, primarily as a backup for aerial navigation, as aircraft switch over to using Global Positioning System (GPS) capabilities as the primary means for navigation. While existing ILS systems will likely remain in place at larger airports for years to come, costly investments in new ILS installations, particularly at smaller airports, have largely halted, as new NextGen procedures using GPS with vertical guidance can offer similar capabilities to appropriately equipped aircraft.[39]

[37] FAA, *Air Traffic by The Numbers,* at https://www.faa.gov/air_traffic/by_the_numbers/media/Air_Traffic_by_the_Numbers_2023.pdf.

[38] See FAA, "Bipartisan Infrastructure Law—Air Traffic Facilities," at https://www.faa.gov/bil/air-traffic-facilities.

[39] Fred Simonds, "ILS on the Block," *IFR,* January 29, 2020, at https://www.ifr-magazine.com/charts-plates/ils-on-the-block/.

The Next Generation Air Transportation System

NextGen is a multifaceted program to modernize and improve the efficiency of the national airspace system, primarily by migrating from a system using ground-based navigation infrastructure and radar tracking of flights to satellite-based navigation and aircraft tracking. Funding for NextGen programs totals almost $1 billion annually, primarily derived from the FAA's F&E account. NextGen is currently transitioning from development and deployment of new technologies and procedures to the full-scale operational utilization of the system's various components. The FAA anticipates that most NextGen capabilities will be fully operational by about 2030.[40]

Core components of the NextGen system include

- **Automatic Dependent Surveillance—Broadcast (ADS-B)**, a system for broadcasting and receiving aircraft identification, position, altitude, heading, and speed data derived from on-board navigation systems, primarily GPS receivers.
- **Performance Based Navigation (PBN)**, navigation using GPS and precision avionics to allow aircraft to fly more efficient routes and arrival and departure paths that improve airspace utilization, potentially allowing for reductions in flight delays and aircraft fuel consumption.
- **System Wide Information Management (SWIM)**, a data network for sharing real-time operational information, including flight plans, weather, airport conditions, and temporary airspace restrictions across the entire airspace system.
- **Decision Support System (DSS) Automation**, a suite of automation and decision-support tools designed to improve aircraft flow management (including traffic flow management, time-based flow management, and terminal flight data management tools that share real-time data among controllers, aircraft operators, and airports to improve strategic traffic flow), airspace utilization, airport arrival and departure efficiency, and airport surface operations.
- **Data Communications (DataComm)**, a digital voice and data network for communications between aircraft and air traffic control.
- **National Airspace System Voice System (NVS)**, a standardized digital voice network for communications within and between FAA air traffic facilities that is to replace aging analog equipment.
- **NextGen Weather**, an integrated platform for providing a common weather picture to air traffic controllers, air traffic managers, and system users.
- **Trajectory-Based Operations (TBO)**, an air traffic concept for strategic planning, management, and optimization of flights by continuous monitoring of predicted flight trajectories throughout the national airspace system using integrated data from the NextGen capabilities described above.

Many of these NextGen capabilities are already operational. Most airlines and many business jet operators are equipped with performance-based navigation capabilities allowing them to fly more efficient routes and airport arrival and departure paths. The network of ADS-B ground receivers linking these ADS-B feeds to air traffic facilities across the country was completed in October 2019, and ADS-B Out (transmission) functionality is now mandatory for most aircraft being operated in controlled airspace, including airspace above 18,000 feet and airspace in busy

[40] FAA, "Forming NextGen: From Vision to Reality," at https://www.faa.gov/nextgen/background/forming.

metropolitan regions near commercial service airports. Airlines have invested in cockpit technologies compatible with FAA DataComm systems, which are now being deployed to several commercial service airport towers.[41]

While the FAA has focused on developing a ground-based network of ADS-B receivers to serve as the backbone for NextGen air traffic surveillance capabilities, other air navigation service providers, led by NAV CANADA, have partnered with satellite communications company Iridium to deploy space-based ADS-B (SBA), being marketed under an Iridium subsidiary called Aireon. The Aireon system relies on a linked network of 66 Iridium satellites to receive ADS-B data from aircraft and relay that data to air navigation service providers in near real-time.[42] The FAA is evaluating SBA for potential application in oceanic and offshore airspace and for other possible use cases, such as search and rescue, accident investigation, and environmental impact analyses.[43]

Looking Beyond NextGen

The FAA refers broadly to the end-state of NextGen implementation as a system of trajectory-based operations (TBO), an air traffic management concept that achieves efficient strategic planning of aircraft flows and airspace utilization through comprehensive analysis of projected flight plan trajectories through space and time. TBO operations will rely on detailed and accurate portrayals of four-dimensional (4D) trajectories of flights, showing how aircraft will traverse though the airspace in three spatial dimensions (latitude, longitude, and altitude) over time (the fourth dimension). The FAA asserts that TBO will allow for enhanced predictability and reliability and reduced uncertainty about airspace operations. This is expected to allow for improved strategic planning and better alignment of strategic plans and tactical actions to manage and control airspace operations on a system-wide basis. From a user perspective this is expected to improve flight scheduling and routing, resulting in fewer delays and reduced fuel burn and emissions.[44] As previously noted, the FAA anticipates that full functionality of NextGen components will be operational by about 2030, thus enabling baseline TBO operational capabilities.

Moving beyond NextGen, the FAA envisions a future national airspace system that will rely on a comprehensive and collaborative framework for information sharing and data analytics to manage and control flight operations in the national airspace system. The FAA is calling this future concept the Info-Centric National Airspace System (ICN). According to the FAA, the ICN will expand upon the core concepts of TBO to increase the performance, efficiency, and safety of airspace operations for traditional flight operations and for new airspace users, including unmanned aircraft systems (UAS), advanced air mobility (AAM) vehicles, and commercial space launch and recovery operations. The agency anticipates that initial capabilities of the ICN will be functional by about 2035.

[41] FAA, "Data Communications (Data Comm)," at https://www.faa.gov/newsroom/data-communications-data-comm-0.

[42] Aireon, "About Aireon," at https://aireon.com/company/; NAV CANADA, "Leveraging ADS-B Surveillance to Optimize Airspace and Enhance Safety and Traffic Flow," at https://www.navcanada.ca/en/air-traffic/space-based-ads-b.aspx.

[43] FAA, "ADS-B Advanced Surveillance Enhanced Procedural Separation (ASEPS)," at https://www.faa.gov/air_traffic/technology/adsb/atc/aseps.

[44] See FAA, *FACTSHEET: Multi Regional Trajectory Based Operations*, at https://www.faa.gov/sites/faa.gov/files/FactSheet-MR-TBO.pdf.

The FAA envisions three key pillars for the development and implementation of ICN: (1) operations, (2) supporting infrastructure, and (3) integrated safety management.[45] Operations will include initiatives to implement TBO across multiple airspace regions; manage operations in high-altitude airspace (above 60,000 feet); manage UAS operations in low-altitude airspace (generally below 400 feet); and integrate AAM operations and vehicles, particularly in airspace above urban regions. Supporting infrastructure will include further evolution of automation and decisionmaking tools for air traffic management; connected aircraft concepts to facilitate data exchange between aircraft, flight operations centers, and air traffic management systems; enhancements to the SWIM architecture and cloud-based services for data exchange; support for information exchange using mobile applications; and updates and enhancements to information management systems. Integrated safety management will establish bespoke safety assurance tailored to specific operational characteristics by utilizing big data capabilities to continuously monitor, model, and assess risks in real-time.

Aviation Cybersecurity

The shift from stand-alone navigation equipment, radar tracking, and analog two-way radios to highly integrated and interdependent computers and networks, both onboard aircraft and in air traffic control facilities, creates inherent cybersecurity vulnerabilities. The FAA Extension, Safety, and Security Act of 2016 (P.L. 114-190) directed the FAA to develop a comprehensive strategic framework to reduce cybersecurity risks to aviation and to establish a cybersecurity research and development plan for the national airspace system.[46] The FAA Reauthorization Act of 2018 (P.L. 115-254) directed the FAA to address cybersecurity in avionics and software systems through its aircraft certification process and assure that flight guidance and control systems are secured from potential hacking through in-flight entertainment systems. In response, the FAA developed the National Airspace (NAS) System Cyber Engineering Facility and NAS Cyber Monitoring System to assess cyber threats and vulnerabilities and conduct cyber testing and evaluation.[47] It is also collaborating with the Department of Homeland Security (DHS) and the DOD on a strategic framework for civil aviation cybersecurity.[48] The act also directed the National Academies of Sciences, Engineering, and Medicine to conduct a study assessing the FAA's cybersecurity workforce. That study found that growing connectivity of FAA systems and aviation digital infrastructure, coupled with a future wave of retirements among the FAA's cybersecurity workforce and a tight labor market for cybersecurity jobs, pose unique challenges to the FAA.[49] The academies' report concluded that the FAA's current recruitment capabilities are insufficient to meet future demand. It also identified a number of key opportunities for recruitment through collaborating with educational institutions and industry, leveraging federal hiring flexibilities, and offering opportunities to train and reskill current FAA employees to take on cybersecurity roles.

Separately, the Transportation Security Administration (TSA) has established specific cybersecurity requirements for commercial passenger airports required to have a security program; these requirements went into effect at the beginning of calendar year 2022. The TSA directives mandate that each covered airport designate a cybersecurity coordinator, complete a

[45] See FAA, "Pillars of Info-Centric NAS," at https://www.faa.gov/about/office_org/headquarters_offices/ang/icn/pillars.

[46] U.S. Government Accountability Office, *Air Traffic Control: FAA Needs a More Comprehensive Approach to Address Cybersecurity As Agency Transitions to NextGen*, April 2015.

[47] See FAA, "Cybersecurity Testing," at https://www.faa.gov/air_traffic/technology/cas/ct/.

[48] See FAA, "Aviation Cyber Initiative (ACI)," at https://www.faa.gov/air_traffic/technology/cas/aci/.

[49] The National Academies of Sciences, Engineering, and Medicine, *Looking Ahead at the Cybersecurity Workforce at the Federal Aviation Administration* (Washington, DC: The National Academies Press), 2021.

cybersecurity vulnerability assessment, develop a cybersecurity incident response plan, and report all cybersecurity incidents to the Cybersecurity and Infrastructures Security Agency (CISA) within 24 hours.[50] These security mandates mimic those TSA imposed for other transportation modes, such as pipelines.

Aeronautical Information Systems

Aeronautical Information Systems refer to information technology systems used to disseminate flight safety information, including information regarding airport and airspace conditions, temporary flight restrictions, and other potential hazards, to airspace users. The FAA is engaged in a multiyear effort to modernize the backbone of the underlying information technology architecture, with a primary focus on upgrading the Notices to Air Missions (NOTAM) system to replace what the agency has described as "failing 'vintage' hardware and software modules" with a single consolidated notification platform.[51] The FAA anticipates that a significant portion of this work will be completed by mid-2025.[52] The NOTAM system suffered a temporary failure in January 2023 that resulted in significant flight disruptions, cancellations, and delays for several hours.[53] This disruption prompted considerable public and congressional scrutiny, including congressional committee hearings to investigate the matter.[54]

In addition to concerns over the need to modernize the underlying architecture of information technology systems and infrastructure, the NOTAM system has been criticized for being arcane and difficult to use and interpret. A July 2017 near accident at San Francisco International Airport, attributed in part to the obscurity of NOTAM information about a closed runway, prompted the National Transportation Safety Board (NTSB) to recommend more effective ways to present safety-critical information.[55] The International Civil Aviation Organization (ICAO) has since launched a global campaign to overhaul NOTAM system standards.[56]

The FAA Reauthorization Act of 2018 (P.L. 115-254, §394) required the FAA to continue developing and modernizing the NOTAM repository in a central location and to provide a web-based, searchable archive of all NOTAMs. This built upon the requirements of the 2012 Pilot's Bill of Rights Act (P.L. 112-153), which directed the FAA to convene a stakeholder NOTAM improvement panel and initiate a NOTAM improvement program with the goals of better

[50] Alan Suderman, "TSA Requires Rail and Airports to Strengthen Cybersecurity," *Federal News Network,* December 2, 2021, at https://federalnewsnetwork.com/government-news/2021/12/tsa-requires-rail-and-airports-to-strengthen-cybersecurity/.

[51] U.S. Department of Transportation, *Budget Estimates, Fiscal Year 2023: Federal Aviation Administration, Facilities and Equipment,* p. 247, at https://www.transportation.gov/sites/dot.gov/files/2022-04/FAA_Budget_Estimates_FY2023.pdf.

[52] Statement of Billy Nolen, Acting Administrator Federal Aviation Administration, in U.S. Congress, Senate Committee on Commerce, Science, And Transportation, *Notice To Air Missions System*, hearings, 118th Cong., 1st sess., February 15, 2023, at https://www.commerce.senate.gov/services/files/22C7E3AC-3EEF-47EE-9DD6-B8A8FB5E826C.

[53] See CRS Insight IN12078, *Federal Aviation Administration's (FAA's) Troubled NOTAM System Has Been on Congress's Radar for Years*, by Bart Elias.

[54] See especially U.S. Congress, Senate Committee on Commerce, Science And Transportation, *Hearing: The Federal Aviation Administration's NOTAM System Failure and its Impacts on a Resilient National Airspace*, 118th Cong., 1st sess., February 15, 2023, at https://www.commerce.senate.gov/2023/2/the-federal-aviation-administration-s-notam-system-failure-and-its-impacts-on-a-resilient-national-airspace.

[55] National Transportation Safety Board (NTSB), *Taxiway Overflight Air Canada Flight 759 Airbus A320-211, C-FKCK*, at https://www.ntsb.gov/investigations/Pages/DCA17IA148.aspx.

[56] International Civil Aviation Organization (ICAO), *Global campaign on NOTAM improvement (NOTAM2021)*, at https://www.icao.int/airnavigation/information-management/Pages/GlobalNOTAMcampaign.aspx.

tailoring NOTAM dissemination to specific flight plans, providing data in a format that is more usable and easier to search, and creating a publicly accessible archive. The NOTAM Improvement Act of 2023 (P.L. 118-4), enacted on June 3, 2023, requires the FAA to establish a task force to review existing methods of disseminating NOTAMs and flight operations information to pilots (as well as corresponding regulations, policies, and practices) and develop a report providing recommendations to improve the presentation of NOTAMs, including how to address specific NTSB recommendations. Similar legislation has been considered in prior Congresses.

Airspace Integration for Novel Uses

Airspace management and air traffic services are anticipated to face demands from a number of new and novel uses, including operations of unmanned aircraft and the continued expansion of commercial space activities. Moreover, the introduction of Advanced Air Mobility (AAM) concepts for transporting people and goods by air over relatively short distances and providing other aviation services using novel vehicles with features including electric propulsion and vertical takeoff and landing capabilities is anticipated to place new demands on airspace management.

Unmanned Aircraft Systems (Drones)

The FAA Modernization and Reform Act of 2012 (P.L. 112-95) directed the FAA to develop a plan to integrate UAS, also known as drones, into the national airspace system. In the decade since, drone operations have proliferated with over 600,000 commercial drones and about 1.4 million recreational drones and model aircraft registered with the FAA as of FY2021.[57] The FAA anticipates that the number of drones operating in U.S. airspace will continue to grow over the next few years, with the commercial fleet expanding to about 800,000-900,000 drones by FY2026.[58] To put this into perspective, there are a little over 200,000 general aviation and air taxi aircraft and about 5,000 airliners currently registered in the United States.[59]

In June 2016, the FAA published a final rule allowing routine commercial operation of certain small unmanned aircraft weighing less than 55 pounds.[60] In order to fly for commercial purposes, operators must obtain a remote pilot certification from the FAA. Flights must stay below 400 feet, and speeds must be kept below 100 miles per hour. Flights are generally limited to daylight hours in good visibility, and the drone must be kept within sight of the operator and cannot be flown over people. The regulations provide a mechanism for commercial entities to obtain waivers from these restrictions on a case-by-case basis. In January 2021, the FAA issued updated regulations allowing for routine operations of UAS over people and at night under certain conditions. To fly at night requires additional remote pilot training and the installation of anti-collision lights that are visible for at least three miles, and flights over people are limited to small UAS assessed to pose a minimal risk of injury.[61]

[57] FAA, *FAA Aerospace Forecast, Fiscal Years 2022-2042,* at https://www.faa.gov/dataresearch/aviation/faa-aerospace-forecast-fy-2022-2042.

[58] Ibid.

[59] FAA, *FAA Aerospace Forecast, FY2022-2042,* at https://www.faa.gov/dataresearch/aviation/faa-aerospace-forecast-fy-2022-2042.

[60] See 14 C.F.R. Part 107.

[61] FAA, "Operation of Small Unmanned Aircraft Systems over People," 86 *Federal Register* 4314-4387, January 15, 2021.

Future expansion of commercial applications for unmanned aircraft may hinge on further regulatory action allowing for routine operations beyond visual line of sight (BVLOS), during night and day and in poor visibility, as well as permitting operations in which multiple drones may be monitored and controlled by a single operator. The FAA Reauthorization Act of 2018 (P.L. 115-254) directed the FAA to authorize package and cargo delivery with small UAS and implement a plan for managing drone traffic in low-altitude airspace. The FAA has issued a limited number of drone operator certificates under existing charter flight regulations to carry out drone delivery demonstration projects. In September 2020, the FAA issued an updated policy allowing for "type certification" of UAS as a special class of aircraft without occupants.[62]

The FAA has been working with industry over the past five years to explore advanced UAS operations and the appropriate roles of federal, state, local, and tribal governments and private sector entities in integrating UAS into the national airspace system, with a particular focus on enabling BVLOS operations. In 2017, the FAA launched the Integrated Pilot Program (IPP) to test and evaluate integration of advanced UAS operations in the national airspace. The IPP program concluded in October 2020 but was followed by the BEYOND program, which continues to operate with eight of the nine IPP participants. The BEYOND program is focusing on advanced UAS operations, including BVLOS, as well as the roles of national, local, state, and tribal interests and security and privacy risks of UAS operations.[63]

The FAA convened a BVLOS aviation rulemaking committee to study the challenges of BVLOS operations and make recommendations to the agency regarding the regulation of BVLOS operations. The committee completed its final report to the FAA in March 2022.[64] The report covers aspects of risk mitigation; operating rules, including detect and avoid capabilities and requirements; and right-of-way rules for low-altitude airspace. A special category of BVLOS operations, referred to as shielded BVLOS operations, involve drone flights that remain within 100 feet of a building or other obstacle that poses a hazard to air navigation. Examples might include building or tower inspections where constant visual contact with the drone cannot be maintained. Since crewed aircraft must remain well clear of these obstacles to avoid potential collisions, drone operations in close proximity to them are not likely to conflict with crewed aircraft operations and are thus considered shielded. The FAA is sponsoring research to help inform regulatory decisions about both shielded BVLOS operations and BVLOS operations in low-altitude airspace.

In January 2021, the FAA also issued regulations requiring all UAS to broadcast remote identification data to assist in tracking and airspace management.[65] Existing UAS not manufactured with remote identification capabilities will be required to retrofit with remote identification broadcast modules or will be limited to operations within FAA-recognized identification areas. Under the FAA's implementation plan, a network of approved remote identification service suppliers will track location and identification information transmitted from drones and provide UAS traffic management services to drone operators. The fee structure for such services is yet to be determined. The majority of operations conducted under these programs have been focused on package delivery. The second predominant focus of operations under these

[62] FAA, "Type Certification of Certain Unmanned Aircraft Systems," 85 *Federal Register* 58251-58255, September 18, 2020. Type certification refers to a regulatory process for approving the airworthiness of a specific aircraft design or "type." Elements of type certification include design reviews and engineering and flight testing of aircraft prototypes.

[63] FAA, "BEYOND," at https://www.faa.gov/uas/programs_partnerships/beyond.

[64] Unmanned Aircraft Systems Beyond Visual Line of Sight Aviation Rulemaking Committee, *Final Report*, March 10, 2022, at https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS_BVLOS_ARC_FINAL_REPORT_03102022.pdf.

[65] FAA, "Remote Identification of Unmanned Aircraft," 86 *Federal Register* 4390-4513, January 15, 2021.

programs has been on infrastructure inspection, including both linear infrastructure, such as railroads, pipelines, and highways, as well as nonlinear infrastructure, such as bridges, electric power facilities, chemical plants, wastewater treatment facilities, and other critical infrastructure sites.[66]

Regulations governing operations of small commercial unmanned aircraft do not apply to drones and remote-controlled aircraft operated strictly for hobby or recreation. The FAA has established statutorily mandated requirements for testing recreational users' knowledge of airspace and safety regulations,[67] and flights must generally stay below 400 feet and keep clear of manned aircraft. Operators of model aircraft and commercial drones must register with the FAA and can do so through an online registration system.

U.S. law provides for specific civil and criminal penalties for operators of drones that interfere with wildfire suppression and related law enforcement or other emergency response activities and for individuals that equip unmanned aircraft with dangerous weapons. The FAA Extension, Safety, and Security Act of 2016 (P.L. 114-190) directed the FAA to set procedures for imposing unmanned aircraft restrictions around critical infrastructure and other sensitive facilities, including amusement parks. The FAA has not yet issued regulations to implement this requirement.

Congress has taken a particular interest in technologies to detect and interdict hostile or errant drones. The FAA Reauthorization Act of 2018 required the FAA to establish a pilot program to assess the use of drone detection and identification technologies. That program is ongoing. The act also authorized the Department of Justice (DOJ) and DHS, including the Coast Guard, to interdict hostile or unauthorized drones in certain instances to protect critical infrastructure sites and high-profile events. Similar authority was granted to DOD and the Department of Energy (DOE) in the National Defense Authorization Act for Fiscal Year 2017 (P.L. 114-328) to protect nuclear energy and nuclear weapons facilities. In contrast to those authorities, which do not expire, the authorities granted to DOJ and DHS were set to expire in October 2022 but were extended through appropriations language until the end of FY2023 (see P.L. 117-328, Section 547). Therefore, options to renew or potentially expand these authorities may arise in the context of FAA reauthorization.

Advanced Air Mobility

AAM refers to a novel transportation system for flying passengers and cargo, typically over relatively short distances ranging from about 10 miles up to roughly 150 miles, using advanced aircraft technologies, principally electric aircraft and aircraft with vertical takeoff and landing capabilities. Future AAM aircraft are envisioned to operate similarly to remotely operated or highly autonomous drones, although flights will be piloted initially. The future introduction of AAM concepts using small electric-powered vertical takeoff and landing (eVTOL) aircraft poses unique challenges to address the regulation and management of low-altitude airspace, flight procedures, infrastructure needs, and related policy issues.

The AAM concept was introduced in 2016 with visions of an on-demand urban air transportation system operating eVTOL aircraft using a network of vertiports (VTOL hubs with multiple VTOL pads and charging infrastructure) and smaller single-pad sites (referred to as vertistops) located in

[66] FAA, *FAA Aerospace Forecast, Fiscal Years 2022-2042,* at https://www.faa.gov/sites/faa.gov/files/2022-06/Unmanned_Aircraft_Systems.pdf.

[67] For more information, see FAA, "The Recreational UAS Safety Test (TRUST)," at https://www.faa.gov/uas/recreational_flyers/knowledge_test_updates.

urban and suburban settings.[68] The use cases for eVTOL aircraft have since expanded to include regional passenger operations to and from small airports; air cargo deliveries; public service operations, including police, fire, and medical services; agricultural operations, such as crop dusting; and private and recreational flights.[69]

A number of companies are engaged in research and development of marketable passenger-carrying AAM vehicles capable of carrying from two to about eight people. However, the unique characteristics of AAM aircraft, including vertical takeoff and landing configurations, electric propulsion, and advanced automation systems, present new challenges for aircraft certification. As a consequence, the FAA is requiring developers to address special conditions to demonstrate vehicle safety and airworthiness before final aircraft type certification approval is made.[70]

Currently, no AAM vehicles have been certified by the FAA, but a few are progressing through the required steps to obtain certification. In December 2022, the FAA issued a notice of proposed rulemaking to permit air carrier operations using powered-lift aircraft capable of vertical takeoffs and landings and low-speed flight to allow for passenger and cargo carrying operations using certified eVTOL aircraft in the future.[71]

There are a number of complex technical challenges related to operational safety and efficiency and the development of ground infrastructure to support AAM operations and electric aircraft. In September 2022, the FAA issued an engineering brief providing initial guidance on the design of vertiports to support operations using eVTOL aircraft.[72] Additionally, the future introduction of AAM technologies raises a number of policy issues, including potential landowner rights to low-altitude airspace over their properties, noise and privacy concerns, and the appropriate role of federal, state, and local governments and private industry stakeholders in accessing, regulating, and managing airspace and flight operations.

Congress has expressed support for promoting and fostering AAM concepts and addressing policy issues regarding this emerging technology. The Advanced Air Mobility Coordination and Leadership Act (P.L. 117-203) mandated the establishment of a federal working group to develop a national strategy for AAM. It also required a Government Accountability Office (GAO) study assessing the interests, roles, and responsibilities of federal, state, local, and tribal governments regarding AAM aircraft and operations. The Consolidated Appropriations Act of 2021 (P.L. 116-260) had also mandated a GAO study of AAM workforce needs and stakeholder views on implementing AAM operations.

That GAO report identified a number of key issues to be addressed before AAM can be widely implemented, addressing the design and certification of AAM vehicles, fostering public acceptance of AAM operations, and developing new ground infrastructure to support AAM operations.[73] Moreover, it identified potential challenges in developing a skilled AAM workforce and postulated that the timeline for certifying AAM aircraft and commencing operations is highly

[68] Uber Elevate, *Fast-Forwarding to a Future of On-Demand Urban Air Transportation,* October 27, 2016, at https://evtol.news/__media/PDFs/UberElevateWhitePaperOct2016.pdf.

[69] FAA, *Urban Air Mobility and Advanced Air Mobility,* at https://www.faa.gov/uas/advanced_operations/urban_air_mobility.

[70] FAA, *Advanced Air Mobility | Air Taxis,* at https://www.faa.gov/air-taxis.

[71] FAA, "Update to Air Carrier Definitions," 87 *Federal Register* 74995-75019, December 7, 2022.

[72] FAA, *Engineering Brief #105: Vertiport Design,* at https://www.faa.gov/sites/faa.gov/files/eb-105-vertiports.pdf.

[73] U.S. Government Accountability Office, *Transforming Aviation: Stakeholders Identified Issues to Address for 'Advanced Air Mobility',* GAO-22-105020, May 2022, https://www.gao.gov/assets/gao-22-105020.pdf.

uncertain and will depend on extensive FAA and industry collaboration on future actions to address unresolved issues.

A provision in the Consolidated Appropriations Act, 2023 (see Division Q, Section 101 of P.L. 117-328) requires DOT to establish a pilot program to provide grants for developing comprehensive infrastructure plans to facilitate AAM operations. The act authorized $12.5 million per year for FY2023 and FY2024 for the program. Individual grants may not exceed $1 million. The DOT was instructed to seek geographical, operational, and project diversity and to prioritize awards to entities working with commercial AAM developers, universities, and research institutions, as well as other relevant stakeholders. At least 20% of the awards are to be used for projects related to infrastructure located in a rural area.

Managing Low-Altitude Airspace

Routine operations of small UAS are generally relegated to altitudes at and below 400 feet above the ground. Restricting drones to these lower altitudes generally mitigates potential risks to other aviation activities but raises concerns about intrusion of privacy, potential nuisance to landowners, and enjoyment of the outdoors, particularly when flights are conducted over private lands or over parks and other sensitive sites.

The National Aeronautics and Space Administration (NASA) has been charged with research and development of a concept called Unmanned Aircraft System Traffic Management (UTM) to handle drones and other low-flying air traffic. Private firms, including Amazon and Google, are reportedly working to develop separate private systems and approaches for controlling low-altitude airspace. However, additional development and testing are needed to field reliable technologies for handling potentially large volumes of low-flying aircraft with varying degrees of autonomy.

It is unclear whether delivery drones and urban air taxis will be allowed to fly where their operators wish, or be restricted to specific routes in the same way that automobiles are limited to traveling on public roads. Also unresolved is the potential conflict between the rights of operators of low-flying aircraft and those of landowners regarding undue nuisance and noise from low-flying aircraft. Debate continues over the roles of municipalities in setting when and where urban air transports can pick up and drop off passengers, what route they will fly, and what curfews or other restrictions might be established for AAM as well as for drone delivery services.

The Drone Integration and Zoning Act (S. 905) seeks to establish formal state, local, and tribal authorities to control airspace within "immediate reaches," which the bill defines as airspace at and below 200 feet above ground level (AGL). Similar legislation was offered in the 117th (S. 600) and 116th (S. 2607) Congresses. The Drone Federalism Act of 2017 (S. 1272, 115th Congress) had similarly sought to ensure that state, local, and tribal governments be granted sufficient authority to impose reasonable restrictions on operations of civil UAS below 200 feet AGL or within 200 feet of a structure (such as a house, apartment building, office, or communications tower) in order to preserve local interests regarding public safety, personal privacy, property rights, and land use management and to mitigate nuisances and noise pollution. Municipalities may play an increasingly important role in setting zoning guidelines for the use of private lands for urban air transportation. While federal regulation of airspace promotes uniformity across the national airspace system, future air mobility concepts may lend themselves to additional local oversight—particularly with respect to zoning and the location of vertiports for advanced air mobility and facilities for delivery drones—to address unique regional transportation needs and challenges.

Supersonic Flight

Supersonic flight refers to flight that is faster than the speed of sound, which is typically around 700 mph at cruising altitudes but varies with pressure, temperature, and other factors.[74] It has been over 45 years since the Concorde, the only certified commercial passenger airliner capable of supersonic flight, first entered service in 1976. The Concorde was retired from service in 2003 amid cost and safety concerns, and no supersonic passenger aircraft have flown since. Throughout its years of operation, the Concorde was criticized for its loud noise at subsonic speeds, particularly during takeoffs and departures, and was restricted from travelling supersonically when over land due to concerns about sonic boom (i.e., the shock wave formed by compression of air waves when an aircraft flies faster than the speed of sound). Community objections to sonic boom as well as the comparatively loud subsonic noise of supersonic aircraft have been major obstacles for public acceptance of supersonic flight.

Despite its flaws and detractors, the Concorde demonstrated that supersonic passenger travel was technically achievable. Future supersonic transport airplanes could be commercially viable if they can offer airline service at reasonably competitive prices while reducing travel time for passengers over long routes. There may also be an entirely separate market for supersonic business jets. Notably, several companies (such as NetJets and Flexjet) offer fractional ownership of general aviation aircraft, a shared-ownership model similar to the time-share model in real estate. This approach could potentially allow a broader array of business and private aircraft users to gain access to supersonic flights at considerably lower cost than full ownership, potentially broadening the potential market for these aircraft.

To address public concerns about sonic boom, companies developing supersonic aircraft believe that they will be able to demonstrate sonic boom signatures that are much quieter and much more acceptable than those of existing supersonic aircraft. The NASA Low Boom Flight Demonstrator program is developing the experimental X-59 QueSST (Quiet Supersonic Transport). The aircraft is designed to fly at Mach 1.42 while producing a sonic boom with a perceived loudness of 75 decibels (dB, comparable to a domestic vacuum cleaner).[75] This would be quieter than the Concorde's perceived loudness of 105 dB (comparable to a thunderclap or a loud sports stadium). A ground-level sonic boom measurement of 75 dB perceived noise level (PNLdB) has been suggested by some NASA researchers as a potentially acceptable level for unrestricted supersonic flight over land, although the FAA has not yet addressed an acceptable level for sonic boom. Congress may consider options for regulating sonic boom levels, areas or corridors where supersonic flights may occur, and noise and sonic boom criteria in the context of FAA reauthorization legislation.

Provisions in the FAA Reauthorization Act of 2018 (P.L. 115-254) required the FAA to submit a report to Congress with recommended regulatory changes on a timeline that would permit overland supersonic flights. The FAA issued that report in April 2020, identifying the timetable for the initial steps to regulate the next generation of civilian supersonic aircraft.

Further, the legislation required the FAA to consult with industry stakeholders on noise-certification issues, including operational differences between subsonic and supersonic aircraft. It also mandated that the FAA conduct rulemaking to revise 14 C.F.R. Part 91, Appendix B,

[74] For further reading see CRS Report R45404, *Supersonic Passenger Flights*, coordinated by Rachel Y. Tang.

[75] With respect to noise, a decibel (dB) is a measure of sound intensity. Decibels are measured on a logarithmic scale where an increase of 10 dB reflects a doubling of the sound pressure. The threshold of human hearing ranges between 0 and 20 dB depending on pitch or auditory frequency. A typical quiet room is about 40-50 dB and a normal conversational voice is about 60dB.

regulations to modernize the process for applying to operate civil aircraft at supersonic speeds for flight testing. In January 2021, the FAA published a final rule defining a new process for obtaining special authorization for supersonic flights that superseded the former Part 91, Appendix B, language.[76]

The 2018 FAA reauthorization act also required the FAA to conduct rulemaking to develop noise standards for sonic booms over the United States and for takeoff and landing and noise test requirements applicable to civil supersonic aircraft. The FAA issued a notice of proposed rulemaking (NPRM) addressing noise certification of supersonic airplanes in April 2020.[77] The proposed rule addressed subsonic noise but did not propose standards for sonic boom in general or for overland operations. The act also included language requiring the FAA to periodically review existing restrictions on supersonic flight of civil aircraft over land in the United States every two years, starting December 31, 2020. The reviews are to determine whether these restrictions may be eased to permit supersonic flight of civil aircraft over land.

With respect to subsonic noise limits, newly designed aircraft certified after December 31, 2017, must meet U.S. "Stage 5" standards (internationally known as Chapter 14 standards, in reference to Chapter 14 of ICAO Annex 16).[78] Stage 5 standards require aircraft to be at least 7 dB quieter than required by the previous Stage 4 noise standards, or 17 dB less than required by Stage 3 standards, cumulatively across three noise measurements (flyover, sideline, and approach).[79] Supersonic aircraft developers argue that the Stage 5 standard was finalized after significant design work on some new supersonic designs had already been completed, and, consequently, significant design changes may be required to pass noise certification tests, including changes that may substantially limit aircraft characteristics such as payload capacity and range. Language in the 2018 FAA reauthorization offered in the Senate (S. 1405, 115th Congress, Section 5017) would have required that noise certification standards for future supersonic aircraft be no more stringent than standards that were in place for large subsonic aircraft on January 1, 2017. This would have had the effect of applying the Stage 4 noise standards in place on January 1, 2017. This language was not included in the enacted version of the 2018 FAA reauthorization act, thus leaving it to the FAA to set noise limits as part of its mandated rulemaking activities to address noise certification of supersonic aircraft. The FAA has proposed specific noise standards that are quieter than Stage 4 limits but higher than Stage 5 requirements that are yet to be finalized. Regardless of whether the FAA adopts these proposed standards, if European countries and other countries insist that supersonic aircraft meet Chapter 14/Stage 5 subsonic noise standards, engine options may be more limited, potentially impacting speed, range, and emissions characteristics of supersonic designs. Gaining international consensus and approvals to fly supersonically over other countries besides the United States may also be a critical element in determining the market viability of future civil supersonic aircraft designs. The 2018 FAA reauthorization act specifically directed the FAA to take a leadership role in creating federal and international policies, regulations, and standards to certify safe and efficient civil supersonic aircraft operations within U.S. airspace.

In the current FAA reauthorization, Congress may consider options for assessing the noise limits for supersonic aircraft and reviewing the FAA's approach, as well as the FAA's efforts to work with other countries to harmonize noise requirements for supersonic aircraft that can strike a

[76] FAA, "Special Flight Authorizations for Supersonic Aircraft," 86 *Federal Register* 3782-3792, January 15, 2021.

[77] FAA, "Noise Certification of Supersonic Airplanes," 85 *Federal Register* 20431-20447, April 13, 2020.

[78] FAA, "Stage 5 Airplane Noise Standards," 82 *Federal Register* 46123-46132, October 4, 2017.

[79] ICAO, "Reduction of Noise at Source," at https://www.icao.int/environmental-protection/Pages/Reduction-of-Noise-at-Source.aspx.

balance between community noise concerns and industries' ability to adopt suitable supersonic engine technologies.

The Supersonic and Hypersonic Aircraft Testing Corridor Act (S. 902) would, if enacted, require the FAA to designate overland supersonic testing corridors running between California and Utah that would primarily be used for testing military aircraft but would be available for testing of civil aircraft so long as such testing does not conflict with military operations or testing in the corridor. Options for providing access to airspace and other opportunities to enable development and testing of supersonic civil aircraft may be an issue of particular interest during FAA reauthorization debate given the continuing interests in and challenges to pursuing supersonic civilian flight.

Regulation of Commercial Space Activities[80]

The FAA Office of Commercial Space Transportation (AST) regulates and licenses commercial space launch and reentry as well as commercial spaceports.[81] In 2022, there were 79 FAA-licensed space launches, up from 54 in 2021 and 39 in 2020.[82] The accelerating rate of commercial launches may raise questions about the resources needed for AST to process license applications promptly and conduct oversight of licensees. It has also led to concern in the commercial aviation industry about the FAA closing airspace more frequently to accommodate planned launches and reentries, resulting in delays or diversions for affected air traffic.

Since 2020, several FAA-licensed commercial launches have carried human occupants into orbit, and several more have carried humans on shorter suborbital flights.[83] In most cases, the FAA is explicitly prohibited from issuing regulations to protect the health and safety of humans aboard commercial spacecraft.[84] That prohibition, which the law describes as a learning period, is scheduled to expire on October 1, 2023. In anticipation of the end of the learning period, the U.S. Commercial Space Launch Competitiveness Act (P.L. 114-90) directed the FAA to facilitate the development of voluntary industry safety standards and assess the industry's readiness for a transition to safety regulation by the FAA. In 2016, the industry standards organization ASTM International formed a committee on commercial spaceflight, which has issued a number of standards and related documents.[85] The FAA has issued several reports to Congress on the status of standards development and the readiness of the industry for safety regulation.[86] As the end of the learning period approaches, Congress may choose to consider whether to extend the learning period again or allow it to lapse.

With the growth of the commercial space launch industry and the emergence of commercial flights to space by wealthy private individuals, some in Congress have suggested the option of

[80] Section contributed by Daniel Morgan, Specialist in Science and Technology Policy.

[81] See 51 U.S.C. Chapter 509 and 14 C.F.R. Chapter III.

[82] FAA, *Licensed Launches*, https://www.faa.gov/data_research/commercial_space_data/launches/?type=Licensed.

[83] For more information, see CRS In Focus IF11940, *Commercial Human Spaceflight*, by Daniel Morgan.

[84] See 51 U.S.C. §50905.

[85] ASTM International, "Committee F47 on Commercial Spaceflight," https://www.astm.org/COMMITTEE/F47.htm.

[86] FAA, *FAA Evaluation of Commercial Human Space Flight Safety Frameworks and Key Industry Indicators* (2017), https://www.faa.gov/sites/faa.gov/files/2021-11/CSLCA_Sec111_Report_to_Congress.pdf; FAA, *U.S. Department of Transportation Evaluation of Commercial Human Spaceflight Activities Most Appropriate for New Safety Framework* (2019), https://www.faa.gov/sites/faa.gov/files/2021-11/New-Safety-Framework-for-Commercial-Human-Space-Flight-Completed-report.pdf; FAA, *Final Report on Voluntary Industry Consensus Standards Development* (2021); and FAA, *U.S. Department of Transportation Evaluation of Commercial Human Space Flight Activities Most Appropriate for New Safety Framework* (2023, draft), https://www.faa.gov/media/27296.

imposing fees or taxes on commercial space companies, either to support AST's licensing activity, for other space-related purposes, or simply by analogy to fees and taxes paid by the commercial aviation industry.[87] AST does not currently charge any fees or taxes.[88]

Aviation Safety

The FAA has responsibility for overseeing compliance with safety regulations at airlines, charter aircraft operators, repair stations, aircraft and aircraft parts design organizations and manufacturers, and other regulated entities. The FAA Office of Aviation Safety (AVS) is responsible for developing regulations and certification standards and conducting oversight of aircraft; pilots, mechanics, and other safety-related personnel; airlines and other aircraft operators; aircraft maintenance and repair facilities; airport safety; and safety aspects of flight operations. It maintains a workforce of more than 7,200 aviation safety workers, including more than 4,000 field inspectors. Major new efforts for aviation safety likely to be considered in FAA reauthorization include

- implementing safety management systems (SMS) throughout the aviation industry;
- implementing aircraft certification reforms; and
- addressing a number of ongoing safety challenges, including oversight of air tour and charter flights, safety of helicopter operations, potential radiofrequency signal interference that could impact air navigation and communications, and concerns over airport surface movement safety.

Safety Management Systems

The FAA defines SMS as a formal organization-wide approach to managing safety risk through structured and systematic procedures, practices, and policies intended to address and improve safety on a continuing basis.[89] It includes formal processes for decisionmaking regarding safety risks; safety assurance; knowledge sharing; and the promotion of a strong safety culture through training, education, and communication. The FAA regards SMS as a proactive approach to managing safety and is taking steps to require its implementation broadly across all sectors of the aviation industry. In 2015, the FAA mandated that commercial passenger and all-cargo airlines that operate under air carrier operational regulations contained in 14 C.F.R. Part 121 implement FAA-approved SMS.

On February 23, 2023, the FAA published a final rule requiring certain commercial service airports to develop an SMS.[90] According to the FAA, 191 airports, included based on the volume of passengers and the number of flight operations, will need to develop and implement an FAA-approved SMS program. All large, medium, and small hub, as well as any airports with commercial international flights and airports with a three-year rolling average of 100,000 annual

[87] See, for example, the SPACE Tax Act (H.R. 7547, 117th Congress) and Member discussion at U.S. Congress, House Committee on Transportation and Infrastructure, *Starships and Stripes Forever—An Examination of the FAA's Role in the Future of Spaceflight*, hearings, 117th Cong., 1st sess., June 16, 2021, https://www.govinfo.gov/content/pkg/CHRG-117hhrg46249/pdf/CHRG-117hhrg46249.pdf, p. 38.

[88] It is explicitly prohibited from charging fees by 51 U.S.C. §50920.

[89] See FAA, *Safety Management System (SMS)*, at https://www.faa.gov/about/initiatives/sms/; FAA, *Safety Management System, National Policy*, Order 8000.369C, June 24, 2020, at https://www.faa.gov/documentLibrary/media/Order/Order_8000.369C.pdf.

[90] FAA, "Airport Safety Management System: Final Rule," 88 *Federal Register* 11642-11674, February 23, 2023.

flight operations are included. The requirements went into effect on April 24, 2023, and will have a staggered implementation schedule. For hub airports, which make up the large majority of airports required to implement SMS, submittal of the SMS implementation plan is required by April 24, 2024. Nonhub airports averaging more than 100,000 annual flight operations are to submit their plans by October 24, 2024, and nonhub airports with less than 100,000 annual flight operations that have commercial international flights are to submit their plans by April 24, 2025. Once the FAA approves an SMS plan submitted by an airport, the airport will then be required to submit an SMS manual and an updated Airport Certification Manual to the FAA within 12 months following the approval date, and it must fully implement its airport SMS program within 36 months following the approval date. As other airports beyond the initial 191 meet the criteria for mandatory implementation of SMS, they will be required to submit an SMS plan to the FAA within 18 months after notification from the FAA that they meet the criteria compelling them to adopt SMS.

The FAA is also taking steps to require SMS implementation for all commuter flight operations and for on-demand commercial air charters and air tour operators. On January 11, 2023, the FAA published a notice of proposed rulemaking that would cover operators regulated under 14 C.F.R. Part 135, which encompasses scheduled commuter flight operations using small aircraft, generally having nine or fewer passenger seats, or charter operations in aircraft having 30 or fewer passenger seats.[91] It would also cover certain passenger flights, primarily air tours, that land and depart from the same airport and stay within a 25-mile radius that may be conducted under 14 C.F.R. Part 91, General Operating and Flight Rules, with a formal letter of authorization to do so from the FAA. The proposed rule would require all such operators to develop, implement, and maintain an FAA-approved SMS program.

While the proposal expands the number of operators that would have to carry out a proactive safety approach under an SMS framework, not all entities would be covered. Notably, the FAA is not at this time proposing to require SMS for: FAA-approved flight schools operated under 14 C.F.R. Part 141; training centers covered under 14 C.F.R. Part 142; aircraft repair stations regulated under 14 C.F.R. Part 145; aircraft fractional ownership programs like NetJets and FlexJet that operate under 14 C.F.R. Part 91 Subpart K; and operations using large aircraft (20 or more passenger seats or a maximum payload of 6,000 pounds or more) not used in common carriage that are regulated under 14 C.F.R. Part 125. The FAA aviation rulemaking committee (ARC) that was convened in 2009 to examine SMS among aircraft operators had recommended SMS requirements for these other regulated entities as well as for the Part 121 air carrier operations already required to have SMS and the Part 135 and Part 91 air tour operations that the FAA is proposing SMS requirements for.[92] In the context of the current FAA reauthorization, Congress may consider whether to expand SMS requirements more broadly across the aviation industry, as well as different options for such an expansion.

Under the same rulemaking, the FAA is also proposing SMS requirements for aircraft and aircraft engine manufacturers as mandated by the Aircraft Certification, Safety, and Accountability Act (Division V of P.L. 116-260). The law specifies that, at a minimum, the SMS be consistent with and complimentary to existing SMSs, allow for operational feedback from product customers and pilots, and allow for FAA approval and routine oversight. The FAA is required to conduct risk-based surveillance, inspections, audits, and continuous monitoring of type and production certificate-holder SMS programs. The FAA was also directed to work closely with ICAO and

[91] FAA, "Safety Management Systems: Notice of Proposed Rulemaking," 88 *Federal Register* 1932-1972, January 11, 2023.

[92] See discussion in FAA, "Safety Management Systems: Notice of Proposed Rulemaking," 88 *Federal Register* 1932-1972, January 11, 2023.

civil aviation authorities in other countries to encourage and assist with adoption of SMS by foreign manufacturers.

The act further specifies that the SMS regulations must provide for a confidential employee reporting system for reporting hazards, issues, concerns, occurrences, and incidents without concern for reprisal. Manufacturers are to be required to submit summary reports of received employee reports at least twice per year. Such information submitted to the FAA is to be protected from public disclosure unless de-identified to protect the identity of submitters.[93] The law also mandates the establishment of a code of ethics for each manufacturer applicable to all employees that formally sets safety as the organization's top priority. As the FAA moves forward with efforts to apply SMS broadly throughout the aviation industry, Congress may take an interest in tracking the FAA's progress on the SMS initiative and the potential challenges and complications with effectively implementing SMS programs, particularly among smaller aviation industry entities. It might consider FAA reporting requirements, GAO reviews, or other oversight actions to monitor SMS implementation as part of the current FAA reauthorization.

Helicopter Operations

In February 2014, the FAA mandated changes in helicopter operational procedures and cockpit technologies to improve operational safety of helicopter air ambulance flights.[94] Subsequently, the FAA Extension, Safety, and Security Act of 2016 (P.L. 114-190) directed the FAA to evaluate and update crash-resistance standards for helicopter fuel systems, and the FAA Reauthorization Act of 2018 (P.L. 115-254) mandated that all new manufactured helicopters be built to meet current crashworthiness standards, which previously applied only to new helicopter designs. Helicopter crashes involving air ambulances in Texas, Missouri, and Colorado in 2015 and a February 2018 air tour helicopter crash in Arizona stand out among aviation accidents that have raised safety concerns about the design of helicopter fuel systems. The accidents have prompted the NTSB to issue recommendations to the FAA that it update regulations and guidelines regarding helicopter fuel system crashworthiness.[95]

The European Union (EU) Aviation Safety Agency (EASA) is contemplating action that would potentially require retrofit modifications to helicopters registered in EU countries to meet upgraded crashworthiness standards. In November 2022, EASA published a proposed amendment outlining various approaches to require retrofitted crash-resistant fuel systems on either some or all EU helicopters by either 2030 or 2038.[96]

Given the potential implications to U.S.-manufactured helicopters operated in Europe, as well as continued NTSB and congressional interest in helicopter safety and crashworthiness, Congress may revisit options to require fuel system improvements to helicopters currently in service, potentially including retrofit requirements for crash-resistant fuel systems in the current civil helicopter fleet.

Additionally, safety concerns have been raised about helicopter air tours following high-profile air tour crashes in New York City and Hawaii. An NTSB investigation of a December 2019

[93] See 49 U.S.C. §44735.

[94] FAA, "Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations," 79 *Federal Register* 9931-9979, April 22, 2014.

[95] See especially, NTSB, Safety Recommendation A-15-12, July 23, 2015, https://www.ntsb.gov/safety/safety-recs/recletters/A-15-012.pdf.

[96] European Union Aviation Safety Agency, Notice of Proposed Amendment 2022-10: Improvement in the Survivability of Rotorcraft Occupants in the Event of a Crash, Phase 1 – Crash Resistant Fuel Systems, at https://www.easa.europa.eu/en/downloads/137237/en.

helicopter air tour crash in Hawaii cited the FAA's failure to act on prior NTSB recommendations, including requiring helicopter air taxi and air tour operators to implement safety management systems and cue-based weather training, as factors in the crash.[97] As noted above, the FAA has issued an NPRM that would mandate SMS among commercial air tour and other commercial helicopter operators. Amid FAA reauthorization debate, Congress may more closely monitor progress and address potential challenges with both moving forward with the FAA's proposal to mandate SMS at small helicopter air tour companies and tailoring effective SMS programs to these operations.

Aircraft Certification Reforms and Safety Oversight

An important FAA function is certifying the safety of aviation products, including aircraft, aircraft engines, and major aircraft components. The FAA has developed a broad set of certification regulations pertaining to the type of aircraft that seeks to balance safety regulations and the degree of FAA oversight with the size and intended use of the aircraft. In the 2018 FAA reauthorization act, Congress directed FAA to delegate its authority over the certification of new and revised aircraft designs to employees of aircraft and component manufacturers.

The FAA Reauthorization Act of 2018 (P.L. 115-254) mandated significant changes in FAA oversight of aircraft certification. It directed the FAA to establish a Safety Oversight and Certification Advisory Committee and required the agency to establish formal objectives to eliminate delays in certification and more closely oversee its Organization Designation Authorization (ODA) program, an established process for delegating certain certification functions to manufacturers. The act also required the FAA to establish a Regulatory Consistency Communications Board to review questions regarding regulatory interpretations related to the certification of aviation products.

Subsequently, two crashes overseas involving a recently certified new variant of the Boeing 737 airplane, known as the Boeing 737 Max, led Congress to revisit these reforms to the aircraft certification process and FAA oversight of aircraft manufacturers and their delegated aircraft certification functions under ODA. In December 2020, the Aircraft Certification, Safety, and Accountability Act (Division V of P.L. 116-260) required the FAA to implement major changes in its policies and procedures concerning certification of transport aircraft, such as commercial passenger and cargo jets, including changes in policies for delegating certification authority to private entities.

The Aircraft Certification, Safety, and Accountability Act mandated that

- the FAA institute extensive changes to the ODA program and oversight of that program;
- aircraft manufacturers implement FAA-approved SMS that establish formal organization-wide procedures, practices, and policies to manage safety-related risks;

[97] Cue-based weather training refers to computer-based training systems used to provide pilots who fly in visual conditions with skills to recognize and respond to indicators of deteriorating weather conditions during flight. NTSB, "Failure of FAA to Implement NTSB Recommendations Contributed to Fatal Air Tour Helicopter Crash, NTSB Says," press release, May 10, 2022, at https://www.ntsb.gov/news/press-releases/Pages/NR20220510.aspx; NTSB, *Collision into Terrain Safari Aviation Inc. Airbus AS350 B2, N985SA*, at https://www.ntsb.gov/investigations/Pages/ANC20MA010.aspx.

- the FAA review and update requirements and guidance addressing flight deck human factors and the design of aircraft-pilot interfaces;[98] and
- the FAA and manufacturers work with international partners to address pilot training standards in the context of aircraft certification and assess operational impacts of new automation technologies.

The act makes it unlawful to interfere with the duties of ODA unit members, including exerting undue pressure on unit members or assigning them work not related to certification duties. The law also repeals two significant provisions of the FAA Authorization Act of 2018 that had directed the FAA to streamline aircraft certification processes and reduce delays, in part by fully utilizing its delegation and designation authorities.

These changes were largely instigated by two crashes involving the Boeing 737 Max, the newest variant of a Boeing narrow-body jet that has been one of the most popular airliners for more than 50 years. These crashes prompted a 20-month-long grounding of the worldwide fleet of Boeing 737 Max airplanes in 2019 and 2020. During this time, congressional attention turned away from streamlining and simplifying certification processes to focus on improving the safety and oversight of those processes, especially with respect to the certification of transport category airplanes used in passenger airline service.

Multiple inquiries prompted by the Boeing 737 Max crashes unveiled concerns regarding certification of transport category airplanes, particularly the handling and review of amendments to existing aircraft type designs. The events also raised concerns over the FAA's delegation of certification functions to aircraft designers and manufacturers under its ODA program. Investigations into the causes of the crashes also raised questions about the increasing use of automated flight control systems and flight crew interactions with those systems, as well as broader concerns regarding human performance and human factors assumptions about pilot reactions to abnormal and emergency situations and alerts. In November 2020, the FAA approved design modifications and changes to pilot training permitting the resumption of 737 Max flights by U.S. air carriers.

Many aviation safety experts attribute the safety advancements in commercial aviation over the past three decades, at least in part, to improvements in aircraft systems technology and flight deck automation. These same factors, though, have also been implicated as causal or contributing factors in several aviation accidents and incidents. The implications of modern flight deck automated systems design have been an issue of concern for more than two decades. In 1996, a human factors team convened by the FAA released a comprehensive study of interfaces between flight crews and highly automated aircraft systems with a focus on interfaces affecting flight path management.[99] The work prompted the FAA to revise its certification requirements for flight guidance systems in 2006.[100] Despite the changes made to address human factors issues in flight guidance system design, the interface between pilots and automated flight guidance systems remains at the crux of commercial aviation safety. This issue has been highlighted in the investigations and findings of several high-profile international aviation accidents that have

[98] According to the Human Factors and Ergonomics Society, *human factors* is described as the scientific discipline concerned with understanding interactions among humans and other elements of a system and the application of scientific knowledge and theory about human abilities to optimize human well-being and overall system performance (see Human Factors and Ergonomics Society, "What is Human Factors and Ergonomics?," https://www.hfes.org/about-hfes/what-is-human-factorsergonomics).

[99] FAA, *Federal Aviation Administration Human Factors Team Report on: The Interfaces Between Flightcrews and Modern Flight Deck Systems*, June 18, 1996, http://www.tc.faa.gov/its/worldpac/techrpt/hffaces.pdf.

[100] FAA, "Safety Standards for Flight Guidance Systems," 71 *Federal Register* 18183-18192, April 11, 2006.

occurred over the past 15 years, including Air France Flight 447, which crashed in the Atlantic on June 1, 2009; Asiana Airlines Flight 214, which crashed at San Francisco International Airport on July 6, 2013; and the crashes of Lion Air Flight 610 on October 29, 2018, and Ethiopian Airlines Flight 302 on March 10, 2019, the two Boeing 737 Max-8 accidents that prompted the lengthy worldwide grounding of that aircraft type. These accidents have raised lingering questions about the design of flight control systems, human factors issues related to pilot interaction with flight deck automation and alerting systems, and flight crew training, in addition to the questions raised about aircraft certification policies, regulations, and practices.

The Aircraft Certification, Safety, and Accountability Act mandated further changes to the aircraft certification process, the ODA program, and FAA oversight of that program. The act, introduced following the worldwide grounding of Boeing 737 Max aircraft after two fatal crashes overseas, requires aircraft manufacturers to implement FAA-approved safety management systems. It requires the FAA to review and update requirements and guidance regarding human factors and human systems integration, particularly those related to aircraft-pilot interfaces. Provisions in the law also require the FAA to reevaluate its practices for certifying variants of existing aircraft models, such as the 737 Max. The act required that, after December 2022, all newly certified aircraft be equipped with updated alerting systems that assist crews in resolving warning signals. However, recognizing that certification delays to the Boeing 737 Max-10 (the largest version of the 737 Max lineup) would have conflicted with this mandate, as the 737 Max lacks these modernized crew alerting capabilities, lawmakers modified a provision in the Consolidated Appropriations Act, 2023 (P.L. 117-328, Division O, Section 501) to exempt any aircraft whose application for an original or amended type certificate had been submitted prior to December 27, 2020. Meanwhile, the law established new requirements for all Boeing 737 Max aircraft to include two additional safety enhancements to improve alerting and to give crews the capability to silence certain alerts to minimize distraction

On December 8, 2022, the FAA issued a proposed rule that would standardize the process for conducting system safety assessments for aircraft systems, including flight controls and engines installed on transport category airlines, to reduce the risk of catastrophic failures arising from latent conditions.[101] On January 11, 2023, the FAA published an NPRM that would require aircraft and aircraft engine manufacturers to implement SMS programs, as mandated by the Aircraft Certification, Safety, and Accountability Act. Furthermore, on March 2, 2023, the FAA published a draft policy statement regarding the revision of procedures for amendments to aircraft type certificates.[102] Under the proposed change that was also mandated by the Aircraft Certification, Safety, and Accountability Act, applicants proposing amendments to type-certified aircraft designs must disclose to the FAA all new systems and intended changes to existing systems in a single document at the beginning of the process for the amended type certification, and this document must be kept current throughout the project. This addresses concerns raised regarding the amended type certification of the Boeing 737 Max over a failure to fully disclose the details of system changes to the aircraft design to the FAA and keep the FAA appraised of modifications to systems as the certification work continued. As the FAA reauthorization debate has evolved, Congress remains interested in aircraft certification reforms and options to gauge FAA and industry progress toward applying these reforms; related FAA reports and GAO audits may be considered in the debate.

[101] FAA, "System Safety Assessments," 87 *Federal Register* 75424-75454, December 8, 2022.

[102] FAA, "Draft Policy Statement: Submission of Outline of New and Changed Systems at the Beginning of the Type Certificate Amendment Process for Transport Category Aircraft," 88 *Federal Register* 13071, March 2, 2023.

Aviation Spectrum and Signal Interference

Starting in late 2021, the rollout of fifth-generation (5G) wireless telecommunications networks in the United States raised concerns at the FAA, airlines, and other aviation operators over fears that certain mid-band or C-band 5G signals could interfere with radio altimeters (i.e., devices onboard aircraft to independently provide the distance between the aircraft and the Earth's surface). The FAA, along with aviation regulators from other countries, first raised concerns about wireless deployments in the C-band in 2015. They cautioned that 5G signals transmitted on nearby frequencies could interfere with radio altimeters, particularly if high-powered 5G base stations were placed close to airport runways.

A 2020 study by RTCA, an aviation industry technical advisory group founded as the Radio Technical Commission for Aeronautics, concluded that expected interference from 5G emissions in the 3.7-3.98 GHz range and spurious or stray 5G emissions that bleed over into the 4.2-4.4 GHz band was likely to exceed safe interference limits for airplanes and helicopters equipped with radio altimeters.[103] Moreover, it determined that stray 5G emissions that might bleed over into the band reserved for radio altimeters would not be considered compliant with international recommendations for radiofrequency protection criteria.

The Federal Communications Commission (FCC), however, maintained that its mandated protections, including limits on the strength of 5G signals and 220 MHz of spectral separation between 5G signals and radio altimeters, adequately mitigate the potential for interference.[104]

The FAA initially restricted the use of approach procedures and automated landing system operations at 88 airports where it determined that the presence of C-band 5G signals could pose a risk of radio altimeter interference.[105] However, service providers subsequently agreed to voluntarily delay activation of 5G transmitters located close to airports until July 5, 2022, thus creating temporary "buffer zones" around airports during the first six months of the 5G rollout.

Subsequent to its initial restrictions, the FAA worked with the aviation and wireless industries to identify incremental steps to continue with the rollout of 5G while minimizing impacts to aircraft operations and, working with manufacturers, approved filter kits to retrofit radio altimeters with protections from 5G interference.[106]

The FAA is continuing to work with industry groups led by RTCA and its European counterpart, the European Organization for Civil Aviation Equipment (EUROCAE), to develop minimum operational performance standards for future radio altimeters that will not be susceptible to potentially harmful radiofrequency interference.

Helicopters responding to medical emergencies also rely on radio altimeters, especially when landing to pick up and drop off patients. Citing the critical societal importance of helicopter emergency medical operations, the FAA has granted temporary regulatory relief from radio altimeter requirements for medical helicopters conducting night-vision-goggle operations, so long as ground observers remain in radio contact with pilots to guide them regarding terrain and

[103] RTCA, Inc., *Assessment of C-Band Mobile Telecommunications Interference Impacts on Low Range Radar Altimeter Operations,* RTCA Paper No. 274-20/PMC-2073, October 7, 2020, at https://www.rtca.org/wp-content/uploads/2020/10/SC-239-5G-Interference-Assessment-Report_274-20-PMC-2073_accepted_changes.pdf.

[104] Federal Communications Commission, *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, FCC 20-22, GN Docket No. 18-122, March 3, 2020, at https://docs.fcc.gov/public/attachments/FCC-20-22A1.pdf.

[105] FAA, *5G and Aviation Safety*, at https://www.faa.gov/5g.

[106] FAA, *FAA Statements on 5G*, June 17, 2022, at https://www.faa.gov/newsroom/faa-statements-5g.

obstacle clearance around landing zones.[107] This exemption expires on January 31, 2024, at which point medical helicopters may also need to install retrofit filters or upgraded radio altimeters.

The ongoing concerns over potential aviation safety impacts from 5G in the United States point to broader concerns that may be of particular interest to Congress in the context of FAA reauthorization. These include coordination between the FAA and the National Telecommunications and Information Administration, the federal agency that represents federal agency spectrum concerns to the FCC; the FAA's relationship with other regulatory agencies, such as the FCC; and the FAA's ability to address complex challenges brought about by the proliferation of wireless technologies and the rapidly evolving technical landscape in which aviation operates.[108]

Airport Surface Movement Safety

The risk of on-airport collisions has been a significant safety concern since the 1977 runway collision of two Boeing 747 aircraft on the island of Tenerife, Spain, which claimed 583 lives in the deadliest aviation disaster in history. Over the past decade, the FAA has addressed surface movement safety though investments in airport lighting and signage improvements, modifications to procedures and communications, and investments in technologies, such as surface radar, runway status lights, final approach runway occupancy signals, and tablet devices for pilots (known as "electronic flight bags") with moving map capabilities. Additionally, the FAA has supported targeted installation of special pavement materials, known as Engineered Materials Arresting Systems (EMAS), at airports where aircraft that overrun a runway could collide with structures or enter bodies of water.

Airport surface movement safety has been the focus of recent attention in 2023 following a spate of high-profile incidents.[109] In response to these close calls and other safety concerns regarding commercial flight operations, the FAA convened a safety summit in March 2023 to discuss options for enhancing flight safety with aviation industry leaders. Suggestions offered at the event included future actions to

- improve collection, analysis, and dissemination of safety data;
- recognize human factors and work conditions, including stress and fatigue, in safety risk models;
- reexamine runway incursion data to identify underlying factors and identify potential remedies;
- identify technologies to augment the existing capabilities of surface surveillance equipment;

[107] FAA, *In the matter of the petition of Helicopter Association International for an exemption from §§ 91.9(a), 91.205(h)(7), 135.160, and 135.179(a) of Title 14, Code of Federal Regulations, Exemption No. 18973*, Regulatory Docket No. FAA-2021-1028.

[108] See CRS In Focus IF12028, *Aviation Concerns Regarding the Rollout of 5G Wireless Telecommunications Networks*, by Bart Elias and CRS In Focus IF12046, *National Spectrum Policy: Interference Issues in the 5G Context*, by Ling Zhu.

[109] See, for example, Ian Duncan, "FAA Launches Safety 'Call to Action' After Recent Airport Near-Misses," *Washington Post*, February 14, 2023, at https://www.washingtonpost.com/transportation/2023/02/14/faa-safety-airlines-incidents/; and Amanda Holpuch, "FAA. Issues Safety Alert After Runway Near Misses," *New York Times*, March 22, 2023, at https://www.nytimes.com/2023/03/22/business/faa-airlines-near-misses.html.

- improve training programs for airport vehicle operators; and
- implement SMS at busy commercial service airports.[110]

Despite the recent attention, data tracking these airport surface incidents, known as runway incursions, do not give any clear indication that risk is increasing. Nonetheless, the sheer number of incidents, over 1,700 in FY2022 and almost 800 in the first half of FY2023,[111] points to the continuing safety risks in the airport surface environment. Runway incursions refer to incidents involving aircraft and ground vehicles that transgress onto active runways, creating situations that pose a hazard to landing or departing aircraft. These incursions are tracked and analyzed by the FAA to determine the underlying factors that could result in a collision on an airport surface. Runway incursions are classified as to whether they are attributed to pilot deviations, vehicle or pedestrian deviation, operational errors by air traffic controllers, or occasionally operational deviation when a controller fails to properly coordinate handling of an aircraft with other controllers. Runway incursions are also classified by severity, ranging alphabetically from Category A incidents, in which a collision was narrowly avoided, to Category D incidents, in which a runway incursion was found to have occurred but posed no immediate safety consequences.[112]

Over the years, the FAA has taken a multipronged approach to addressing airport surface movement safety, including developing risk indices to identify and examine runway safety events and implement risk-based strategies targeting particular airport configurations and hot spots at airports that are prone to high-risk incursion incidents. The FAA has also deployed technologies including runway status lights to alert aircrews and airport vehicle drivers and Airport Surface Detection Equipment-Model X (ASDE-X) in control towers to provide controllers with surface movement displays that provide visual and audible alerts of traffic conflicts and potential collisions. ASDE-X is currently deployed at 35 of the busiest airports in the United States. The FAA has also developed the Airport Surface Surveillance Capability (ASSC), which augments airport surface detection by integrating ADS-B signals and aircraft position data from airport sensors using a process with surface radar signals called multilateration. ASSC is currently deployed at eight airports in the United States. The FAA has also developed related educational materials for pilots and has worked with airports to make improvements, such as improved taxiway markings and signage, to mitigate runway incursion risks.[113]

The FAA Modernization and Reform Act of 2012 (P.L. 112-95) required the FAA to develop a strategic runway safety plan that includes specific national goals and proposed actions to enhance runway safety, particularly at commercial service airports. The act also required the FAA to develop a process for tracking and investigating runway incidents and deploy systems to alert air traffic controllers and pilots of potential runway incursions into the NextGen implementation. The plan, published in November 2012, indicated that the FAA is using a number of data collection and analysis tools to identify and mitigate safety risks in airport surface movements and terminal area operations.[114] The FAA also committed to specific actions, including the installation of

[110] FAA, "Readout from the FAA Aviation Safety Summit Breakout Panels," at https://www.faa.gov/newsroom/readout-faa-aviation-safety-summit-breakout-panels.

[111] FAA, "Runway Incursion Totals by Quarter, FY2023 vs. FY2022," at https://www.faa.gov/airports/runway_safety/statistics/year/?fy1=2023&fy2=2022.

[112] FAA, "Runway Incursions," at https://www.faa.gov/airports/runway_safety/resources/runway_incursions.

[113] FAA, "Runway Safety," at https://www.faa.gov/airports/runway_safety.

[114] FAA, *The Strategic Runway Safety Plan*, November 2012, at http://www.faa.gov/airports/runway_safety/news/congressional_reports/media/The%20Strategic%20Runway%20Safety%20Plan.pdf.

runway status lights at 23 large airports and the installation of EMAS at additional airports without standard runway safety areas to mitigate risks of runway overruns.

Section 334 of the FAA Reauthorization Act of 2018 required the FAA to consult with the NTSB to develop a report examining various opportunities to improve runway safety, including the use of runway awareness and advisory systems onboard large jets; technologies to detect and warn of improper runway alignments; and utilization of ASSC, potentially providing warnings of potential runway incursions directly to the cockpit and improving analytic capabilities to track runway incursions and assess the effectiveness of runway safety initiatives. The FAA issued the required report in November 2020.[115] It stated that, although runway awareness and advisory systems were authorized for almost 90% of air carrier operations and about one-third of charter operators, these systems and other initiatives would decrease wrong surface landings (e.g., landing on a runway other than the runway assigned by air traffic control or on a taxiway) by only about 6%-7%, and the systems are extremely costly. For these reasons, the FAA also reported that it is continuing to evaluate whether to require use of runway advisory systems or other possible solutions. The FAA reported that it has enhanced ASDE-X, ASSC, and terminal radar systems capabilities to better detect wrong surface alignment to improve detection of potential errors during takeoffs and landings. It also reported that it had deployed a taxiway arrival prediction enhancement to ASDE-X at 14 airports.

The FAA has also evaluated ASSC capabilities to detect wrong surface alignment, particularly at San Francisco International Airport (SFO), where, in July 2017, an Air Canada jet aligned for landing on an active taxiway and overflew at low altitude four aircraft waiting to depart.[116] Following that incident, the FAA took action to expand the airport surface coverage of the ASSC system and made procedural changes to require precision instrument approaches at night and modify shift hours and staffing in the tower cab.

The FAA reports that it continues to rely on its Runway Incursion Mitigation Program to focus airport infrastructure projects to improve safety at airport surface locations, such as complex intersections, that have experienced multiple runway incursions.[117] Given the heightened concerns over airport surface movement safety, Congress is likely to place specific attention on this topic in the FAA reauthorization debate.

Pilot and Flight Attendant Fatigue

The Airline Safety and Federal Aviation Administration Extension Act of 2010 (P.L. 111-216) mandated changes to airline pilot flight time and rest requirements and the development of fatigue risk management plans. In response, the FAA published a final rule on Flightcrew Member Duty and Rest Requirements on January 4, 2012.[118] This added 14 C.F.R. Part 117, which prescribes passenger-airline-flight-crew flight time, duty time, and rest requirements based on crew size, time of day, time and distance away from home base, and other factors. The regulation also

[115] FAA, Letters to the Honorable Roger Wicker, Chairman, Committee on Commerce, Science, and Transportation, United States Senate and the Honorable Peter A. DeFazio, Chairman, Committee on Transportation and Infrastructure, U.S. House of Representatives, In response to the requirement of Section 334 of the Federal Aviation Administration (FAA) Reauthorization Act of 2018, November 4, 2020, at https://www.faa.gov/sites/faa.gov/files/2021-11/Runway_Safety_report_PL115-254_Section_334.pdf.

[116] FAA, "ADS-B Airport Surface Surveillance Capability (ASSC)," at https://www.faa.gov/air_traffic/technology/adsb/atc/assc.

[117] FAA, "Airports Runway Incursion Mitigation (RIM) Program," at https://www.faa.gov/airports/engineering/incursions_excursions/rim.

[118] FAA, "Flightcrew Member Duty and Rest Requirements," 77 *Federal Register* 329, January 4, 2012, at https://www.govinfo.gov/content/pkg/FR-2012-01-04/pdf/2011-33078.pdf.

requires airlines to implement a fatigue risk management system. The rules went into effect on January 14, 2014.

While these regulations are mandatory for passenger airlines, compliance is optional for all-cargo carriers that operate under 14 C.F.R. Part 121. Pilot labor organizations have long argued for uniform fatigue regulations under an umbrella "single level of safety" approach, although the FAA and the airline industry maintain that air cargo operations are sufficiently different and that separate regulatory requirements are appropriate. Long-standing efforts to include all-cargo pilots under the same set of duty and rest rules as passenger airline pilots did not pass in the 114th Congress (e.g., S. 1612), and legislation offered in the 115th Congress (e.g., S. 1423) was not incorporated into the previous FAA reauthorization legislation. In both the 116th (S. 826) and the 117th (S. 2350) Congresses, similar introduced legislation sought to apply the same flight crew duty and rest requirements applicable to passenger airline pilots to flight crew operating all-cargo air carrier aircraft. Such requirements have not been enacted into law or considered by the FAA in formal rulemaking. There may be congressional interest in revisiting duty time and rest requirements for all-cargo pilots during the FAA reauthorization debate.

Although recent Congresses did not address changes to fatigue rules for all-cargo crews, language mandating changes to flight attendant duty period limits and rest requirements was included in the FAA Reauthorization Act of 2018. Specifically, Section 335 of the act required the FAA to issue a final rule giving flight attendants at least 10 hours of consecutive rest following any scheduled duty period of 14 hours or less. The law further stipulated that the rest period could not be reduced under any circumstances. On October 12, 2022, the FAA published a final rule on flight attendant duty period limitations and rest requirements that went into effect on November 14, 2022, and compliance was required by January 10, 2023. The regulation generally codifies the language of the statutory provision and requires a rest period of at least 10 consecutive hours between the completion of the scheduled duty period and the commencement of the subsequent duty period, noting that the rest period may not be reduced to less than 10 consecutive hours. In the context of the current FAA reauthorization, Congress may examine compliance with these new regulations and potential operational challenges to airlines related to cabin crew staffing and potential scheduling conflicts associated with regulatory compliance.

Aviation Workforce

Airline Pilot Supply and Training

Between 2000 and 2009, the NTSB conducted 11 major accident investigations involving regional air carriers, 7 of which were attributed to pilot performance and decisionmaking. Scrutiny of regional airline safety followed the February 12, 2009, crash of Continental flight 3407, operated by Colgan Air, a now-defunct regional airline that operated flights under a partnership agreement with Continental Airlines (which subsequently merged with United Airlines in 2012). In response to concerns raised in the aftermath of these accidents, especially the Colgan Air crash, legislation addressing airline flight crew standards, training, and work conditions, including maximum duty periods and rest time requirements, was included in the Airline Safety and Federal Aviation Administration Extension Act of 2010 (P.L. 111-216). Enactment imposed a specific mandate for the FAA to increase to 1,500 hours the minimum flight time requirement to qualify for certification needed to be hired as an airline pilot, with some latitude for the FAA to authorize certain related academic training to substitute for a portion of the flight time requirement.

In response, the FAA published a final rule on July 15, 2013, that became effective immediately and required airline first officers to hold an Airline Transport Pilot (ATP) certificate and a type rating for the aircraft to be flown.[119] The ATP certificate typically requires a minimum of 1,500 hours of total flight time as a pilot, thus giving rise to the common reference to this as the "1,500 hour rule."

Notwithstanding the general 1,500-hour flight time requirement, certain applicants may qualify for an ATP certificate with restricted privileges, commonly referred to as a restricted ATP or R-ATP certificate. To qualify for an R-ATP certificate, the pilot applicant must have served as a military pilot who was not removed from service due to a lack of flight proficiency or disciplinary action involving aircraft operations, or the applicant must have completed an accredited program at an institution of higher education that has been authorized by the FAA to certify graduates for ATP certification based on academic and aeronautical experience. Military pilots and former military pilots can be issued an R-ATP certificate with a minimum of 750 total flight hours that may consist of a combination of military training and flight operations as well as civilian flying. A holder of a bachelor's degree from an accredited and authorized institution can be issued an R-ATP certificate with a minimum of 1,000 hours, and a holder of an associate's degree from an accredited and authorized institution can be granted the R-ATP with a minimum of 1,250 hours.

Additionally, the FAA imposed a new requirement, effective August 1, 2013, stating that in order to serve as pilot-in-command (captain) in Part 121 operations, a pilot must have accumulated a minimum of 1,000 hours in air carrier operations.[120]

There has been debate over whether there is a current or potential future labor shortage of qualified pilots to fill airline vacancies and meet airline growth projections. Moreover, debate over whether the 1,500-hour rule is a possible contributing factor in creating a potential shortage of qualified pilot applicants for airline jobs has been contentious ever since the changes to pilot qualification standards were first considered in congressional debate prior to the 2010 act. A 2014 GAO study pointed to various economic indicators suggesting that demand for pilots had not outstripped supply, even after the 1,500-hour rule had gone into effect. The GAO study raised concerns about potential future pilot shortages driven primarily by the high costs of flight training and low entry-level pay at regional airlines at the time.[121]

The rapid downturn in air travel as a result of the COVID-19 pandemic also changed the dynamics of the airline hiring pipeline to some extent in 2020 and 2021. Airlines responded to the rapid downturn in passenger air travel by halting hiring and offering incentives for early retirements to pilots and other airline employees. While pandemic relief funds and associated conditions of accepting these funds prevented airlines from furloughing pilots in 2020 and 2021, industry-wide payrolls of pilots and copilots shrunk by about 7% during this time largely due to the early retirement incentives and hiring freezes. Pilot payrolls in 2021 remained below 2019 levels by 3,573 positions. Similarly, new pilot supply shrunk during the pandemic as annual original ATP certifications issued by the FAA declined in 2020. However, relatively steady levels of newly issued commercial and flight instructor certifications over the past three years may suggest that the future pilot pipeline remains robust despite pandemic restrictions that limited the ability to conduct flight training to some extent. However, airlines will likely face challenges

[119] FAA, "Pilot Certification and Qualification Requirements for Air Carrier Operations," 78 *Federal Register* 42323-42380, July 15, 2013, corrected by Federal Aviation Administration, "Pilot Certification and Qualification Requirements for Air Carrier Operations," 78 *Federal Register* 45055-45056, July 26, 2013.

[120] 14 C.F.R. §121.436(a)(3).

[121] GAO, *Aviation Workforce: Current and Future Availability of Airline Pilots*, GAO-14-232, February 2014, at https://www.gao.gov/assets/gao-14-232.pdf.

hiring sufficient numbers of pilots in the near-term due to a limited supply of qualified candidates. Long-term growth in air travel demand could also impose challenges to the adequacy of future pilot supply.

Potential options to increase the supply of airline pilots that have been sought include further relaxing qualification standards for airline first officers and raising the airline pilot retirement age, currently set at 65, as well as fostering interest in and providing opportunities to individuals seeking pilot careers, including those from economically disadvantaged communities and from underrepresented segments of the population.

In April 2022, Republic Airways petitioned the FAA seeking partial relief from the 1,500-hour rule to allow graduates of its pilot training program to apply for an R-ATP certificate with 750 hours, the same level of flight experience required for current or former military pilots. In September 2022, the FAA issued a formal denial of that exemption request. The FAA, however, held open the possibility that, in the future, airlines or flight training providers could develop mission-specific training programs that could better prepare students to operate within the complex environment of air carrier operations that might be considered suitable by the FAA to issue R-ATP certificates.[122]

As part of the current FAA reauthorization debate, the airline industry—and in particular regional airlines—may seek congressional action to address potential pilot shortages by creating additional flexibilities in the 1,500-hour rule. This may be pursued even while the current statute provides the FAA some latitude with respect to alterative training programs to qualify for R-ATP certification. In the 2018 FAA reauthorization debate, options to reframe the 1,500-hour rule did not gain traction. Additionally, Congress may consider other options to ease concerns over pilot supply, such as revisiting age limits for airline pilots.

Airline Pilot Retirement Age

While International Civil Aviation Organization (ICAO) standards set in 2006 hold that the maximum age for flights crewed by more than one pilot should be 65, including at least one pilot under age 60, some countries do not follow this standard. Notably, Canada, Australia, and New Zealand have no formal age limit for airline pilots, and Japan raised its pilot retirement age to 68 in 2015.[123] The International Air Transport Association (IATA), a trade organization that represents airlines globally, is pressing ICAO to reexamine airline pilot age limits to address potential pilot shortages as well as possible age discrimination against healthy older pilots.[124]

During the 117th Congress, legislation was introduced to increase the mandatory airline pilot retirement age from 65 to 67 (H.R. 8513, S. 4607) but was not enacted. Similar bills have been introduced in the 118th Congress (H.R. 1761, S. 893).

Future Aviation Workforce Development

With regard to growing future pilot supply and ensuring a robust pipeline of civilian pilots, legislation has focused on fostering aviation workforce development. The FAA Reauthorization Act of 2018 (P.L. 115-254, Section 625) authorized up to $5 million annually through FY2023 in

[122] FAA, *Denial of Exemption In the Matter of the Petition of Republic Airways, Inc., for an exemption from § 61.160(a) of Title 14, Code of Federal Regulations*, Exemption No. 19419, Regulatory Docket No. FAA-2022-0535, at Regulations.gov.

[123] "IATA Urges ICAO to Remove Pilot Age Limits," *Aero News Network,* August 19, 2022, at http://www.aero-news.net/index.cfm?do=main.textpost&id=484c27c5-c198-4534-b55e-1b9c9fcb3f15.

[124] Ibid.

grants to support aviation workforce development and the education of future aircraft pilots. It includes an additional annual authorization of $5 million to support programs to foster and train the future aviation maintenance workforce. The two programs were fully funded in FY2020 through FY2023 and a total of $10 million in grants were awarded each fiscal year. In the context of future FAA reauthorization debate, Congress may seek to review the outcomes of these programs and assess whether they should be reauthorized or potentially expanded or whether they may need to be replaced with alternative initiatives and approaches to build the future pilot and aviation maintenance technician workforce.

One particular potential source of future pilots and aviation maintainers is military veterans, including those with no specific flight training who may have worked in aviation-related job specialties while in the military or might otherwise have an interest in pursuing a career as a pilot or aircraft mechanic.

From 2017 to 2020, the DOT's Volpe Center conducted a demonstration project, called the Forces to Flyers program. The program examined how additional financial support for flight training beyond the limitations of GI Bill education assistance benefits provided by the Department of Veterans Affairs could improve the accessibility and outcomes of civilian flight training pursued by former military officers and enlisted personnel who were not trained as pilots by the military but have an interest in pursuing a career as a civilian pilot.[125] Participants in the program had a high success rate in attaining commercial multiengine certifications under an accelerated timeline (18 months). This program's outcomes may suggest that additional grants or scholarships, combined with structured flight training, could help propel aspiring veterans to careers as civilian pilots.

The American Aviator Act (S. 4045, 117th Congress) proposed an authorization of $5 million annually through FY2028 for the FAA to provide grants to certain approved pilot training schools that have authorization to issue R-ATP certificates for flight training to supplement funding from existing veterans' education benefits. This or similar initiatives to provide financial resources and support to veterans seeking training for pilot or aircraft mechanic certification may be considered in the context of current FAA reauthorization debate.

Aviation Maintenance Training

The aviation industry has also raised concerns about the sufficiency of labor supply of aviation maintenance technicians that service and repair aircraft, aircraft engines, avionics, and other aircraft components. However, GAO has reported that both the overall pool of aircraft mechanics and the number of new mechanic certificates issued has increased by 11%-12% from 2017 to 2022, reflecting an annualized growth rate of about 2%.[126] Moreover, student enrollments at aviation maintenance technical schools in the United States increased at a similar rate over that period and consisted of about 21,000 students in total as of 2022. GAO conceded that uncertainty regarding future demand for aviation maintenance workers makes it difficult to assess whether these numbers will be sufficient to meet future workforce needs. While pay for aviation

[125] Lora Chajka-Cadin and Catherine L. Taylor, "Forces to Flyers Pilot Training Demonstration Evaluation and Research on Pilot Career Pathways, Final Report," U.S. Department of Transportation, Volpe Center, December 2020, DOT-VNTSC-OSTR-21-01, at Forces to Flyers Pilot Training Demonstration Evaluation and Research on Pilot Career Pathways (bts.gov).

[126] Government Accountability Office, *Aviation Workforce: Supply of Airline Pilots and Aircraft Mechanics, Statement of Heather Krouse, Director, Physical Infrastructure, Testimony Before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives*, GAO-23-106769, April 19, 2023.

maintenance jobs has increased by about 12% between 2017 and 2022, airline employment has declined by about 13%, according to GAO.

Factors contributing to the decline may include increasing numbers of retirements of airline mechanics; competition from other industries for jobs requiring similar skills; lack of awareness and negative public perceptions of aviation maintenance careers; lower wages compared to skilled maintenance jobs in other industries; undesirable work conditions, such as late night shifts, work in inclement weather, and exposure to various workplace hazards; and inadequate training resources and facilities.

Moreover, GAO pointed out that the lack of diversity among aviation maintenance workers, as well as pilots, factors into hiring shortfalls; GAO reported that stakeholders identified that the industry has not historically been particularly successful in its efforts to recruit and retain students from diverse backgrounds.[127]

The FAA Reauthorization Act of 2018 directed the FAA to update regulations to modernize training programs at aviation maintenance technical schools. Similarly, Section 135 of the Consolidated Appropriations Act, 2021 (P.L. 116-260) directed the FAA to adopt industry-backed standards using an interim final rule. The FAA published the interim rule on May 24, 2022, with an effective date of September 21, 2022.[18] Under the new regulations, the FAA relies on the Department of Education and national accrediting organizations to approve curricula, instructional delivery, and other program details for each aviation maintenance training school, while the FAA will continue to oversee facilities, equipment, and instructor qualifications. Additionally, the FAA will retain responsibility for setting mechanic certification requirements, which it plans to update, and will continuously assess student pass rates as a key performance-based measure.

In the context of FAA reauthorization, Congress may consider legislative options to examine the FAA's implementation of these changes and possible future regulatory actions to move beyond the interim final rule to final regulations governing the training environment and curriculum for aviation maintenance technician schools. Congress may also consider additional options to improve interest in aviation maintenance careers and integrate aviation maintenance technician training and certification into high school and collegiate programs, as well as programs for military servicemembers and veterans.

Airline Industry Issues

U.S. carriers have largely recovered from the COVID-19 pandemic-induced reduction in travel. U.S. passenger airlines posted an 8% increase in operating revenues in 2022 compared with 2019. In the first three months of 2023, passenger volume through airport TSA checkpoints was 0.6% below the 2019 levels.[128]

The increasing air travel demand is likely to put pressure on airlines to add capacity and focus on serving the metropolitan area hub airports. Washington Reagan National Airport (DCA), a capacity-constrained large hub airport near Washington, DC, is under a federally imposed slot control and perimeter rule that would require legislation to be enacted to grant additional slots and exemptions for nonstop flights beyond the 1,250-mile perimeter.[129] Starting in the 1960s, the

[127] Ibid, p.12.

[128] Airlines for America, *The State of U.S. Commercial Aviation*, updated April 20, 2023.

[129] FAA limits the number of takeoffs and landings (slots) per hour because of congestion and delay at DCA. DCA is (continued...)

federal government placed restrictions on flights to help manage congestion and delays and to direct longer flights to Washington Dulles International Airport to spur growth there. There are currently 40 daily beyond-perimeter flights (20 round trips) to and from DCA, including the 16 beyond-perimeter slot exemptions required as part of the 2012 FAA reauthorization, the latest legislation that dealt with the DCA slots and perimeter rule.[130] This issue is likely to be part of the current FAA reauthorization.

The increasing air travel demand seemed to have strained airline operations and internal systems, which led to increasing delays and cancellations in 2022 and well into 2023. Southwest Airlines' extensive flight cancellations and significant delays over the December 2022 holiday period disrupted travel and stranded numerous passengers.[131] The carrier's meltdown, initially caused by winter storms, was compounded by an internal breakdown of its crew-scheduling system. The severe disruptions and passenger frustration have drawn attention to federal airline consumer protection rules and DOT's authority in aviation consumer protections (discussed in the "Airline Consumer Protection" section).

However, this air travel recovery appears to be uneven, as multiple small, nonhub airports have experienced air service cuts or have lost air service entirely.[132] Even communities in the Essential Air Service (EAS) program that have been receiving federally subsidized air service could risk losing service. On March 10, 2022, SkyWest Airlines notified DOT of its intent to terminate EAS service at 29 communities, stating the pilot staffing challenges as the reason. Since then, DOT has been having difficulty finding replacements; it has managed to secure replacement carriers for about 11 of those communities while holding SkyWest to continue providing service to the rest until replacement carriers take over.[133]

The SkyWest situation brought attention to DOT's long-standing difficulties in finding enough air carriers interested and able to cover the number of communities in the EAS program, as the agency has been trying to make this highly regulated program work in a deregulated environment. Congress may want to revisit the program and consider measures that would enable EAS to fulfill its intended purposes more efficiently and effectively.

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also subject to the 1,250-mile limit on the distance of nonstop flights to and from the airport, known as the *perimeter rule*. For more information on DCA slots and the perimeter rule, including the historical and legislative context, see Government Accountability Office, *Reagan National Airport: Information on Effects of Federal Statute Limiting Long-Distance Flights*, GAO-21-176, November 2020, at https://www.gao.gov/products/gao-21-176.

[130] FAA Modernization and Reform Act of 2012, P.L. 112-95, Section 414.

[131] Southwest Airlines disclosed in its regulatory filing on January 6, 2023, that it had cancelled more than 16,700 flights from December 21 through December 31.

[132] Lori Aratani, "With routes slashed during pandemic, small airports are on shaky flight path," *Washington Post*, April 6, 2022, at https://www.washingtonpost.com/transportation/2022/04/06/regional-airport-flights-commercial-service/; *WTOP News*, "Smaller cities set to lose service as airlines pull back," July 15, 2022, at https://wtop.com/travel/2022/07/smaller-cities-set-to-lose-service-as-airlines-pull-back/; and Julie Weed, "Regional Airports Have Lost A large Number of Flights," *New York Times*, December 3, 2022, at https://www.nytimes.com/2022/11/23/travel/airlines-cut-flights-regional-airports.html.

[133] See DOT, *90-Day Notice of SkyWest Airlines, Inc.'s Intent to Terminate Essential Air Service*, DOT-OST-2001-10682-0259, March 10, 2022, at https://www.regulations.gov/document/DOT-OST-2001-10682-0259. Per CRS discussion with DOT via email on March 6, 2023: SkyWest subsequently withdrew its notice at two communities; DOT was able to find replacement carriers for 11 of those communities while SkyWest continues to service the rest per DOT hold-in orders.

Essential Air Service to Small Communities[134]

The Airline Deregulation Act of 1978 (P.L. 95-504) gave airlines almost total freedom to determine which domestic markets to serve and what airfares to charge. This raised concern that communities with relatively low passenger levels would lose service as carriers shifted their operations to serve larger and often more profitable markets. Congress established the EAS program to help ensure a continuation of service to those small communities that were served by certificated air carriers before deregulation, with subsidies if necessary. The EAS program is administered by the Office of the Secretary of Transportation, which determines the minimum level of service required at each eligible community by specifying

- a hub through which the community is linked to the national network;
- a minimum number of round trips and available seats that must be provided to that hub;
- certain characteristics of the aircraft to be used; and
- the maximum permissible number of intermediate stops to the hub.

Over the years, Congress has limited the scope of the program, mostly by eliminating subsidy support for communities within a reasonable driving distance of a major hub airport. The FAA Modernization and Reform Act of 2012 adopted additional EAS reform measures, including Section 421, which amended the definition of an "EAS eligible place"[135] to require a minimum number of daily enplanements. The 2018 FAA reauthorization did not significantly alter the EAS program.

Under the 2012 act, for locations to remain EAS-eligible, they must have participated in the EAS program at any time between September 30, 2010, and September 30, 2011. An EAS-eligible place is now defined as a community that, during this period, either received EAS for which compensation was paid under the EAS program or received from the incumbent carrier a 90-day notice of intent to terminate EAS following which DOT required it to continue providing service to the community (known as "holding in" the carrier). Since October 1, 2012, no new communities may enter the program should they lose their unsubsidized service, except for locations in Alaska or Hawaii.

Communities eligible for EAS in FY2011 remain eligible for EAS subsidies if[136]

- they are located more than 70 miles from the nearest large or medium hub airport;
- they require a rate of subsidy per passenger of $200 or less, unless the community is more than 210 miles from the nearest hub airport;
- the average rate of subsidy per passenger is less than $1,000 during the most recent fiscal year at the end of each EAS contract, regardless of the distance from hub airport; and
- they have an average of 10 or more enplanements per service day during the most recent fiscal year beginning after September 30, 2012, unless these locations are

[134] See CRS Report R44176, *Essential Air Service (EAS)*, by Rachel Y. Tang.

[135] 49 U.S.C. §41731.

[136] The Department of Transportation Appropriations Act of 2000 (P.L. 106-69), Section 332, enacted the 70-mile rule and the $200-per-passenger subsidy rule.

more than 175 driving miles from the nearest medium or large hub airport or unless DOT is satisfied that any decline below 10 enplanements is temporary.

These limitations apply to the contiguous 48 states and Puerto Rico. EAS communities in Alaska and Hawaii are exempt from these requirements.

EAS Funding and Subsidies

The EAS program is funded through mandatory annual transfers of overflight fees paid to the FAA by foreign aircraft that fly through U.S. airspace but do not land in the country, supplemented by discretionary appropriations from the aviation trust fund. During the COVID-19 pandemic, EAS received additional appropriations from the Treasury general fund—$56 million in FY2020 under the CARES Act (P.L. 116-136) and $23.332 million under the Consolidated Appropriations Act, 2021 (P.L. 116-260).

DOT currently subsidizes air service to serve more than 170 communities that otherwise would not receive any scheduled commercial air service. At the end of FY2022, DOT was providing subsidies of over $424 million for service at about 111 communities in the contiguous 48 states, Hawaii, and Puerto Rico and 61 communities in Alaska. EAS funding for FY2023 is estimated to continue growing to over $491 million, with nearly $137 million from overflight fees and over $354 million from discretionary appropriations.[137]

Policy Enforcement and Issues

Since 2014, DOT has issued multiple tentative orders announcing its intention to enforce the statutory EAS program criteria. Dozens of communities were determined to have failed to meet one or two statutory eligibility criteria required to remain in the program—the $200-per-passenger subsidy cap for communities within 210 miles of the nearest medium or large hub and the minimum of 10 enplanements per day. Most of these communities filed for and received waivers, which kept them eligible to received subsidized EAS. A very small number of these communities had their eligibility terminated. These waivers not only contributed to rising program costs but also missed the opportunity to assess the effectiveness of applying the criteria had they been carried out.

These program criteria are not being enforced through FY2023. Concerned about COVID-19-related impact on EAS communities, Congress instructed DOT in multiple appropriations acts not to apply the eligibility criteria—the per-passenger subsidy cap and 10-enplanement minimum requirement—as a requirement for communities to remain eligible from FY2020 through FY2023.[138]

Airline Consumer Protection[139]

The 1978 deregulation of the airline industry in the United States eliminated federal control over many airline business practices, including pricing and domestic route selection. However, the federal government continues to legislate and enforce certain consumer protections for airline

[137] EAS funding update via email from DOT on March 5, 2023.

[138] The Consolidated Appropriations Act, 2021 (P.L. 116-260); Consolidated Appropriations Act, 2022 (P.L. 117-103); and Consolidated Appropriations Act, 2023, (P.L. 117-328).

[139] See CRS Report R43078, *Airline Passenger Rights: The Federal Role in Aviation Consumer Protection*, by Rachel Y. Tang.

passengers. Congress largely determines the degree to which the rights of airline passengers are codified in law or developed through DOT rulemaking.

The House Committee on Transportation and Infrastructure and the Senate Committee on Commerce, Science, and Transportation are the primary congressional committees of jurisdiction over airline passenger rights. Congress can authorize or require DOT to enact rules on certain issues, and it can enact requirements for airlines through direct legislation. In specific cases, DOT may take enforcement actions against air carriers that violate consumer protection rules.

Most of DOT's consumer rules are based on 49 U.S.C. §41712, which directs it to "protect consumers from unfair or deceptive practices." Some are based on DOT's authority to require air carriers in interstate transportation to provide "safe and adequate service" (49 U.S.C. §41702). The interpretation of the phrase "unfair or deceptive" can significantly affect the scope of DOT's enforcement authority.

DOT Notices of Proposed Rulemaking

On March 28, 2022, DOT published an NPRM, Accessible Lavatories on Single-Aisle Aircraft, which addresses certain accessibility issues for passengers with disabilities.[140] This proposed rule would require airlines to ensure that at least one lavatory on new single-aisle aircraft with 125 or more passenger seats is large enough to permit a passenger with a disability to approach, enter, and maneuver within the aircraft lavatory, as necessary; to use all lavatory facilities; and to leave by means of the aircraft's on-board wheelchair.

On August 22, 2022, DOT issued an NPRM, Airline Ticket Refunds and Consumer Protections, that proposes to

- codify its long-standing interpretation that it is an unfair business practice for an airline or a ticket agent to refuse to provide requested refunds to consumers when a carrier has cancelled or made a significant change to a scheduled flight and consumers found the alternative transportation offered to be unacceptable;
- define the terms *significant change* and *cancellation*;
- require airlines and ticket agents to inform consumers that they are entitled to a refund if that is the case before making an offer for travel credits, vouchers, or other compensation in lieu of refunds;
- require that airlines and ticket agents provide nonexpiring travel vouchers or credits to consumers holding nonrefundable tickets for scheduled flights to, from, or within the United States who are unable to travel as scheduled in certain circumstances related to a serious communicable disease; and
- require airlines and ticket agents to provide refunds, in lieu of nonexpiring travel vouchers or credits, if they received significant financial assistance from the government because of a public health emergency. [141]

On October 20, 2022, DOT initiated an NPRM, Enhancing Transparency of Airline Ancillary Service Fees, which proposes to

[140] See DOT, "Notice of Proposed Rulemaking: Accessible Lavatories on Single-Aisle Aircraft: Part 2," DOT-OST-2021-0137, March 18, 2022, at https://www.regulations.gov/document/DOT-OST-2021-0137-0001.

[141] See DOT, "Notice of Proposed Rulemaking: Airline Ticket Refunds and Consumer Protections," DOT-OST-2022-0089, August 3, 2022, at https://www.regulations.gov/document/DOT-OST-2022-0089-0004.

- require airlines and ticket agents to clearly disclose passenger-specific or itinerary-specific baggage fees, change fees, and cancellation fees whenever fare and schedule information is provided to consumers;
- require airlines and ticket agents to clearly disclose passenger-specific or itinerary-specific fees for adjacent seating whenever fare and schedule information is provided to consumers traveling with young children; and
- require that airlines provide useable, current, and accurate information regarding baggage fees, change fees, cancellation fees, and adjacent seating fees, if any, to ticket agents that sell or display the carrier's fare and schedule information. [142]

Congress could consider codifying or modifying these regulations during the FAA reauthorization.

Unruly Airline Passengers

FAA regulations prohibit interference with flight and cabin crewmembers. Specifically, 14 C.F.R. §§91.11, 121.580, and 135.120 state that "no person may assault, threaten, intimidate, or interfere with a crewmember in the performance of the crewmember's duties aboard an aircraft being operated." Per 49 U.S.C. §46318, the FAA has the express authority to fine individuals who assault or threaten crewmembers or any other individual onboard an aircraft or who take any action that poses an imminent threat to the aircraft or people onboard. Language in the FAA Reauthorization Act of 2018 (P.L. 115-254) increased the maximum civil penalty for such violations from $25,000 to $35,000. This penalty is adjusted annually for inflation and effective January 6, 2023, was set at $42,287 per violation.[143] The FAA notes that one incident could result in multiple violations. The act also expanded the scope of the statute to include sexual assault in addition to physical assault.

Furthermore, 49 U.S.C. §46504 authorizes criminal penalties, including fines and imprisonment up to 20 years, for assaulting or intimidating pilots or flight attendants and thereby interfering with the performance of their official duties. Stiffer penalties are available when the prohibited conduct involves use of a dangerous weapon. It is up to DOJ to prosecute disruptive or violent passengers.

Regarding incidents at commercial airports in the United States, 49 U.S.C. §46503 establishes criminal penalties, including fines and imprisonment up to 10 years, for assaults against federal, airport, or air carrier employees with security duties, when the assault interferes with these duties. As with Section 46504, additional penalties are available for prohibited conduct involving a dangerous weapon. Depending on circumstances, Section 46503 may encompass incidents directed at airline and airport employees, including airline customer service agents, airport security contractors, and airport law enforcement officers, as well as TSA screeners.

Regarding serving alcohol to passengers, 49 U.S.C. §44734 requires airline flight attendant training to include training to recognize intoxicated passengers, deal with disruptive passengers, and recognize and respond to potential human trafficking victims. It also requires situational training "on the proper method for dealing with intoxicated passengers who act in a belligerent manner."

[142] See DOT, *Enhancing Transparency of Airline Ancillary Service Fees*, DOT-OST-2022-0109, at https://www.regulations.gov/docket/DOT-OST-2022-0109.

[143] FAA, "Revisions to Civil Penalty Amounts," 88 *Federal Register* 1114-1132, January 6, 2023.

Additionally, 49 U.S.C. §44918 mandates that air carriers provide a training program for flight and cabin crew primarily aimed at protecting and defending against terrorist threats. This training must cover recognition of suspicious activities, crew communication and coordination, self-defense, and situational training exercises regarding various threat conditions. The statute also requires TSA to offer, free of charge, voluntary advanced self-defense training to airline flight and cabin crewmembers that includes training in techniques to deter a passenger who might present a threat; self-defense; and methods to subdue an attacker.

In response to growing concerns over unruly passengers, the FAA launched the "Zero Tolerance for Unruly and Dangerous Behavior Toolkit" in 2021, which includes airport signage, internet-based messaging, and public service announcements aimed at increasing awareness about enforcement actions to deter unruly behavior. Overall, unruly passenger conduct in the first five months of 2023 has dropped by almost 70% compared to the same period in 2021.[144] Despite these efforts, the FAA noted that since late 2021, it has referred over 250 serious incidents of unruly passenger conduct to the Federal Bureau of Investigation (FBI).[145] The Protection from Abusive Passengers Act (H.R. 2394; S. 1058) seeks to establish a process for banning unruly fliers, reported by the FAA or DOJ to the TSA, from commercial airline flights.

Aviation and the Environment

It is within the FAA's purview, in coordination and consultation with the Environmental Protection Agency (EPA), to regulate and mitigate the environmental impacts of aviation and take actions to address air transportation noise and emissions.[146] The FAA's goals include reducing the number of people exposed to significant noise around U.S. airports, reducing significant air quality impacts from aviation, and improving the efficiency of air transportation, in part, by increasing the utilization of sustainable aviation fuels.[147]

Aircraft Noise

FAA regulations set noise limits for aircraft certification. During the aircraft certification process, sound levels are measured under three conditions: (1) full-power takeoff; (2) flyover; and (3) approach. A normalization procedure, called the Effective Perceived Noise Level (EPNL), is used to account for tones and sound duration. The sum of these three measurements must be below the noise certification standard for that particular aircraft, which depends on its maximum takeoff weight and the number of engines. Noise certification standards, referred to as *stages*, have become more stringent over the years as engine and airframe noise reduction technology has improved. Aircraft produced in the late 1960s through 1975 had to meet Stage 2 noise standards. In the mid-1970s, the FAA set more stringent Stage 3 criteria for new aircraft and aircraft engines, which became mandatory for all new jet airplanes by the late 1980s. Noisier Stage 2 airplanes were gradually phased out and were completely banned from routine operation in U.S. airspace by 2016. In 2005, the FAA promulgated Stage 4 standards, which mandated a cumulative

[144] FAA, "Unruly Passenger Statistics," at https://www.faa.gov/unruly.

[145] FAA, "FAA Refers More Unruly Passenger Case to FBI in 2023," April 13, 2023, at https://www.faa.gov/newsroom/faa-refers-more-unruly-passenger-cases-fbi-2023.

[146] Notably, the National Environmental Policy Act (NEPA. 42 U.S. Code §§4321 et seq.), and special purpose environmental laws and regulations, require environmental impact analyses of proposed airport actions that are subject to FAA decision. Additionally, 42 U.S.C. §7571 requires the EPA to consult with the FAA on aircraft engine emissions standards, and 49 U.S.C. §44715 requires FAA to control and abate aircraft noise and sonic boom and consider related regulatory proposals from the EPA.

[147] FAA, *Office of Environment and Energy,* at https://www.faa.gov/about/office_org/headquarters_offices/apl/aee.

reduction of 10 EPNLdB across the three measurement conditions compared with Stage 3, and in 2017, the FAA adopted Stage 5 standards requiring a further cumulative reduction of 7 EPNLdB below Stage 4 standards. Since these standards apply to new aircraft designs only, it usually takes several years for operational noise levels to noticeably decrease as airline fleets are replaced.

To describe noise levels in communities, aircraft noise is modeled based on flight operations across an average busy day for an airport or flight route. Noise events are aggregated over the 24-hour period, and penalties of 10 dB are added to nighttime flights between 10 p.m. and 7 a.m. The resulting single descriptor of the noise environment is known as the day-night average sound level (DNL). Since the 1970s, community reaction to aircraft noise levels has been described in terms of annoyance response measured through community surveys. Based on analyses of annoyance response as a function of DNL, the FAA has developed recommendations regarding acceptable land uses. The FAA concluded that strong community reaction to aircraft noise levels is likely above 65 DNL and advises that residential land use is generally not suitable for locations above this level.

Efforts to reduce aircraft noise impacts to communities focus on three key strategies: (1) quieting noise sources, such as aircraft engines and airframes; (2) increasing the distance between aircraft and communities through land use planning and noise abatement procedures; and (3) attenuating sound along the transmission path through means such as "soundproofing" homes by installing heavier insulation and thicker, double-paned windows. Although land use planning is largely a local government issue, the FAA provides advisory guidance on compatible land uses. It also provides federal funding to mitigate noise in impacted residential communities using Airport Improvement Program (AIP) funds set aside for environmental mitigation. This funding pays for sound insulation in homes and, in some cases, purchases of homes in areas highly impacted by aircraft noise. This is sometimes done in conjunction with major airport expansions such as runway lengthening or the addition of a new runway that creates new noise impacts to nearby residential communities. Historically, Congress has addressed airport noise concerns by setting aside 35% of discretionary funding under the AIP for noise mitigation and abatement. Generally, these funds may be used only within the 65 DNL-noise-impact area around an airport. The combination of these three approaches has led to a significant reduction in the residential population exposed to aircraft noise levels above 65 DNL over the past four decades, despite considerable growth in air traffic.[148]

As part of the NextGen effort, the FAA is establishing new approach and departure patterns at airports to implement precision navigation capabilities. The FAA refers to these procedures as Performance Based Navigation (PBN). To implement PBN in complex airspace around major metropolitan areas, the FAA is conducting a number of projects under its "metroplex" program, a contraction of "metropolitan" and "complexes" that describes very large metropolitan areas, often consisting of two or more cities. A process the FAA calls Optimization of Airspace and Procedures in the Metroplex (OAPM) integrates NextGen procedural changes in a comprehensive plan to reconfigure flight patterns and air traffic operations in a manner intended to make the best use of NextGen precision navigation and aircraft tracking capabilities. In planning each metroplex airspace reconfiguration, the FAA prepares an environmental assessment allowing for input from communities that may be affected by proposed changes to flight patterns. Currently there are 11 metroplex projects in various stages of study and implementation. The FAA reversed an earlier airspace restructuring it had implemented in Phoenix, AZ, following numerous noise complaints, criticism regarding limited community involvement in the process, and legal action challenging implementation of the flight path changes. The FAA previously implemented a major

[148] See CRS Report R46920, *Federal Airport Noise Regulations and Programs*, by Rachel Y. Tang.

airspace redesign separate from its metroplex program in the New York-New Jersey-Philadelphia region, which has also faced considerable community criticism. Some other major metropolitan areas and airports, including Chicago, Boston, and Seattle, are not being considered under formal FAA metroplex implementation plans but have faced community concerns about flight path changes associated with NextGen implementation to varying degrees.

The FAA Modernization and Reform Act of 2012 (P.L. 112-95) included language allowing the FAA to proceed with the lowest level of environmental review, known as a categorical exclusion. Following backlash from this approach, particularly in Phoenix, Congress reexamined how the FAA was conducting its noise analyses and engaging with communities regarding its metroplex projects. The FAA Reauthorization Act of 2018 (P.L. 115-254) mandated that the FAA complete its review of alternatives to DNL and 65 DNL guidelines. The legislation directed the FAA to study the potential health and economic impacts of aircraft noise on communities and to assess whether aircraft approach and takeoff speed restrictions could reduce noise impacts without affecting flight safety. It also required the FAA to allow airports to request changes to departure patterns and flight track variations to reduce the concentration of flight paths over certain neighborhoods due to PBN, improve its community engagement practices, and appoint regional noise ombudsmen to liaise with communities impacted by noise stemming from NextGen changes. FAA officials testified in September 2019 that the agency was working to meet these requirements.[149]

As NextGen transitions to full-scale operations, concerns over community noise from new flight patterns may limit the extent to which NextGen improves airspace utilization and efficiency. As part of the NextGen effort, the FAA has redesigned terminal airspace around the largest urban areas through initiatives it refers to as metroplex projects. The redesigns are intended to make the best use of performance-based navigation and improved aircraft tracking capabilities. Some of these changes have increased overflights above communities that previously experienced relatively little aircraft noise, triggering resident complaints. The FAA Reauthorization Act of 2018 included provisions directing the FAA to review its community engagement practices, appoint regional noise ombudsmen, and assess the use of dispersed headings and lateral track variations to approach and departure paths at airports that request such analyses. The legislation also instructed the FAA to complete a study assessing alternative ways to gauge aircraft noise impacts, but the FAA has largely concluded that its existing assessment methods are appropriate while acknowledging that supplementary noise metrics may be helpful to support public understanding of community noise effects.[150] A 2021 FAA-sponsored study found that communities around U.S. airports are much less tolerant of aircraft noise than policies based on decades-old research.[151] This suggests that the FAA will continue to grapple with community noise concerns as it expands capacity and reconfigures airspace to improve efficiency utilizing NextGen capabilities. In the context of FAA reauthorization, Congress may consider whether FAA noise policies and its practices for assessing noise impacts around airports and under flight paths should be updated to reflect apparent changes in community tolerance of aircraft noise as indicated by the 2021 study.

[149] See CRS In Focus IF11420, *Aircraft Noise and Air Traffic Control Modernization*, by Bart Elias.

[150] FAA, *Report to Congress, FAA Reauthorization Act of 2018 (*P.L. 115-254*), Section 188 and Sec 173,* April 14, 2020, at https://www.faa.gov/about/plans_reports/congress/media/Day-Night_Average_Sound_Levels_COMPLETED_report_w_letters.pdf.

[151] Nicholas P. Miller et al., *Analysis of the Neighborhood Environmental Survey, Final Report*, DOT, DOT/FAA/TC-21/4, February 2021, at https://www.airporttech.tc.faa.gov/Products/Airport-Safety-Papers-Publications/Airport-Safety-Detail/ArtMID/3682/ArticleID/2845/TC-21-4-Analysis-of-NES.

National Parks and Air Tour Management[152]

The statutory and regulatory framework for conducting air tours over national parks has been of ongoing interest to Congress. The National Parks Air Tour Management Act of 2000 (Air Tour Act) governs commercial air tours over most units of the National Park System as well as tribal lands within or abutting park units.[153] The Air Tour Act required the FAA and the National Park Service (NPS) to create air tour management plans (ATMPs) for sites at which operators apply to conduct commercial air tours.[154] Each plan could prohibit or limit air tours, such as by route and altitude restrictions.[155] The purpose of a plan is to mitigate or prevent any harm commercial air tours may cause to natural and cultural resources, visitor experiences, and tribal lands. Development of an ATMP requires environmental review under the National Environmental Policy Act (NEPA).[156]

Under the law and its implementing regulations, the FAA received applications to conduct commercial air tours at more than 100 parks and/or tribal units.[157] However, development of ATMPs for these sites proceeded more slowly than expected after the law's 2000 enactment, and through 2021, no ATMPs had been completed. During this period, some air tour operators still could continue activities under interim operating authorities provided in the act.[158] Also during this period, the 112th Congress enacted broad aviation legislation, the FAA Modernization and Reform Act of 2012 (P.L. 112-95), with provisions amending the Air Tour Act to streamline agency actions, in part because of the slow progress in completing ATMPs. These provisions specified that, in lieu of an ATMP, the NPS Director and the FAA Administrator may enter into a voluntary agreement with a commercial air tour operator that would govern commercial air tours over a park unit.[159] P.L. 112-95 also exempted park units with 50 or fewer annual air tour flights from the requirement to establish an ATMP or voluntary agreement.[160] As of February 2023, the

[152] Laura B. Comay, Specialist in Natural Resources Policy, contributed this section.

[153] P.L. 106-181, Title VIII (49 U.S.C. §40128). The Air Tour Act does not apply to Grand Canyon National Park, tribal lands in or abutting Grand Canyon National Park, or air routes over Lake Mead National Recreation Area used solely for air tours over Grand Canyon National Park (49 U.S.C. §40128(e) and (f)). An earlier law, the National Parks Overflight Act of 1987 (P.L. 100-91), and subsequent statutes contained provisions specific to Grand Canyon National Park. For more information, see CRS Report R42955, *Motorized Recreation on National Park Service Lands*, by Laura B. Comay, Carol Hardy Vincent, and Kristina Alexander, section on "Site-Specific Conflict: Grand Canyon National Park."

[154] 49 U.S.C. §40128(b)(1)(A). The requirement covers commercial air tours over National Park System units, tribal lands within or abutting a unit, and areas within a half-mile of a unit's borders (with exceptions described in the previous footnote).

[155] 49 U.S.C. §40128(b)(3).

[156] 42 U.S.C. §§4321-4370f.

[157] FAA, "Supplement to Notice of Interim Operating Authority Granted to Commercial Air Tour Operators Over National Parks and Tribal Lands Within or Abutting National Parks," 70 *Federal Register* 58778, October 7, 2005. The FAA's implementing regulations are at 14 C.F.R. §136.37. Also see FAA, "Act Requirements—Air Tour Management Plan," at https://www.faa.gov/about/office_org/headquarters_offices/ara/programs/air_tour_management_plan/more_tour_management_plan.

[158] 49 U.S.C. §40128(c). The interim authority is available specifically to "existing" commercial air tour operators who were "actively engaged in the business of providing commercial air tour operations over a national park" in the year proceeding the 2000 enactment of the Air Tour Act (49 U.S.C. §40128(g)(2)).

[159] P.L. 112-95, Title V, Section 501(c). Voluntary agreements may contain conditions for the conduct of commercial air tours (e.g., regarding routes, altitudes, or time-of-day restrictions), provide for air tour fees, and provide incentives for the adoption of quiet aircraft technology, among other conditions. After an opportunity for public review and consultation with any tribes whose lands may be flown over, a voluntary agreement may be implemented "without further administrative or environmental process."

[160] P.L. 112-95, Title V, Section 501(b).

agencies reported that 54 park units with air tours were exempted from requirements to establish an ATMP or voluntary agreement because they had fewer than 50 annual flights.[161]

A 2020 court order required the FAA and the NPS to file a plan that would enable the agencies to bring 23 eligible parks into compliance with the Air Tour Act in two years, or to provide specific reasons why compliance would take longer.[162] In 2022, the agencies completed 10 ATMPs covering Arches National Park, Bryce Canyon National Park, Canyonlands National Park, Death Valley National Park, Glacier Bay National Park, Great Smoky Mountains National Park, Mount Rainier National Park, Natural Bridges National Monument, Olympic National Park, and the San Francisco Bay Area parks.[163] In the first half of 2023, the agencies completed voluntary agreements with operators at the Statue of Liberty National Monument and Governors Island National Monument.[164] The agencies also released draft ATMPs for four parks (Haleakala National Park, Hawai'i Volcanoes National Park, Mount Rushmore National Memorial, and Badlands National Park), several of which propose to significantly curtail or eliminate authority for air tours at the parks.[165] Planning also is in progress for a number of other units.[166]

Congress has conducted oversight and considered legislation related to the agencies' progress on ATMPs and voluntary agreements, and related to park overflights more generally. Some stakeholders seek to limit or prohibit commercial air tours over national parks owing to concerns about noise, resource protection, and safety, while others advocate for greater flexibility for air tour operators whose economic stability may depend on providing overflights and whose business may contribute to local economies. In the 118th Congress, H.R. 1071 proposes a prohibition on commercial air tours over national parks as well as certain other protected areas. H.R. 2613 proposes amending the Air Tour Act to require that voluntary agreements address the "wellbeing" of communities that fall under park air tour flight routes.

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[161] FAA, "Air Tour Management Plans: Frequently Asked Questions," February 2023, at https://www.faa.gov/about/officeorg/headquartersoffices/ara/air-tour-management-plans-frequently-asked-questions. The number of exempted parks may change from year to year based on changes by operators in the numbers of air tours flown. The NPS Director also can withdraw an exemption in order to protect park resources and values or visitor use and enjoyment. Exemptions have been withdrawn for Mount Rainier National Park, Death Valley National Park, Canyon de Chelly National Monument, and Muir Woods National Monument.

[162] In re Public Employees for Environmental Responsibility, 957 F.3d 267 (D.C. Cir. 2020). For more information, see FAA, "Air Tour Management Plan," at https://www.faa.gov/about/office_org/headquarters_offices/ara/programs/air_tour_management_plan. Under the court order, the agencies also must submit quarterly updates on their progress.

[163] Links to the plans are available from FAA at https://www.faa.gov/about/office_org/headquarters_offices/ara/programs/air_tour_management_plan; and from NPS at https://www.nps.gov/subjects/sound/airtours.htm. The San Francisco Bay Area parks include Golden Gate National Recreation Area, Muir Woods National Monument, San Francisco Maritime National Historical Park, and Point Reyes National Seashore.

[164] Ibid. Prior to the court order, NPS and FAA also had completed voluntary agreements with air tour operators at Big Cypress National Preserve and Biscayne National Park, and with some (but not all) operators at Glen Canyon National Recreation Area and Rainbow Bridge National Monument. As discussed, no ATMPs had been completed prior to the court order.

[165] Ibid. This information is current as of June 1, 2023. In particular, the draft plan for Hawai'i Volcanoes National Park proposes to reduce air tours from a 2017-2019 annual average of 11,376 commercial air tours to an authorized 1,565 tours annually. For Mt. Rushmore National Memorial (2017-2019 annual average 3,914 tours) and Badlands National Park (2017-2019 annual average 1,425 tours), air tours over the park or within one-half mile of the park's boundary would be prohibited altogether.

[166] Additional parks with plans in progress include Bandelier National Monument, Canyon de Chelly National Monument, Glen Canyon National Recreation Area, Lake Mead National Recreation Area, Mount Rushmore National Memorial, and Rainbow Bridge National Monument. FAA, "Air Tour Management Plans: Frequently Asked Questions," February 2023, at https://www.faa.gov/about/officeorg/headquartersoffices/ara/air-tour-management-plans-frequently-asked-questions.

FAA Actions Regarding Aircraft Emissions

The Clean Air Act (CAA) of 1970 directs the EPA to establish air pollution standards, including those applicable to aircraft exhaust. The FAA, in consultation with EPA, regulates the emissions of gas turbine (jet) engines, including allowable limits for exhaust smoke, hydrocarbons, carbon monoxide, and nitrogen oxides.[167]

In 2010, the FAA launched the Continuous Lower Energy, Emissions, and Noise (CLEEN) program, a partnership program with industry to foster advances in aircraft emissions reductions as well as reduced noise and improved fuel efficiency. Section 743 of the FAA Reauthorization Act of 2018 (P.L. 115-254) specifically recognized the CLEEN program and directed the FAA to enter into cost-sharing cooperative agreements using a competitive process and to set specific performance objectives for the program regarding reduced fuel burn, emissions, and noise. Since its inception, the program has progressed through three five-year phases, each with specific quantitative goals for reductions in aircraft noise, fuel burn, and emissions levels of nitrous oxides and nonvolatile particulates for progressively reducing environmental impacts beyond established international standards. Industry partners participating in the CLEEN program must agree to match federal funding. Through the first two phases of CLEEN from 2010 to 2020, the FAA provided $225 million in funding while industry partners, generally consisting of large engine and aircraft manufacturers, contributed $388 million.[168]

In addition to CLEEN, the FAA supports advancement in aircraft emissions reductions and reductions in other environmental impacts of aviation through its Center of Excellence for Alternative Jet Fuels and the Environment, also known as the Aviation Sustainability Center or ASCENT. ASCENT is a cooperative research consortium led by Washington State University and the Massachusetts Institute of Technology that receives funding from the FAA, EPA, NASA, and DOD. Its research is focused on meeting the environmental and energy goals of the NextGen system, including reducing noise, improving air quality, reducing climate impacts, and energy efficiency; exploring commercial-scale sustainable aviation fuel production; and exploring science-based solutions to benefit the aviation industry and improve the health and quality of life of those living and working around airports.[169] In 2017, ASCENT replaced the Partnership for Air Transportation Noise and Emissions Reduction (PARTNER) to carry on research and development to address existing and anticipated aviation noise and emissions challenges.

In November 2021, the FAA published the United States Aviation Climate Action Plan addressing greenhouse gas (GHG) emissions, including carbon dioxide, nitrous oxide, and methane, from aviation sources.[170] The plan sets a goal of net-zero GHG emissions from aviation sources in the United States, including all domestic flights and all international flights to and from U.S. airports, by 2050. The plan endeavors to achieve this objective through operational improvements in air traffic management and supporting infrastructure, a transition to sustainable aviation fuel (SAF), participating in international market-based mechanisms and standards to incentivize investment in more efficient and sustainable aircraft technologies, and initiatives to reduce carbon emissions from airport operations and infrastructure. These options are discussed in further detail below.

[167] See 14 C.F.R. Part 34, *Fuel Venting and Exhaust Emission Requirements for Turbine Engine Powered Airplanes.*

[168] FAA, "Continuous Lower Energy, Emissions, and Noise (CLEEN) Program," at https://www.faa.gov/newsroom/continuous-lower-energy-emissions-and-noise-cleen-program.

[169] See "ASCENT—The Aviation Sustainability Center," at https://ascent.aero/.

[170] FAA, *United States 2021 Aviation Climate Action Plan*, November 9, 2021, at https://www.faa.gov/sustainability/aviation-climate-action-plan.

Carbon Dioxide Emissions Standards and Offsetting Schemes[171]

The EPA, in consultation with the FAA, sets emission levels for specified pollutants from aircraft in accordance with Section 231 of the Clean Air Act.[172] Aircraft emission standards currently exist for fuel venting and engine hydrocarbons, carbon monoxide, nitrogen oxides, particulates, and carbon dioxide (CO_2). The standard-setting language under CAA Section 231 is similar to the statutory language for other mobile sources (e.g., cars, trucks, buses). As opposed to its regulation of other vehicle emissions, the EPA must meet additional statutory requirements for aircraft and aircraft engines: (1) the EPA Administrator must consult with the Administrator of the FAA and the Secretary of Transportation in developing emission standards; (2) the EPA Administrator cannot change standards if doing so would "significantly increase noise and adversely affect safety"; and (3) the President may disapprove any such standards if the Secretary of Transportation finds that they "would create a hazard to aircraft safety." CAA Section 232 requires the FAA to enforce the standards at the time a newly manufactured engine is certified for emissions.[173]

Due to the global nature of the commercial aircraft industry and its customer base, the EPA has generally regulated emissions from aircraft only after the United States has negotiated an international agreement through the ICAO.[174] In March 2017, ICAO adopted international CO_2 standards for newly developed commercial aircraft engines to begin in 2020.[175] In accordance with the ICAO negotiations and the CAA, EPA promulgated GHG emission standards for aircraft engines equivalent to the CO_2 standards adopted by the ICAO.[176]

Additionally, ICAO member states agreed on a Market-Based Mechanism (MBM) for offsetting future carbon emissions from aviation, referred to as the "Carbon Offsetting and Reduction Scheme for International Aviation" (CORSIA). CORSIA is to address "any annual increase in total CO_2 emissions from international civil aviation (i.e., civil aviation flights that depart in one country and arrive in a different country) above the 2020 levels, taking into account special circumstances and respective capabilities."[177] The program relies on the use of emissions units from carbon markets to offset the amount of CO_2 emissions that cannot be reduced through the use of sustainable aviation fuels or technological and operational improvements. CORSIA began in 2021, and participation is voluntary through 2026. The U.S. aviation industry agreed to participate during ICAO negotiations. To fulfill the U.S. commitments under the Chicago

[171] Richard K. Lattanzio, Specialist in Environmental Policy, contributed this section.

[172] 42 U.S.C. §7571; 40 C.F.R. Part 87, "Control of Air Pollution from Aircraft and Aircraft Engines."

[173] 42 U.S.C. §7572; 14 C.F.R. Part 34, "Fuel Venting and Exhaust Emission Requirements for Turbine Engine Powered Airplanes."

[174] ICAO is a United Nations specialized agency established in 1944 to manage the administration and governance of the Convention on International Civil Aviation (the Chicago Convention), including environmental standards, to which the United States is a member state. ICAO has no direct regulatory or enforcement authority. After member states agree to a negotiated set of international standards, they implement these standards through their own domestic laws and regulatory processes.

[175] ICAO, Resolution A39-2: "Consolidated statement of continuing ICAO policies and practices related to environmental protection—Climate change."

[176] EPA, "Control of Air Pollution from Airplanes and Airplane Engines: GHG Emission Standards and Test Procedures," 86 *Federal Register* 2136, January 11, 2021.

[177] ICAO, Resolution A39-3: "Consolidated statement of continuing ICAO policies and practices related to environmental protection—Global Market-based Measure (MBM) Scheme." Due to the effects of the Coronavirus Disease 2019 (COVID-19) pandemic on 2020 air travel and emission levels, ICAO adopted Resolution A41-22, which establishes adjustments to the definition of the CORSIA baseline as follows: for the pilot phase (2021-2023), the total CO_2 emissions covered by CORSIA in 2019; and for the first and second phases (2024-2035), 85% of the total CO_2 emissions covered by CORSIA in 2019.

Convention with respect to the MBM, the FAA implemented the CORSIA Monitoring, Reporting, and Verification Program in 2019.[178] Whether and what additional authorities would be needed by EPA and FAA to "issue proposed emission standards" for CORSIA's mandatory trading scheme beginning in 2027 remains under consideration.

Sustainable Aviation Fuels[179]

Sustainable aviation fuel (SAF) is generally regarded as a drop-in fuel "derived from renewable or waste-based feedstocks that, relative to petroleum-based fuels, provide reduced carbon dioxide emissions."[180] Some in Congress and the Administration, as well as some industry and stakeholder organizations, actively support the adoption of SAF for multiple reasons, including environmental reasons (e.g., greenhouse gas emission reduction for the aviation sector) and economic reasons (e.g., new market for biomass feedstock).[181] In general, SAF can be blended up to 50% by volume with conventional jet fuel.[182] EPA reports that nearly 7.9 million gallons of renewable jet fuel were produced domestically in 2022.[183]

Both Congress and the executive branch have taken recent measures to support SAF. For instance, the Inflation Reduction Act of 2022 (IRA; P.L. 117-169) established a new SAF tax credit (26 U.S.C. §40B) effective for 2023 and 2024. SAF will qualify for the new clean fuel production tax credit (26 U.S.C. §45Z), when that provision becomes effective in 2025. The IRA also established a competitive grant program at DOT to support "projects located in the United States that produce, transport, blend, or store sustainable aviation fuel, or develop, demonstrate, or apply low-emission aviation technologies" (49 U.S.C. §44504 note).[184] In 2021, the Biden Administration announced the new Sustainable Aviation Fuel Grand Challenge with a goal to produce 3 billion gallons of SAF by 2030, among other things.[185] In addition, the private sector has announced SAF purchase agreements, an airline-coordinated SAF fund, and the incorporation of SAF in plans to reach net-zero commitments.[186]

Congress may consider certain items as it oversees current SAF initiatives and if it debates changes to legislative support for SAF. For example, there is an ongoing discussion about SAF lifecycle GHG emission reductions, including which method to use, what reporting measurements

[178] FAA, "FAA's CORSIA Monitoring, Reporting & Verification Program," 84 *Federal Register* 9412, March 14, 2019.

[179] Kelsi Bracmort, Specialist in Natural Resources and Energy Policy, contributed this section.

[180] U.S. Department of Energy (DOE), *FAQ: Sustainable Aviation Fuels*, March 22, 2023. Drop-in fuels are interchangeable with petroleum fuels and can be used with existing fuel infrastructure.

[181] For more information on SAF, see CRS Report R47171, *Sustainable Aviation Fuel (SAF): In Brief*, by Kelsi Bracmort and Molly F. Sherlock.

[182] DOE, *Sustainable Aviation Fuel: Review of Technical Pathways*, DOE/EE–204, September 2020.

[183] EPA, "RINs Generated Transactions," at https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rins-generated-transactions. The 2022 production volume is for jet fuel registered for the Renewable Fuel Standard (RFS) program. Compliant fuels for the RFS include transportation fuel, heating oil, and jet fuel. For more information on the RFS, see CRS Report R43325, *The Renewable Fuel Standard (RFS): An Overview*, by Kelsi Bracmort.

[184] For more information, see Federal Aviation Administration, *IRA Section 40007 FAST-SAF and FAST-Tech Grant Program*, December 14, 2022.

[185] The White House, *FACT SHEET: Biden Administration Advances the Future of Sustainable Fuels in American Aviation*, September 9, 2021. The three principal agencies involved in the SAF Grand Challenge are DOE, the U.S. Department of Transportation, and the U.S. Department of Agriculture. For more information, see DOE, *Memorandum of Understanding Sustainable Aviation Fuel Grand Challenge*, September 8, 2021.

[186] For more information, see Delta, "Delta's deal with Gevo pushes SAF goal forward," press release, March 22, 2022; Amrith Ramkumar, "United Airlines Creates Fund for Sustainable Aviation Fuel," *Wall Street Journal*, February 20, 2023; and Boeing, "Boeing Takes New Role to Help Cut Aviation Emissions Faster," press release, August 8, 2022.

to use, what benchmark to use, and what components to include. Another item Congress may consider is biomass feedstock availability, competition, and cost. Further, Congress may consider the amount of time and level of financial support it wants to direct to SAF and if SAF will be a "bridge" fuel to another aviation fuel or technology.

Unleaded Aviation Gasoline[187]

The general aviation (GA) sector in the United States consists mostly of small piston-engine airplanes and helicopters, nearly all of which operate on aviation gasoline (avgas).[188] Lead is commonly added to avgas to achieve the octane rating needed for the safe operation of high-performance aircraft with high-compression engines, which account for about one-third of the GA fleet and a larger percentage of fleet fuel consumption. While leaded avgas—specifically "100LL" grade avgas—is not required by a majority of the GA fleet, it can be used by all types of piston-engine aircraft. Thus, 100LL avgas is typically the fuel grade made available to GA operators at airports across the United States. Lead, however, is a highly toxic substance. The Centers for Disease Control and Prevention (CDC) concluded that exposure to even low concentrations of lead, including prenatal exposure, has been linked to decreased cognitive performance in children, among other health damages.[189] EPA estimates that approximately 5.2 million people live within 500 meters of an airport runway, 363,000 of whom are children age 5 and under.[190]

EPA has authority under the CAA to issue emission standards for aircraft engines and fuels.[191] Since at least 2007, EPA has evaluated the impact of lead emissions from the GA sector.[192] In October 2022, EPA issued a proposed determination that lead emissions from piston-engine aircraft cause or contribute to air pollution, which may reasonably be anticipated to endanger public health and welfare.[193] EPA's proposed determination is the first step toward the application of EPA's and the FAA's statutory authorities to address the pollution. If EPA makes an affirmative final determination, the agency would be required to propose regulatory standards, which would trigger the FAA's statutory mandate to "prescribe standards for the composition or chemical or physical properties of an aircraft fuel or fuel additive to control or eliminate aircraft emissions the

[187] Richard K. Lattanzio, CRS Specialist in Environmental Policy, contributed this section.

[188] Piston-engine aircraft, as opposed to turbine-engine jet aircraft, have one or more piston-powered engines connected to a propeller to provide thrust to move the aircraft on the ground and through the air. Piston-engine aircraft are most commonly used for personal and recreational transportation (67%), business (12%), instructional flying (8%), medical transportation (less than 1%), and the remainder includes hours spent in other applications, such as aerial observation and aerial application. Aerial application for agricultural activity includes crop and timber production, which involve fertilizer and pesticide application and seeding cropland. 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)," at https://www.faa.gov/data_research/aviation_data_statistics/general_aviation/CY2019/.

[189] CDC, "Health Effects of Lead Exposure," at https://www.cdc.gov/nceh/le,ad/prevention/health-effects.htm.

[190] EPA, "National Analysis of the Populations Residing Near or Attending School Near U.S. Airports," EPA-420-R-20-001, 2020, at https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100YG4A.pdf.

[191] 42 U.S.C. Part B and 42 U.S.C. §7545, respectively.

[192] EPA, "Petition Requesting Rulemaking to Limit Lead Emissions from General Aviation Aircraft; Request for Comments," 72 *Federal Register* 64570, November 16, 2007.

[193] EPA, "Proposed Finding That Lead Emissions from Aircraft Engines That Operate on Leaded Fuel Cause or Contribute to Air Pollution That May Reasonably Be Anticipated to Endanger Public Health and Welfare," 87 *Federal Register* 62753, October 17, 2022. For data and analysis of piston-engine aircraft emissions of lead at U.S. airports, see EPA, "Regulations for Emissions from Vehicles and Engines," at https://www.epa.gov/regulations-emissions-vehicles-and-engines/epas-data-and-analysis-piston-engine-aircraft-emissions.

Administrator of the Environmental Protection Agency decides under section 231 of the Clean Air Act."[194] EPA's final determination is scheduled for release in the fall of 2023.[195]

Over the past 25 years, the FAA has engaged with the GA industry and fuel developers on work toward an unleaded drop-in replacement fuel for 100LL that can satisfy the performance requirements of the entire piston-engine fleet. Currently, the FAA is developing a multilayered strategy based on various recommendations in the 2021 National Academies of Sciences, Engineering, and Medicine report commissioned by Section 177 of the FAA Reauthorization Act of 2018 (P.L. 115-254).[196] This includes continued collaboration with industry through the Piston Aviation Fuels Initiative (PAFI).[197]

Electric Aircraft

Similar to the ongoing transition to electric automobiles, one option for moving aircraft away from the use of fossil fuels is to replace engines, particularly reciprocating combustion engines on smaller aircraft, with electric motors. The FAA has approved a few small electric-powered training aircraft, and some larger electric aircraft capable of ferrying passengers and cargo are in development and testing.[198]

A significant challenge to transitioning to electric propulsion for aircraft is the weight of batteries, which correspondingly limits the effective range of current era electric aircraft. Safety requirements further complicate this issue. This is in part due to the increased weight of aircraft structures to improve occupant survivability and due to requirements for reserve fuel capacity as an additional margin of safety. To fly only in daylight and good weather, aircraft are required to have 30 minutes of reserve capacity.[199] At night, that increases to 45 minutes. To operate under instrument flight rules (IFR) and operate in lower visibility or in clouds, an aircraft must be able to fly to its intended destination, be able to then proceed to a designated alternate, and thereafter, be able to sustain flight for another 45 minutes.[200] These requirements place considerable challenges on using electric propulsion as a viable option for many existing commercial flight operations, where adequate aircraft range and the capability to fly in clouds and reduced visibility are necessary, using currently available battery technology.

Despite current limitations and challenges of electric motors, batteries, and fuel cell technologies, electric propulsion is considered viable for electric-powered vertical takeoff and landing (eVTOL) aircraft under consideration for AAM missions (see "Advanced Air Mobility"). The short-range, low-altitude missions envisioned for AAM, such as urban air taxi operations, are seen as particularly suitable candidates for electric propulsion. However, even for these

[194] 49 U.S.C. §44714.

[195] Office of Management and Budget, "Fall 2022 Unified Agenda of Regulatory and Deregulatory Actions," at https://www.reginfo.gov/public/do/eAgendaMain.

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

[197] See FAA, "Piston Engine Aviation Fuels Initiative (PAFI) Background and Program Update," https://www.faa.gov/about/initiatives/avgas/piston-engine-aviation-fuels-initiative-pafi-background-and-program-update.

[198] Tom Page, "Why Electric Airplanes are Taking Off at Flight Schools," *CNN Business,* September 8, 2022, at https://www.cnn.com/2022/09/01/business/pipistrel-velis-electro-flight-training-spc-intl/index.html; Adreas Spaeth, "Are Electric Planes Ready for Takeoff?," *Deutsche Welle (DW),* at https://www.dw.com/en/are-electric-planes-ready-for-takeoff/a-64491147#; and Teresa Nowakowski, "NASA's Electric Plane Will Take Flight This Year—but Its Future Is Uncertain," *Smithsonian Magazine,* January 27, 2023, at https://www.smithsonianmag.com/smart-news/nasas-electric-plane-will-take-flight-this-year-but-its-future-is-uncertain-180981521/.

[199] See 14 C.F.R. §91.151 Fuel requirements for flight in VFR conditions.

[200] See 14 C.F.R. §91.167 Fuel requirements for flight in IFR conditions.

applications, questions remain regarding suitable batteries or potentially other options, such as hybrid solutions using a combination of batteries and hydrogen fuel cells, to provide acceptable range capabilities.[201]

Hydrogen-Powered Aircraft

Aircraft using hydrogen fuel for propulsion are in the early stages of development with no certainty they will reach commercial deployment. Airbus and Boeing have fielded demonstrator vehicles using hydrogen in fuel cells or in gas turbines or using both in hybrid propulsion architectures.[202] In 2020, Airbus announced its goal of having a commercial aircraft using hydrogen propulsion by 2035.[203] The International Energy Agency assesses hydrogen propulsion for aviation as being at the concept and early prototype stages.[204]

Aviation programs on hydrogen are part of the multiagency activities coordinated by the U.S. DOE's Hydrogen and Fuel Cell Technologies Office.[205] DOE noted the continued challenge of on-board storage of hydrogen and the weight of the containers for high-pressure gas or low-temperature liquid storage.[206] The FY2023 appropriation included $118 million for DOE to address these and other challenges for hydrogen storage.[207] Work on assembled vehicles continues, and the Department of Defense has already demonstrated hydrogen fuel-cell unmanned aerial vehicles (UAVs).[208] In the context of current FAA reauthorization, Congress may explore options for promoting and incentivizing alternative aircraft propulsion and power sources, including electric battery and hydrogen power, as well as possible funding mechanisms to support further research and development of these technologies.

FAA Research and Development

The FAA maintains a portfolio of research and development programs to support its operational missions of operating the national airspace system, regulating safety among civil aviation operators, and addressing aviation impacts on the environment. The FAA receives advice and recommendations regarding its research program through the Research, Engineering, and Development Advisory Committee (REDAC), a group of advisors from industry, academia, and

[201] James Careless, "Are Batteries Truly Enough to Power eVTOLS?," *Avionics International (Digital)*, February/March 2021, at https://interactive.aviationtoday.com/avionicsmagazine/february-march-2021/are-batteries-truly-enough-to-power-evtols/.

[202] Boeing, "Boeing Breakthrough in All-Composite Cryogenic Propellant Tank Advances Technology Readiness," press release, February 2, 2022, at https://boeing.mediaroom.com/news-releases-statements?item=130996; and Airbus, "Airbus reveals hydrogen-powered zero-emission engine," press release, November 30, 2022, at https://www.airbus.com/en/newsroom/press-releases/2022-11-airbus-reveals-hydrogen-powered-zero-emission-engine.

[203] Jillian Ambrose, "Airbus reveals plans for zero-emission aircraft fueled by hydrogen," *The Guardian*, September 21, 2000.

[204] International Energy Agency, *ETP Clean Energy Technology Guide*, September 21, 2022, at https://www.iea.org/data-and-statistics/data-tools/etp-clean-energy-technology-guide?selectedSector=Aviation.

[205] Sunita Satyapal, Director, DOE Hydrogen and Fuel Cell Technologies Office, 2022 AMR Plenary Session, June 6, 2022, p. 85, at https://www.energy.gov/sites/default/files/2022-06/hfto-amr-plenary-satyapal-2022-1.pdf.

[206] DOE, *DOE National Clean Hydrogen Strategy and Roadmap (Draft—September 2022)*, September 2022, p. 47. Prepared pursuant to §40314 of the Infrastructure Investment and Jobs Act (IIJA; P.L. 117-58).

[207] DOE, Office of the Chief Financial Officer, *FY 2024 Congressional Justification: Volume 2*, March 2023, p. 24, at https://www.energy.gov/sites/default/files/2023-03/doe-fy2024-budget-volume-2-crosscutting-v3.pdf.

[208] K. Swider-Lyons, *Hydrogen Fuel Cells for Small Unmanned Air Vehicles*, U.S. Naval Research Laboratory, May 26, 2016, at https://www.energy.gov/sites/prod/files/2016/05/f32/fcto_webinarslides_h2_fc_small_unmanned_air_vehicles_052616.pdf.

other government agencies. REDAC assesses aviation research needs in five major areas: operations, airport technology, aviation safety, human factors, and environment and energy. The FAA is statutorily required to develop and update a five-year National Aviation Research Plan on an annual basis.[209] These plans serve as an important framework for FAA research, engineering, and development goals, as well as priorities, and budget planning. The plan lays out the five-year research and development (R&D) goals and anticipated funding requirements.

The FAA conducts research on aviation and air traffic systems at the William J. Hughes Technical Center in Atlantic City, NJ, and research on training, human factors, and aeromedical research at the Mike Monroney Aeronautical Center, in Oklahoma City, OK. The FAA also sponsors research conducted at 13 centers of excellence (COEs). The COEs are organized as university consortia that receive FAA grants as well as nonfederal funding. Other organizations that play important roles in FAA research and development include the DOT Volpe Center in Cambridge, MA; the MITRE Corporation Center for Advanced Aviation System Development (CAASD), which is the FAA-sponsored federally funded research and development center (FFRDC) for civil aviation; and the Transportation Research Board Airport Cooperative Research Program (ACRP). Both MITRE CAASD and the ACRP have their own budget line items in the FAA budget. The Volpe Center, however, operates as a cost reimbursable resource that receives no direct appropriations but gets funding from the FAA and other DOT components. In addition to specific Research, Engineering, and Development appropriations, FAA research activities are funded about 30% through the Facilities and Equipment (F&E) account and about 15% is derived from the AIP.

In FAA reauthorization cycles, the House Science, Space, and Technology Committee has historically worked to develop a stand-alone bill to serve as the basis for the FAA R&D title. For example, in the 115th Congress, the FLIGHT R&D Act (H.R. 3198), served as the vehicle for consideration of reauthorizing FAA R&D activities. That bill, as amended by the committees and in conference, became the R&D title (Title VII) of the FAA Reauthorization Act of 2018 (P.L. 115-254). Similarly, in the 112th Congress, the Federal Aviation Research and Development Reauthorization Act of 2011 (H.R. 970), formed the basis for the R&D title that was incorporated into the FAA Modernization and Reform Act of 2012 (P.L. 112-95).

Key research and development issues that may arise in FAA reauthorization debate include

- modernizing air navigation services, air traffic control, and airspace management technologies and services;
- addressing aviation safety, including safety research to support the FAA's missions of overseeing aircraft certification, aircraft maintenance, flight operations, and the qualifications and medical fitness of pilots and other safety-critical personnel;
- examining potential technological improvements to aviation infrastructure, such as airport runways, and taxiways, and airport ecosystems; and
- studying options for mitigating environmental impacts of aviation, including aircraft noise and emissions, and potential risks to aviation operations and infrastructure from environmental factors, including weather.

[209] See FAA, "National Aviation Research Plan," at https://www.faa.gov/about/office_org/headquarters_offices/ang/narp.

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