A Report by a Panel of the

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION

for the Federal Aviation Administration

# FAA UAS and AAM Integration: Evaluating Partnerships and Research for Future Airspace Safety

NATIONAL ACADEMY OF PUBLIC ADMINISTRATION®

April 2025

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# FAA UAS and AAM Integration: Evaluating Partnerships and Research for Future Airspace Safety


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## About the Academy

The National Academy of Public Administration is an independent, nonprofit, and nonpartisan organization established in 1967 and chartered by Congress in 1984. It provides expert advice to government leaders in building more effective, efficient, accountable, and transparent organizations. To carry out this mission, the Academy draws on the knowledge and experience of its over 1,000 Fellows—including former cabinet officers, Members of Congress, governors, mayors, and state legislators, as well as prominent scholars, career public administrators, and nonprofit and business executives. The Academy helps public institutions address their most critical governance and management challenges through in-depth studies and analyses, advisory services and technical assistance, congressional testimony, forums and conferences, and online stakeholder engagement. Learn more about the Academy and its work at www.NAPAwash.org.

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# Foreword

The Federal Aviation Administration (FAA) regulates the United States national airspace system (NAS) to ensure the safe operation of civil aviation and commercial space transportation. As new technologies such as unmanned aircraft systems (UAS) and advanced air mobility (AAM) continue to rapidly evolve, the FAA is responsible for developing rules for new aircraft operations, ensuring that they are safe to fly and operate in busy airspace.

Ensuring the safe integration of these systems into the NAS has been a challenge. The regulatory process is—by design—deliberate and often cannot keep pace with the rapid proliferation and technological advancement of UAS and AAM. Unlike traditional aircraft, the development of new UAS and AAM technologies are developed over the course of months to years, rather than decades.

To assist in identifying and advancing research priorities and strategies, the FAA relies on partnership programs, consisting of industry; institutes of higher education; state, local, and tribal governments; and test sites. These partnerships provide crucial data the FAA uses in its decision-making and rulemaking processes.

As directed by the FAA Reauthorization Act of 2024, the FAA contracted with the National Academy of Public Administration (Academy) to assess the current state of FAA partnerships for research, development, demonstration, and testing to advance UAS and AAM and to facilitate the safe integration of UAS into the NAS. Specifically, the Academy was tasked with evaluating the utilization and impact of the FAA's partnership programs in conducting research; technology transfer; and science, technology, engineering, and mathematics outreach and education.

As a congressionally chartered, independent, nonpartisan, and nonprofit organization with over one thousand distinguished Fellows, the Academy has a unique ability to bring nationally recognized public administration experts together to help government agencies address their most pressing management challenges. We are grateful for the constructive engagement of the many FAA employees and external stakeholders who provided important observations and context to inform this report. We also thank the subject matter experts who contributed to this research. I am deeply appreciative of the work of the four Academy Fellows who served on this Panel and commend the Study Team that contributed valuable insights and expertise throughout the project.

James-Christian Blockwood
President and Chief Executive Officer
National Academy of Public Administration

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# Acronyms and Abbreviations

| Acronym or Abbreviation | Definition |
|---|---|
| Academy | National Academy of Public Administration |
| AAM | Advanced air mobility |
| ASSURE | Alliance for System Safety of UAS through Research Excellence |
| AUS | UAS Integration Office |
| AVSED | Aviation and Space Education |
| BVLOS | Beyond visual line of sight |
| CAA | Civil aviation authority |
| CAMI | Civil Aerospace Medical Institute |
| COA | Certificate of waiver or authorization |
| COE | Center of excellence |
| CRADA | Collaborative research and development agreement |
| DOD | Department of Defense |
| DOE | Department of Energy |
| DOT | Department of Transportation |
| FAA | Federal Aviation Administration |
| FFRDC | Federally funded research and development center |
| GAO | Government Accountability Office |
| K-12 | Kindergarten through twelfth grade |
| NAS | National airspace system |

| | |
|---|---|
| NARP | National Aviation Research Plan |
| NASA | National Aeronautics and Space Administration |
| NextGen | NextGen Office |
| QCE | Qualified commercial entity |
| R&D | Research and development |
| REB | Research and Development Executive Board |
| REDAC | Research, Engineering, and Development Advisory Committee |
| RFP | Request for proposal |
| RTT | Research transition team |
| SBIR | Small Business Innovation Research |
| STEM | Science, technology, engineering, and mathematics |
| STTR | Small Business Technology Transfer |
| T2 | Technology Transfer Program |
| UAS | Unmanned aircraft systems |
| UAS BAA | Unmanned Aircraft Systems Broad Agency Announcement |
| UAS-CTI | Unmanned Aircraft Systems Collegiate Training Initiative |
| Volpe | Volpe National Transportation Systems Center |
| WJHTC | William J. Hughes Technical Center |

# Executive Summary

The Federal Aviation Administration (FAA) regulates the United States national airspace system (NAS), which is a complex network that includes airports, aircraft, and air traffic control facilities. Its mission is to regulate civil aviation and US commercial space transportation, maintain and operate air traffic control and navigation systems for both civil and military aircraft, and develop and administer programs relating to aviation safety and the NAS.

In exercising this mission, the FAA is responsible for safely integrating new and emerging entrants, such as unmanned aircraft systems (UAS) and advanced air mobility (AAM), into the NAS. These new entrants present the FAA with the challenge of appropriately regulating and integrating nontraditional aircraft into the NAS while preserving airspace safety within the existing navigation and air traffic system.

As the aviation industry continues to evolve, the safe integration of UAS and AAM into the NAS will play a pivotal role in shaping the future of air travel and transportation. The FAA's commitment to advancing research and fostering partnerships has laid a strong foundation for addressing the challenges and opportunities presented by these emerging technologies. The agency has made substantial progress through its partnerships and research initiatives, addressing critical work, such as complex drone operations. The collaborative efforts of various stakeholders, including industry, academia, and government entities, have been instrumental in driving innovation and ensuring the safe integration of these new entrants. The ongoing efforts to refine regulations; enhance data sharing; and support science, technology, engineering, and mathematics (STEM) education will be crucial to incorporating UAS and AAM into the aviation ecosystem.

As directed by the FAA Reauthorization Act of 2024, the FAA contracted with the National Academy of Public Administration (Academy) to assess the current state of FAA partnerships for research, development, demonstration, and testing to advance UAS and AAM and to facilitate the safe integration of UAS into the NAS. The analysis was guided by four principal themes: partnerships and their research scope; the utilization and impact of partnerships; data dissemination and information sharing; and STEM outreach and funding models. The study's period of performance was from August 12, 2024 to June 12, 2025.

The Academy assembled a four-member Panel of Fellows to direct this study. The Panel included experts in national transportation and security, research and development, partnership funding models, and technology transfer. The Panel provided guidance to the Study Team, reviewed and approved study findings and conclusions, developed recommendations, and approved the draft and final reports. The Panel's recommendations, below, are based on study findings and are organized according to research themes.

### Utilization, Impact, and Funding of Research Partnerships

**4.1** Assess and address FAA UAS-related organizational concerns raised by partners. Concerns include multiple layers of review, stovepipe structure, high-level approvals for new research, and the need for a clear delineation of roles and responsibilities. If organizational structure and process challenges are not currently part of planned action, develop a process and timeline for addressing them.

**4.2** The FAA and UAS Integration Office (AUS) should establish a repeatable process for reviewing and updating all UAS partnership agreements (i.e., ASSURE and BEYOND) that anticipates rulemaking and other future needs, including ensuring requirements within task orders are prioritized and clearly defined.

**4.3** The FAA should refine the waiver and exemption process to reduce uncertainty and improve timeliness, to include standardizing the timeline for approval or disapproval, limiting paperwork, and providing training and guidance on how to submit requests.

**4.4** To help identify and address UAS process challenges on an ongoing basis, the FAA and AUS should consider expanding utilization of the lessons learned process in place under AUS's Safety and Integration Division (AUS-400) to more broadly identify UAS challenges and steps to advance UAS partnerships.

**4.5** The FAA and AUS should develop a process for identifying its specific long-term, crosscutting UAS and AAM data needs, including timeframes, and conveying those needs to partners. This will increase partners' awareness of the FAA's long-term UAS and AAM strategies, goals, and requirements for research data, enabling them to align with FAA plans and appropriately resource their efforts in support of FAA data needs.

**4.6** The FAA UAS partnership agreements should include provisions to require or encourage FAA partnership program participants to share their R&D data with other partnership programs, when contractually feasible, to fully inform the FAA's tasking and facilitate partners' ability to focus on specific data requirements and gaps. To enable this, the following are needed: provisions to eliminate the barriers to sharing that exist today; contractual language that requires and authorizes sharing; and agreements between partners that facilitate sharing and address responsibilities and liabilities on the part of the partners. Agreements should detail how the FAA intends to use the data to inform certification, rules, standards processes, and other regulatory activities.

**4.7** The FAA should ensure that project managers for UAS partnership research projects are knowledgeable of ongoing FAA UAS research programs and outcomes and have the means to engage with other research partnership program managers to enable them to provide appropriate direction and coordination to their assigned research projects.

**4.8** The FAA should more broadly leverage the data sharing already occurring among organizations contributing to the UAS standards and rules, when and if appropriate, to inform all R&D being conducted by UAS partnerships.

**4.9** The FAA should utilize data on waivers and exemptions submitted for approval. The specific technologies identified for development in these waiver and exemption requests would provide the FAA with a wealth of information on what industry is working on. This data is currently considered, but not in a structured, intentional way. The FAA should develop a process to organize and analyze this data for subsequent use.

**4.10** The leaders of the UAS Integration Office, in coordination with the AAM Integration Office, should develop a UAS research roadmap that clearly identifies what research areas AUS, and the FAA overall, plan to focus on over the next three years to direct research and development and identify research gaps and duplication.

**4.11** The FAA (AUS and Financial Services Office) should assess the need for an agile funding type that enables it to respond to current technological advancements, rather than committing funds to projects that may take three years to finish and be technologically outdated when complete.

**4.12** The FAA should request from Congress appropriate baseline funding for the BEYOND program to support the cost of ensuring participation of public entities and their consortia.

**4.13** The FAA should request appropriations for baseline funding to support the UAS Test Sites.

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### Effective Strategies for the FAA's Dissemination of Partnership Research Outcomes

**5.1** The FAA should document the existing ends, ways, and means of information- and data-sharing methods from the FAA to its formal partnerships, informal network, and the broader public.

**5.2** The FAA should explore opportunities to deepen the level of cooperation with select foreign civil aviation authorities that share similar R&D priorities.

**5.3** The FAA should explore opportunities to support technology transfer with small businesses such as the small business voucher program, model or partner with other agencies' SBIR/STTR programs, and collaborate with state and local organizations to increase private sector participation.

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### Broadening UAS and AAM STEM Education and Outreach

**6.1** Prioritize increasing STEM outreach and education to audiences other than K-12 students, including educators, college students, and expanding efforts to include reskilling and upskilling adults already in the workforce.

**6.2** Collaborate with research partnerships to create a standardized UAS STEM program, including goals and performance metrics, and with other FAA programs and federal agencies to avoid duplication and share best practices and lessons learned.

**6.3** Continuously evaluate the effectiveness of prior UAS STEM outreach initiatives to identify gaps and integrate lessons learned into future planning.

**6.4** The partnership programs should continue to leverage nonfederal funding sources for UAS and AAM STEM outreach through engagements with state and local governments, private philanthropic foundations, and industry.

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# Chapter 1: Introduction

The Federal Aviation Administration (FAA) regulates the United States national airspace system (NAS) to ensure the safe operation of civil aviation and commercial space transportation. As new technologies such as unmanned aircraft systems (UAS) and advanced air mobility (AAM) continue to rapidly develop, the FAA is responsible for developing rules for new aircraft operations, ensuring that they are safe to fly and operate in busy airspace. Prior to integrating new aircraft into the NAS, the FAA solicits rigorous research and testing by research partners to thoroughly understand the new aircraft and technologies.

## 1.1 Scope of Work

As directed by the FAA Reauthorization Act of 2024, the FAA contracted with the National Academy of Public Administration (Academy) to assess the current state of FAA partnerships for research, development, demonstration, and testing to advance UAS and AAM and to facilitate the safe integration of UAS into the NAS.[1] The study's period of performance was from August 12, 2024 to June 12, 2025.

In accordance with the statement of work, the Study Team carried out the following four tasks.

Task 1 – Current Partnerships and Scope: Document and describe the FAA's existing partnerships and their research areas.

Task 2 – Utilization and Impact of Partnerships: Evaluate the effectiveness and necessity of current and potential future partnerships.

Task 3 – Dissemination and Information Sharing: Assess strategies for effectively sharing research outcomes and data.

Task 4 – STEM Outreach and Funding Models: Review strategies for ensuring broad participation and optimal funding structures for the FAA's partnerships.

## 1.2 Study Approach and Methodology

The Academy assembled a four-member Panel of Fellows to direct this study. The Panel included experts in national transportation and security, research and development, partnership funding models, and technology transfer. The Panel provided guidance to the Study Team, reviewed and approved study findings and conclusions, developed recommendations, and approved the draft and final reports.

The Academy's research comprised three phases, described below.

### *Phase 1: Background Research*

During phase 1, the Study Team conducted a kickoff meeting with the FAA, developed the work plan, and assembled the Panel of Fellows. The purpose of the kickoff meeting was to establish agreement on the project scope, approach, and methodology. In addition, the Study Team

[1] FAA Reauthorization Act of 2024, Pub. L. No. 118-63, § 1045, 138 Stat. 1412.

initiated research tasks that included an initial review of public literature, including FAA, Government Accountability Office (GAO), and Congressional Budget Office reports, to achieve the following objectives:

- Develop a thorough understanding of the FAA's work related to unmanned aircraft systems, including related missions, policies, activities, operational frameworks and structures, funding, and relationships with stakeholders.
- Identify the FAA's current partners and relevant stakeholders in the unmanned air systems field.
- Identify current challenges that may impede mission performance.
- Develop an understanding of how the FAA disseminates information to the public, partners, and other stakeholders.
- Develop an understanding of how the FAA broadens participation and inclusivity through partnerships.
- Identify the current funding models the FAA uses for partnerships.

### *Phase 2: Data Collection and Analysis to Answer Research Questions*

During phase 2, the Study Team continued to collect and analyze quantitative and qualitative data from primary and secondary sources. Data collection techniques included an analysis of official internal and external documents and interviews with approximately 130 people, including FAA personnel, internal and external stakeholders, and subject matter experts. See Appendix B for the full list of interviewees. The Study Team also researched similar organizations and agencies to identify best practices and benchmarks for partnerships and information dissemination.

### *Phase 3: Preparation of Draft and Final Reports*

During the final phase, the Study Team analyzed the data collected throughout the first and second phases of the study. The Panel and Study Team developed a final set of findings and related recommendations and briefed the FAA on them. Incorporating feedback from the FAA and the Panel, the Study Team prepared the draft and final reports. After delivery of the final report, the Study Team and Panel provided briefings on the study's findings and recommendations to the FAA.

### *Study Limitations*

The study was conducted on an expedited timeline, which limited the Study Team's ability to reach certain industry stakeholders and validate some of the information with the FAA.

## 1.3 Organization of the Report

**Chapter 1 (current chapter)** describes the study, including its scope, goals, and methodology. It concludes with an overview of the report's organization.

**Chapter 2** provides background on the FAA's organizational structure as it pertains to UAS and AAM.

**Chapter 3** describes the FAA's research and development process and how it informs research requirements. The chapter also outlines the FAA's current UAS and AAM partnerships, including research requirements, types of agreements, and funding models.

**Chapter 4** discusses how the FAA uses research and outcomes produced by UAS and AAM partners. The chapter also identifies existing challenges that hinder the FAA's ability to fully utilize research results and outcomes, as well as how the FAA mitigates research duplication and identifies gaps. The chapter also outlines partnership funding models and relevant benchmarking.

**Chapter 5** describes the FAA's current efforts to disseminate research partnership outcomes and data, including through technology transfer.

**Chapter 6** discusses FAA partnership UAS STEM education and outreach efforts.

**Chapter 7** concludes the report.

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# Chapter 2: Background on the FAA's Role in UAS and AAM Research and Regulation

UAS and AAM are new entrants into the national air space whose integration requires research, regulation and operational inputs from across the FAA's multiple business lines and offices.

## 2.1 Defining the Scope of New Entrant Aircraft

UAS and AAM vehicles represent new categories of aircraft seeking entry into the NAS. To operate in the NAS, all aircraft, including piloted gliders, jet planes, and helicopters, must meet FAA requirements, such as aircraft certification and pilot licensing. UAS and AAM new entrants present the FAA with the challenge of appropriately regulating and integrating nontraditional aircraft into the NAS while preserving airspace safety within the existing navigation and air traffic system.

UAS and AAM are aircraft with important distinctions. AAM vehicles tend to be larger and heavier than UAS vehicles. AAM vehicles may be piloted in person or remotely. UAS vehicles are self-directed with no human pilot intervention. AAM vehicles will engage with air traffic control, whereas operation of UAS vehicles requires the development of new traffic management systems. Finally, UAS and AAM operations take place in different classes of airspace.

There are also differences between traditional aircraft and new entrants, which pose unique research and regulatory challenges for the FAA. There is a large variety of UAS and AAM designs, including airframe, materials, and equipment, depending on intended use and manufacturer. These design characteristics factor into operational limitations that new rules must address. Development timelines are much shorter for AAM and UAS than traditional commercial aircraft and can be measured in months to years rather than decades. As in most such areas of public policy, UAS and AAM development outpaces the regulatory process.

## 2.2 UAS and AAM Research at the FAA

The FAA's mission is to provide the safest, most efficient aerospace system in the world. It is the regulator for all US civil aviation, which includes airspace use, air traffic control, navigational facilities, and aircraft noise. To achieve this mission, the FAA is structurally organized into five lines of business (See figure 1 for the FAA's organizational chart):

- Air Traffic Organization (AJO)
- Airports (ARP)
- Aviation Safety (AVS)
- Security and Hazardous Materials Safety (ASH)
- Commercial Space Transportation (AST)

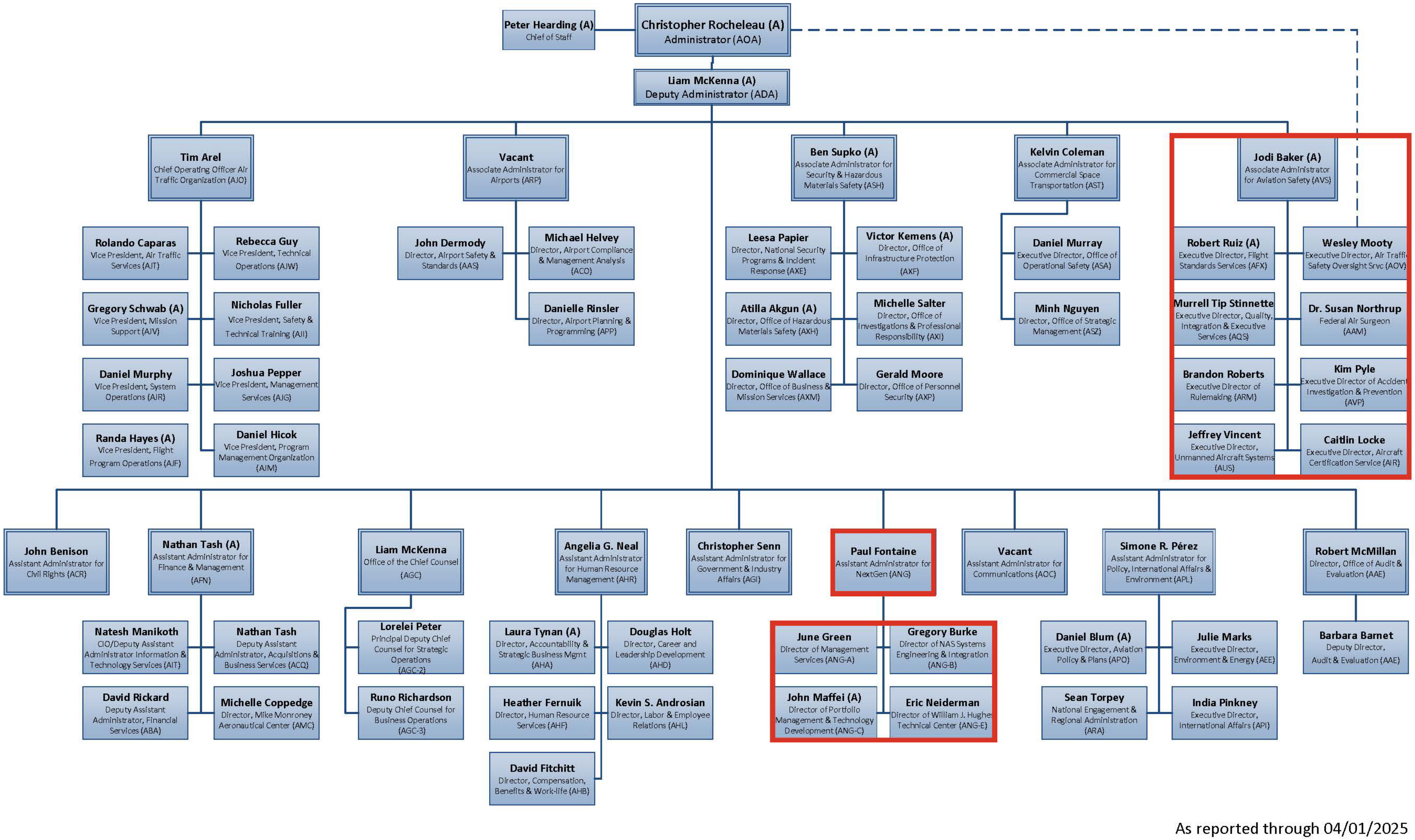


*Figure 1. FAA Organizational Chart last updated April 1, 2025 (Federal Aviation Administration)*

Each business line has unique research requirements and data needs to develop their regulatory and operational approaches for integrating UAS and AAM. For example, to approve an AAM vehicle to move people from one airport to another would require actions by multiple lines of business, each with their own authorities and requirements for operational approval.

## *The Aviation Safety Office*

AVS is responsible for the coordination of UAS and AAM applied research. It handles the certification, production approval, and continued airworthiness of aircraft and the certification of pilots, mechanics, and others in safety-related positions.[2] These responsibilities include certifying operational and maintenance enterprises in domestic civil aviation and certifying and providing safety oversight of US commercial airlines and air operators.

AVS houses both the Unmanned Aircraft Systems (AUS) and Advanced Air Mobility Integration Offices that coordinate UAS and AAM research.[3] Recent efforts have centralized much of the FAA's UAS and AAM efforts into these two offices. AUS coordinates research, development, demonstration, and testing through its partnership programs and other research partners. The AAM Integration Office is currently being established and will manage its research portfolio through the Senior Technical Experts Office working with Aircraft Certification Service and Flight Standards Service.

## *The UAS Integration Office*

Within the Aviation Safety Office, the UAS Integration Office leads the FAA's efforts to safely integrate unmanned aircraft systems into the NAS.[4] The office is divided into four functional units that are linked through the UAS Integration Office's Front Office:

- The Enterprise Services Division (AUS-100) provides mission support, such as financial and human capital resources, strategic planning, and performance management, including tracking congressionally mandated milestones.
- The International Division (AUS-200) supports the FAA's global UAS-related activities through engagement with international partners on a bilateral, regional, and global basis, including harmonizing regulations and policies.
- The UAS Research, Engineering & Analysis Division (AUS-300) develops the FAA's plans, strategies, and requirements for applied UAS research for NAS integration policy, rulemaking, and implementation. The office manages research partnership programs, including BEYOND, UAS Broad Agency Announcement Program (UAS BAA), and UAS Test Sites, leveraging the expertise of research partners within and external to the FAA.

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[2] "Aviation Safety (AVS)," Federal Aviation Administration, last modified January 5, 2023, https://www.faa.gov/about/office_org/headquarters_offices/avs.
[3] The FAA's naming convention for internal organizations is a three letter code, starting with the letter "A." Therefore, the organization focused on unmanned aircraft systems (UAS) is the Unmanned Aircraft Systems Office (AUS).
[4] "UAS Integration Office," Federal Aviation Administration, last modified March 28, 2024, https://www.faa.gov/about/office_org/headquarters_offices/avs/offices/aus#:~:text=The%20AUS%20Front%20Office%20is,%2C%20regional%2C%20and%20global%20basis.

- The Safety and Integration Division (AUS-400) collaborates across the FAA and works closely with industry to solve operational and technical challenges to UAS integration. AUS-400 serves as a policy liaison, supporting standards development and rulemaking efforts in conjunction with the Office of Rulemaking.

## *The NextGen Office, UAS Research and Development Portfolio Branch*

The UAS Research and Development Branch is located under NextGen's New Entrants Division and is responsible for executing the FAA's UAS research and development efforts. Those responsibilities include early UAS research efforts through the Alliance for System Safety of UAS through Research Excellence (ASSURE), which is a partnership program and center of excellence (COE). NextGen is responsible for the management, administration, and funding for the ASSURE COE program. AUS-300 provides input to and manages the collection of the research requirements from the FAA research sponsor and other FAA organizations that would benefit from the research. AUS-300 also prioritizes the research to support external timelines for activities such as standards development. The branch manages the request for proposal (RFP) to the ASSURE COE, FAA's review and approval of the submitted proposal, and the award process. AUS-300 issues the funding agreement. The branch also administers the ASSURE program management office and is responsible for oversight of the project execution, including timelines and deliverables, and the conduct of semiannual program management reviews.

## *The Advanced Air Mobility Integration Office*

The Advanced Air Mobility Integration Office drives the requirements for AAM research across the FAA. The office was recently established and is in the process of being staffed. Prior to its creation, most of the FAA's AAM research was conducted by NextGen through a Research Transition Team (RTT) with the National Aeronautics and Space Administration (NASA), and a portion was conducted by the UAS Integration Office. Part of the impetus for a new office was the need to coordinate the AAM research to enable the field to move toward testing and demonstration activities. To that end, the research component will be managed by the AVS Senior Technical Experts Office, which includes chief scientists, technical advisors, and senior technical specialists. The AAM Integration Office will collect and develop the research requirements and then push the research out to NASA, NextGen, and others to conduct. The AAM Integration Office also is working towards setting up new AAM test sites in 2025 and establishing an advisory and rulemaking committee to work through challenges related to autonomous AAM.

# Chapter 3: Research Strategies and UAS and AAM Partnerships

The FAA's uses multiple approaches to advance UAS and AAM integration. From developing research strategies through project execution, the FAA engages partners who can provide critical support. The FAA's research partnerships (ASSURE, BEYOND, UAS BAA, and UAS Test Sites) provide access to key UAS and AAM research stakeholders. Furthermore, the FAA relies on external partners, including federal, research, standards, and international organizations who contribute to the advancement of UAS and AAM.

## 3.1 Research Strategies for UAS and AAM

The FAA develops research priorities and strategies in several ways. External stakeholders, including the private sector, academia, Congress, federal agencies, state and local governments, and research entities provide input. Each group has different and overlapping priorities that the FAA must consider and appropriately incorporate into the National Aviation Research Plan (NARP), which guides current and future research goals. The FAA identifies six technical areas of research crucial to meeting its mission:

- Aircraft safety assurance
- Digital systems and technologies
- Environmental and weather impact mitigation
- Airport infrastructure and technologies
- Aerospace performance and planning
- Human and aeromedical factors[5]

The FAA's strategic plan, which includes UAS and AAM research and development, sets the framework for the applied research, development, demonstration, and testing tasks with which FAA partnership programs engage. The process begins with the research needs being collected and prioritized by each FAA office, and then fed upwards into the organization. Offices' priorities are presented to the Research, Engineering, and Development Advisory Committee (REDAC) and the Research and Development Executive Board (REB) representing external and internal FAA perspectives and are supported by the WJHTC director. Input from these organizations is collected by NextGen and ultimately used to develop the NARP and support the development of the US Department of Transportation's (DOT) Annual Modal Research Plan.

### *National Aviation Research Plan*

NARP is a comprehensive framework that integrates input from various stakeholders to define and guide the FAA's research priorities and strategies. The five-year plan represents the vision of the current administration, DOT secretary, and FAA administrator. It ensures that research priorities are appropriately addressed, aiming to minimize overlap and duplication. The NARP

[5] "Technical Areas of Research," Federal Aviation Administration, last modified September 12, 2024, https://www.faa.gov/about/office_org/headquarters_offices/ang/grants/research/tech.

forms a cohesive strategy for current and future aviation research, enabling the FAA to incorporate emerging technology and address and adapt to current and anticipated challenges.

While the document addresses a five-year research period, it must be submitted to Congress annually as part of the budget process. As a result, the document is somewhat iterative, requiring annual updates from stakeholders, including DOT, FAA offices, REDAC, and the REB. The FAA's Research and Development Annual Review is a companion to the NARP and documents the accomplishments of the research completed in the prior fiscal year.

## *DOT Research, Development and Technology Strategic Plan, and Annual Modal Research Plan and Program Outlook*

The FAA's research and development (R&D) portfolio emphasizes innovation within the NAS to prepare for the next generation of aviation. This includes making the system more adaptable, sustainable, resilient, equitable, and safer while advancing aviation in an environmentally responsible and energy-efficient manner.

The FAA's R&D priorities align with the *US DOT Research, Development, and Technology (RD&T) Strategic Plan,* which includes safety, economic strength and global competitiveness, equity, climate and sustainability, transformation, and organizational excellence goals. This framework ensures strategic goal alignment to enhance the US transportation system's safety, mobility, and efficiency.

The DOT requires an Annual Modal Research Plan for each operating administration or mode, including the FAA. The document outlines the planned research for the upcoming fiscal year and provides an outlook for the fiscal year after that. All DOT operating administrations are statutorily required to submit this plan annually for review and approval by the assistant secretary of research and technology.[6] The FAA's plan describes its research and development investments supporting policy making, planning, regulation, certification, standards development, and the modernization of the NAS.

## *The FAA Research, Engineering, and Development Advisory Committee*

The FAA REDAC is a congressionally mandated committee that advises the FAA administrator and provides a forum to receive advice from external stakeholders. "REDAC members include experts from aviation, aerospace, and related emerging technology-focused corporations, universities, associations, consumers, and Federally Funded Research and Development Centers."[7] It does not give directives to the FAA, only guidance and recommendations. REDAC focuses on several areas of aviation research, including NAS operations airport technology, aviation safety, human factors, and environment and energy. REDAC meets twice yearly to review

[6] 49 U.S.C. §6501 (2015).
[7] Federal Aviation Administration, *United States Department of Transportation Annual Modal Research Plans FY 2024 Program Outlook FY 2025* (Federal Aviation Administration, June 1, 2023), 6, https://www.transportation.gov/sites/dot.gov/files/2024-08/AMRP%20FY2024-2025%20FAA_2.pdf.

the FAA's R&D portfolios, offering advice on where the FAA should prioritize from a three-year-out perspective.

REDAC has subcommittees that investigate more specific research areas. These subcommittees report back to the main committee on adjustments to new and existing research and the partnerships that support those activities, such as COEs, test sites, and their academic and private sector participants.

### *Research & Development Executive Board*

The REB is comprised of one representative from each of the FAA's seven business lines and assistant administrators who sponsor or manage R&D program funds. REB coordinates the development of the FAA's annual R&D investment portfolio. The REB coordinates with upper-level FAA management to determine research priorities, defend the R&D budget, and identify impacts from congressional changes during the budget process. The REB operates with assistance from the REB support team, program planning teams, and an Office of Budget and Programs financial manager to prepare for the budget.

## 3.2 Partnership Programs and External Research Partners

This report categorizes the FAA's research, development, demonstration, and testing partnerships into two distinct categories: partnership programs and external research partners. The primary focus of the report is on the partnership programs which include ASSURE (a COE), BEYOND, UAS BAA, and UAS Test Sites. Each of these programs provides an opportunity for industry, academia, and FAA staff to partner in UAS and AAM research. Some partnership programs also carry out STEM outreach related to UAS (see chapter 6).

In addition to the partnership programs, the FAA also has an extensive network of external research partners, which may conduct research directed to them by the FAA or be engaged in joint research with the FAA. These research partners include additional FAA COEs, federally funded research and development centers (FFRDCs) (i.e., MITRE Center for Advanced Aviation System Development), and other federal agencies (e.g., NASA, Department of Defense (DOD), Department of Interior, and Department of Homeland Security). Other FAA external research partners are not directly involved with the research efforts but build off of the research results to support regulatory efforts and implementation, including international civil aviation authorities (CAAs) and standards organizations.

### *Partnership Programs*

The FAA's partnership programs create various opportunities for industry, academia, and public institutions (state, local, and tribal) to collaborate on research relevant to operationalizing the use of UAS and AAM. This section will provide an overview of the four partnership programs.

**ASSURE**

ASSURE's mission is to "provide high-quality research & support to autonomy stakeholders both within and outside the US to safely and efficiently integrate autonomous systems into the national and international infrastructure, thereby increasing commerce and overall public safety and benefit."[8] ASSURE fosters innovation by supporting research, development, testing, and evaluation activities, as well as promoting STEM outreach initiatives to introduce students to UAS and build a skilled workforce. ASSURE's research covers a wide range of topics, and its results inform the activities of various public and private UAS operations. As a team, the ASSURE universities offer the FAA a broad set of research capabilities; individually, the universities provide unique research expertise.

| **ASSURE Quick Look** |
|---|
| **Participants:** Mississippi State (lead) and other ASSURE universities, affiliates and industry |
| **Funding:** Provided by individual FAA organizations; requires a 1:1 match by COEs |
| **Contracting Vehicle:** Master teaming agreement among universities, cooperative agreements and indefinite delivery/indefinite quantity contracts between the FAA and individual institutions |
| **Data/Report:** Research report and datasets submitted to the FAA; research results required to be shared publicly |

In 2024, the ASSURE program was extended as part of the FAA's reauthorization. Specific responsibilities of the COE include conducting research and training on integration of UAS and AAM into the NAS; promoting and facilitating collaboration among academia, the FAA, federal partners, and other stakeholders; establishing goals to advance technology and improve engineering practices; and facilitating continued education with respect to UAS and AAM integration.[9]

***ASSURE Funding Structure***

ASSURE receives administrative funding and project-specific funding. Mississippi State, as the lead university and administrator of ASSURE, receives funding to serve in a managerial role. Research funding goes from the FAA to each individual university's principal investigator for the specific project award. Collaborations of core and affiliate universities, industry partners, and governments may participate in research projects through the ASSURE program.

In FY 2023, ASSURE received approximately $86.1 million in total funding; of that amount program management received about $8.4 million, and the remainder—about $77.7 million—was awarded as grants to the core schools to fund sixty projects. Each project had a different level of cost share from the research group undertaking the project.[10]

ASSURE uses multiple contracting approaches to manage its coalition of members. A master teaming agreement between Mississippi State and the ASSURE universities defines the roles and responsibilities of the participants. For each participating university, the FAA has a cooperative

[8] "About," ASSURE, last modified March 3, 2025, https://www.assureuas.org/about/.
[9] FAA Reauthorization Act of 2024, Pub. L. No. 118-63, § 1006, 138 Stat. 1388.
[10] ASSURE, *Annual Report 2023* (ASSURE, n.d.), https://assureuas.com/wp-content/uploads/2024/03/ASSURE_2023_Annual_Report_DigitalVersion_Fweb.pdf.

agreement and indefinite delivery/indefinite quantity contract. Therefore, when a grant is awarded, the FAA directly funds the selected universities through their individual agreements.

### *ASSURE Program Structure*

ASSURE project partnerships develop through collaborative applications between academic institutions, industry, and government partners. Under ASSURE, the FAA can direct research requirements to the COE or respond to research proposals from COE members. ASSURE members can submit white papers to the FAA for consideration and prioritization. If approved, the FAA will develop the white papers into RFPs. Often, the authors of the white paper that initiated an RFP ultimately will be selected to be on the awarded research team.

The network of ASSURE universities allows for the recruitment of a diverse group of experts for each project. The FAA distributes an RFP to the ASSURE manager at Mississippi State. The manager then distributes it to the ASSURE network; members may respond to the entire request or a specific task within the RFP. The ASSURE manager collects the responses to the RFP and determines the team of universities that will be included in the response based on their capacity and capabilities.

Once awarded, the team undertakes the research and Mississippi State performs quality control and project management on behalf of the FAA. This design alleviates some of the FAA's challenges regarding research team recruitment. The FAA has reliable, collaborative teams to turn to through ASSURE, rather than having to build relationships with potentially new researchers for every RFP.

### *ASSURE Communication and Data Sharing*

ASSURE research results are submitted to the FAA and published publicly. Under the COE mandate from Congress, ASSURE is obligated to share research publicly. There are nondisclosure agreements with industry partners. However, the obligation to share publicly is nonnegotiable. As part of the public report, ASSURE communicates the research findings and includes recommendations for rulemaking, where appropriate, based on the areas where the research identified the need for guidance or regulation.

## BEYOND

The FAA BEYOND program was launched in October 2020 to continue the work of the concluded UAS Integration Pilot Program. BEYOND phase 1 started as a four-year program with eight "lead" participants. The program supports the advancement of beyond visual line of sight (BVLOS) operations through the engagement of industry and public sector communities. It addresses, and community

| **BEYOND Quick Look** |
|---|
| **Participants:** State and tribal governments, industry partners, and original equipment manufacturers |
| **Funding:** No direct program funding; lead participants and industry partners provide in-kind resources |
| **Contracting Vehicle:** Memorandum of agreement with the FAA; letter of intent or memorandum of understanding among participants |
| **Data/Report:** Monthly and semiannual reporting requirements. |

benefits of drone use.[11] BEYOND phase 1 concluded in 2024; phase 2 will continue the program per the FAA Reauthorization Act of 2024.

***BEYOND Program Structure***

BEYOND partnerships develop through shared state, local, tribal, and commercial needs for local UAS and AAM operations. There are eight public institutions designated as lead participants in the BEYOND program. A unique aspect of this program is that the lead participants must be a state, local, territorial, or tribal government or public entity. These lead participants represent a mix of state DOTs, academic institutions, and a tribal nation. Each lead participant has their own set of partners, most of which consist of private sector industry. Participation in the BEYOND program is voluntary and participants receive no funding from the FAA. Each partnership is managed by the lead participant and structured through a letter of intent or memorandum of understanding with regional partners (public and private organizations) that provide the best effort or most in-kind resources to the partnership.

There are eight BEYOND program lead participants:

- Choctaw Nation of Oklahoma
- Kansas Department of Transportation
- Memphis-Shelby County Airport Authority, Tennessee
- Mid-Atlantic Aviation Partnership, Virginia (Virginia Tech and commercial partners)
- North Carolina Department of Transportation
- North Dakota Department of Transportation
- The City of Reno, Nevada
- University of Alaska – Fairbanks

The BEYOND program's primary focus is to resolve NAS integration issues by identifying the needs of state, local, and tribal organizations and commercial and industrial partners BVLOS operations. The BEYOND lead participants and their partners work with the FAA to obtain waivers and exemptions to demonstrate, test, and evaluate BVLOS operations. The FAA provides overall BEYOND goals and key performance indicators, but each lead participant and their partner(s) pursue challenges they want to address within those objectives. There are three goals of BEYOND research on BVLOS:

- BVLOS without visual observer approval and operations
- Repeatable BVLOS without visual observer approval and operations
- Scalable BVLOS without visual observer approval and operations

The FAA Reauthorization of 2024 extended the BEYOND program and directed the FAA administrator to consider expanding the program to include additional state, local and tribal government participants, and expanding the scope to include automation in civil aircraft, including UAS; operation of these systems and technologies, including BVLOS; and their societal and economic impacts.[12]

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[11] "BEYOND," Federal Aviation Administration, last modified March 25, 2025, https://www.faa.gov/uas/programs_partnerships/beyond.
[12] FAA Reauthorization Act of 2024, Pub. L. No. 118-63, § 920, 138 Stat. 1353.

*BEYOND Communication and Data Sharing*

BEYOND participants communicate with the FAA and among themselves via in-person and virtual meetings. BEYOND participants submit semiannual narratives of their successes and challenges, as well as operational safety data.[13] This includes UAS monthly flight reports, Automated Data Service Provider (ADSP) reports, and UAS anomaly reports.[14]

**UAS Broad Agency Announcement Program**

| UAS BAA Program Quick Look |
|---|
| **Participants:** QCEs and UAS test sites |
| **Funding:** FAA match of funding proffered by the QCEs and match of up to $6 million for use at test sites |
| **Contracting Vehicle:** Firm fixed price contract |
| **Data/Report:** Research report submitted to the FAA and may or may not be released to the public |

The UAS BAA Program (Broad Agency Announcement 692M15-19-R-00020) was sponsored by the UAS Program and Data Management Branch in the UAS Integration Office. A unique aspect of this program was its direct engagement with qualified commercial entities (QCEs). The program's purpose was to allow QCEs to demonstrate and validate their UAS technologies at one of the seven Test Sites. The UAS BAA included five calls for proposals and was open for five years from the date of the original issuance in June 2019 and its closing in June 2024. The program was reauthorized in FY 2024, but as of April 2025, no RFP had been published.

UAS BAA projects were funded by the QCEs with the FAA providing match funding. Moreover, the FAA Reauthorization Act of 2024 provided additional funds for the QCEs' use of UAS test sites, up to $6 million annually to be shared equally among the sites. For each UAS BAA project, the period of performance for an award was generally one year, and the magnitude of individual projects are around one million dollars.[15]

*UAS BAA Program Structure*

The UAS BAA program utilized RFPs to identify industry research priorities in specific topics. The FAA communicated its research needs through calls for white papers under the BAA. Each call included a list of "interest topics" the white papers should address. Listed below are the interest topic areas:

- Detect and Avoid Capability
- Beyond-Visual-Line-of-Sight Operations
- Operation of Multiple Small Unmanned Aircraft Systems

[13] The BEYOND Semi-Annual Report instructions request that lead participants respond to the following outline format: executive summary, accomplishments, missions, outcomes, lessons learned, community engagement, collaboration, safety process, societal and economic benefits, future activities, challenges and other discussions. Federal Aviation Administration, *BEYOND Semi-Annual Report* (Federal Aviation Administration, n.d.), https://www.reginfo.gov/public/do/DownloadDocument?objectID=112859101.

[14] Federal Aviation Administration, "Agency Information Collection Activities; Proposals, Submissions, and Approvals: Unmanned Aircraft Systems BEYOND and Partnership for Safety Plan Programs," Regulations.gov, September 18, 2024, https://www.regulations.gov/document/FAA-2024-2158-0001.

[15] https://govtribe.com/opportunity/federal-contract-opportunity/aviation-research-baa-692m1520r00004Data provided by the Federal Aviation Authority, April 10. 2025.

- Unmanned Aircraft Systems Traffic Management
- Improvement of Privacy Protections Through the Use of Advances in UAS Technology
- Command & Control
- Other Critical Priorities

Applicants could respond to specific calls or apply at any time during the BAA's life. AUS-300 provided the technical review of the UAS BAA program submissions. The submission flexibility benefited QCEs and the FAA as it allowed them to respond to and propose new research and testing topics under the seven overarching interest topics. To apply, QCEs submitted a white paper on one or more of the interest topics, a technology readiness level calculation demonstrating that the technology to be tested is within levels 5–7, and a letter of attestation between the QCE and a test site detailing a rough federal cost and QCE matching cost estimate.

This “reverse acquisition” process allows the FAA to learn about the latest and greatest technologies from industries’ perspectives. The broad interest topics and the FAA’s flexibility within those categories permit industries to demonstrate their interests to the FAA. Through the UAS BAA program and working closely with Flight Standards Services and subject matter experts to determine requirements, the FAA can test and validate new UAS or AAM technologies.

### *UAS BAA Communication and Data Sharing*

The UAS BAA calls led to multiple contract awards and public research reports. Over the course of the program, thirty-five contracts were awarded to twenty-seven different QCEs; some QCEs were awarded more than one contract. Based on publicly available data from the first four calls, six different UAS test sites were engaged (as of April 2025, the reports from the fifth call had not been published). The Northern Plains UAS Test Site was used most frequently with nine UAS BAA contracts, followed by the New York UAS Test Site with six contracts. Table 1 below lists each call’s number of awardees, public reports, and the UAS Test Sites utilized.

*Table 1. UAS BAA Calls Summary Statistics*[16]

| Call # | Awardees per Call | Awardee Public Reports Published | UAS Test Sites Utilized |
|---|---|---|---|
| Call 001 | 7 Awardees | 1 published | NV and six unnamed |
| Call 002 | 5 Awardees | 2 published | (3) ND, and two unnamed |
| Call 003 | 7 Awardees | 7 published | (3) ND, (2) NY, AK, and NV |
| Call 004 | 10 Awardees | 10 published | (3) ND, (4) NY, AK, VA, and one unnamed |
| Call 005 | 6 Awardees | Currently unpublished | Currently unpublished |

UAS BAA recipients provide their research results and datasets directly to their FAA sponsor. Final reports may be published, but it is not a requirement to share them, in part or in whole, among the UAS and AAM research communities. Over the first two calls, less than half the projects published a public summary. Comparatively, all awarded projects for the third and fourth calls were published.

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[16] Data for Table 21 was developed from the published UAS BAA reports from calls 1–4.

## UAS Test Sites

| UAS Test Sites Quick Look |
|---|
| **Participants:** Public entities (state and municipal organizations) and private companies |
| **Funding:** User fees; no FAA funding |
| **Contracting Vehicle:** Established by other transaction authority; fee for service agreements with customers |
| **Data/Report:** Report only flight data from private users; other data owned by the user |

The FAA established seven UAS Test Sites across the United States. The test sites are independent and do not function as an integrated network of providers. The UAS Test Sites support the safe integration of UAS technology into the NAS and provide an environment that fosters opportunities for technology transfer. Six test sites were established through a competitive process per the requirements outlined in the FAA Modernization and Reform Act (2012), with the seventh added at the direction of the FAA Extensions, Safety, and Security Act of 2016.[17] There are seven UAS Test Sites:

- Alaska Center for Unmanned Aircraft Systems Integration, AK
- Mid-Atlantic Aviation Partnership, VA
- New Mexico State University UAS Test Site, NM
- New York UAS Test Site, NY
- Northern Plains UAS Test Site, ND
- State of Nevada, NV
- Texas A&M University Corpus Christi Autonomy Research Institute, TX

In 2024, the FAA Reauthorization Act directed the administrator to carry out and update the UAS Test Site Program, including selecting and designating up to two new test sites should the Administrator deem it of interest to enabling safe UAS integration into the NAS.[18]

Test sites allow public and private organizations to develop technology related to ongoing research, such as BVLOS operations and other UAS innovations. They provide airspace locations that have been secured by the FAA for demonstration and testing of UAS and AAM. To use the site, each customer first must obtain a public or civil certificate of authorization (COA) from the FAA allowing it to operate. Test site staff can assist their customers with the application process. A portion of the test data, per agreement with the customer, is shared with the FAA as part of the use requirement for the test site.

Each test site is unique, operating in different regions of the country with various public and private partners, and offering different capabilities and facilities. They generally work with the same FAA programs, but their private partners differ, and their varying operational environments—in terms of geography, temperature, precipitation, etc.—provide unique challenges. For instance, the Alaska test site is one of the sites that leads additional locations outside its primary facility, operating in Oregon and Hawaii. Other test sites have operational footprints that extend beyond their primary facility. Additionally, it significantly emphasizes

[17] FAA Extension, Safety, and Security Act of 2016, Pub. L. No. 114-190, § 2201, 30 Stat. 629.
[18] FAA Reauthorization Act of 2024, Pub. L. No. 118-63, § 925, 138 Stat. 1355.

long-distance transportation and delivery-related testing because many stakeholders in Alaska rely upon aviation for survival in otherwise isolated environments.

Despite their different foci and locations, the UAS Test Sites compete with each other for customers. However, this competition is tempered by each site's unique qualifications. Every test site does not offer the same set of capabilities. Therefore, test site operators work together to support each other and refer customers based on their specific needs. Operators are also willing to share their expertise or provide advice to other UAS Test Sites to maintain these relationships.

The COA or waiver application process with the FAA can be lengthy (thirty to ninety days) and ultimate approval is not assured. The UAS test sites therefore also compete with other federal agency test sites, which do not require an FAA-issued COA or waiver. Both NASA and DOD have locations with secured airspace that are used for testing. Therefore, commercial companies have the option to shop their research around different federal agencies to seek the most beneficial testing conditions.

Companies also may choose to use test locations outside of the United States. Depending on companies' needs, testing or conducting flight hours in other countries can be less expensive and timelier than using US UAS Test Sites. Additionally, some countries have different testing parameters which, for example, might make it easier to conduct BVLOS and BVLOS testing over people.

### *UAS Test Sites Funding Structure*

The UAS Test Sites are supported primarily through funding sources external to the FAA. There are no funds from the FAA or other federal sources for test site-specific operations. All test sites are operated by public institutions, such as state or local governments and universities, and rely on 'soft money" or fee-for-service agreements to generate operational income. The test sites report that they are not at capacity and could accommodate growth. However, the ebb and flow of soft money cycles expose these public institutions to the risk of financial loss. Without steady operational funding, test sites are hesitant to commit funding for increasing staff or making capital investments. Test site customers include researchers in the ASSURE and BEYOND programs and other public or private entities. QCEs in the UAS BAA program are required to use one or more test sites as part of their proposed research. This arrangement creates a soft money revenue stream for the Test Sites. For FY 2025–28, the FAA anticipates matching the QCE's investment by providing additional funding for the use of the designated test site under UAS BAA awards. In general, however, test sites are responsible for developing and maintaining their own customer base and revenue streams.

### *UAS Test Sites Communication and Data Sharing*

The UAS Test Sites report data for various programs per FAA requirements. The test sites report various data to the FAA depending upon the program, the type of activities the test site engages in, and nondisclosure agreements with non-FAA contracted work. A test site's work with customers is often protected by a nondisclosure agreement, and there is no congressional mandate to publicly report results. The test sites have to report to the FAA quarterly and submit a final report including the number of flights conducted. Other avenues of communication between the FAA and the test sites include monthly meetings with FAA management and biannual technical interchange meetings with all test sites to assess their maturity and compare and contrast operations, data, and processes.

The FAA Reauthorization Act of 2024 created additional requirements for data sharing between test site sponsors and the FAA. The Act directs the administrator to "...develop data sharing and collection requirements for test ranges to support the unmanned aircraft systems integration efforts of the Administration and coordinate periodically with all test range sponsors to ensure the test range sponsors know— (A) what data should be collected; (B) how data can be de-identified to flow more readily to the Administration; (C) what procedures should be followed; and (D) what development, testing, and evaluation would advance efforts to safely integrate unmanned aircraft systems into the national airspace system."[19] Test sites are not directly funded by the FAA, which creates some data sharing challenges. When the FAA funds a project, they have ownership of the results. Since test sites are not funded by the FAA, the data is owned by the paying customer, not the FAA. Test sites have reported that they would like greater clarity from the FAA on its testing and data needs; however, the FAA's ability to direct the sites to conduct that work is limited because such requests are unfunded.

**Observation 3.1:** The seven UAS Test Sites are independent and do not function as an integrated and coordinated network of providers. Each UAS Test Site has unique technical experience; demonstration and testing capabilities; and geographic, climatological, and population density attributes. Test Sites compete with each other, other federal agencies, and test locations in other countries to generate operational revenue.

## *External Partners*

The FAA's efforts to integrate UAS and AAM into the NAS involve more than the partnership programs. The FAA engages with other partners who either conduct, consume, or build on the FAA's research. These partners include federal, research, international, and standards organizations. Industry participates among these categories of partners; however, its involvement is less direct than with the FAA partnership programs described previously.

### Federal Partners

The FAA's UAS research activities feature many relationships with other federal agencies, departments, independent establishments, and government corporations. However, most of these are not research collaborations or partnerships. Relationships vary, with most involving only general awareness and basic communication but no research collaboration or partnership. For instance, the FAA works with the Departments of Commerce, Homeland Security, and Interior, among others, through the Federal Emergency Management Agency, Customs and Border Protection, National Park Service, and National Oceanic and Atmospheric Administration. Each of these organizations has different needs and goals for their UAS activities. However, these agencies and others are often end users of UAS technology rather than research partners. They utilize approved UAS technologies, which are sometimes new innovations, to achieve their missions, but generally they do not partner directly with the FAA on research of these technologies. They may or may not share data from their UAS activities with the FAA to inform

[19] 49 U.S.C. § 44803 (2018).

research, rulemaking, and other work. When partnership is an option, funding is achieved through interagency agreements. However, the FAA generally does not receive funding from most federal partners.

Compared to other federal agencies, NASA and DOD demonstrate a slightly more communicative, cooperative, and coordinated relationship with the FAA for select UAS research. For example, NASA and the US Air Force may partner with the FAA on research directly or through a research partnership program, sometimes utilizing the FAA's UAS test site facilities or involving some type of data sharing. However, these agencies also engage in other research that remains entirely independent of the FAA.

The FAA's relationship with NASA is the closest to a research partnership. The two agencies utilize RTTs to collaborate and share data. The six active RTTs include AAM, digital mesh technology and applications, upper E traffic management, UAS traffic management, system-wide safety, and wildfire management.[20] Each RTT has a focused set of requirements with five to seven years of planned activities. Both agencies have established a joint management plan for the RTTs that define what is being delivered by each agency and when.

**Observation 3.2:** Federal partners' involvement includes those directly engaged in UAS or AAM research (e.g., NASA and DOD) and those who are end users of established technologies or testers of commercial technologies (e.g., Department of Homeland Security and Department of Interior).

### Research Partners

#### *Volpe National Transportation Systems Center*

The Volpe National Transportation Systems Center (Volpe) does not receive congressional appropriations. It is a fee-for-service organization that undertakes projects for the DOT and FAA, as well as others, such as DOD, NASA, the Department of Energy (DOE), the Environmental Protection Agency, and the National Park Service. The center focuses on applied research driven by the needs of DOT and its various modes. Volpe's expertise in aircraft noise emissions is relevant to UAS and AAM. Additionally, it administers DOT's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs.

#### *MITRE Center for Advance Aviation System Development*

MITRE Center for Advanced Aviation System Development is an FFRDC that conducts research for the FAA to understand the basic needs in the UAS and AAM field so that it can then work with standards groups and industry to refine that research. For example, it has been involved in the FAA's UAS Integration Pilot Program, and BEYOND programs. MITRE has data sharing agreements with the FAA and access to the FAA's data.

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[20] Research, Engineering, and Development Advisory Committee, *Summer Fall Meeting Minutes* (Federal Aviation Administration, October 16, 2024), https://www.faa.gov/about/office_org/headquarters_offices/ang/redac/redac-fullComm-meeting-minutes-10162024.pdf.

### *Civil Aerospace Medical Institute*

CAMI carries out research funded by sponsors across the FAA. CAMI provides medical certification, research, education, and occupational health services focused on the "human element in flight and the entire human support system that embraces civil aviation.[21]"

CAMI has two research divisions: human factors and aerospace medical research. CAMI receives its research requirements from both the industry and policy holders within the FAA. A policy office puts forth research requirements and, depending on the budget line item, that research requirement may fall to CAMI's research divisions. The recommendations that CAMI produces may be advisory or used for standards. Additionally, CAMI's data is often provided to those who request their research results, such as stakeholders, policy offices, or the standards office.

### *The FAA William J. Hughes Technical Center*

WJHTC is a research center that supports the efficient, safe development of the NAS through research, engineering, development, testing, and evaluation of aviation technologies.[22] WJHTC is administered by NextGen. It is funded through a combination of congressionally appropriated budget line items and other funding mechanisms. Specifically, WJHTC's research budget includes a line item that supports UAS and AAM research. This funding is part of the FAA's overall R&D portfolio. The research portfolio is developed with input from various stakeholders, including FAA offices, industry, academia, and other government agencies, reviewed by REDAC and REB, and supported by the director of the WJHTC. Additionally, the WJHTC administers ASSURE, which involves a 1:1 dollar match for contributions. The WHJTC also engages in technology transfer activities, including cooperative research and development agreements (CRADAs), which are a significant part of its funding and collaboration efforts.

**Observation 3.3:** Research partners outside the partnership programs (e.g., MITRE Center for Advanced Aviation System Development, Volpe, WJHTC, and CAMI) provide direct research and research strategy and planning support to the FAA through a variety of funding mechanisms. These mechanisms include direct FAA funding, fee-for-service, and FFRDC contracts (e.g., cost-reimbursable).

## Standards Partners

Standards organizations coordinate standards development to be used in support of or in compliance with regulations and are not directly involved with FAA research. The standards development process requires the participation, input, and work of industry participants, the FAA, other government stakeholders, and standards groups. Major standards groups include the ASTM International, American National Standards Institute, and Radio Technical Commission for Aeronautics (RTCA).

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[21] Civil Aerospace Medical Institute, *The Civil Aerospace Medical Institute* (Federal Aviation Administration, September 15, 2017), https://www.faa.gov/sites/faa.gov/files/about/office_org/headquarters_offices/avs/CAMIBrochure.pdf.
[22] "William J. Hughes Technical Center," Federal Aviation Administration, last modified March 19, 2025, https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc.

Standards groups have committees on topics such as UAS and AAM. Members of these committees include industry, the FAA, and any other stakeholders who wish to participate and provide input. The FAA is part of RTCA committees via a "government authorized representative." For ASTM, the FAA is a member of committees on UAS (e.g., Committee F38 on Unmanned Aircraft Systems).

The American National Standards Institute helps gather and coordinate information from the UAS industry and other stakeholders on what standards and, ultimately, rules should be developed and the research gaps that inhibit rule development for UAS. Using this information, the American National Standards Institute produces a roadmap—funded by the FAA—that identifies gaps in the UAS environment and provides the industry's research priorities for the FAA to consider.

The final products that standards groups produce, with the FAA's participation, are aviation standards, standards documents, trainings, and symposiums. Standards groups' stakeholders and members bring data to committees in the standards development process. The FAA also provides data to standards committees. Datasets that are part of standards are accessible to committee members, such as industry and the FAA.

**Observation 3.4:** Standards groups are not directly involved with the FAA's UAS and AAM research. However, they are integral partners who support the implementation of new rules or, in the absence of a rule, may work ahead with their members and industry to develop agreed-upon standards, certifications, and training that the FAA may or may not adopt in future regulatory actions.

### International Partners

The FAA has two types of international partners or peers in UAS and AAM. The first type of partner is the CAAs of other countries that operate like the FAA. The FAA's closest CAA partners are Canada, the United Kingdom, Australia, and New Zealand. The FAA also has strong relationships with other CAAs, such as Switzerland, Italy, Japan, and South Korea, among others. The second type of international partner is convening bodies. These convening bodies are membership groups to which the FAA and other CAAs belong. These convening bodies, such as the Joint Authorities for Rulemaking on Unmanned Systems and the International Civil Aviation Organization, coordinate and develop global standards and recommended practices, provide guidance, and review regulations for traditional aircraft and new entrants, such as UAS and AAM.

There is very little joint funding for UAS or AAM research among international partners. However, the FAA has one of the largest budgets for research, and its results are leveraged by CAAs. Therefore, the FAA is more likely to be the primary funder rather than cofunder of research in the international arena. International partners consume FAA research and support it by sharing datasets, case studies, and other operational information where appropriate.[23]

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[23] Certain foreign CAA interviewees who share similar R&D priorities, indicated an interest in deepening the cooperation with the FAA, to include conducting joint research in areas of mutual interest to spread the cost of research and development. This may include joint research with the Canadian, British, and Australian authorities. Interviews with NextGen officials also suggest there may be partnership

The FAA and international partners also share information on process approaches. For example, the FAA and Switzerland's CAA (FOCA) have a declaration of interest, where the two organizations can have regular communications on UAS topics, such as UAS traffic management. The declaration provides for open and flexible exchanges. Both the FAA and FOCA have a risk-based approach to the regulation of UAS. For example, FOCA developed and adopted a risk methodology called the specific operations risk assessment, to determine the risk posed by a complex drone operation. Such operations include those that are BVLOS, above 120 meters, or with a drone that weighs more than twenty-five kilograms. This risk approach allowed for the safe testing of BVLOS delivery in Zurich. The FOCA brought this methodology to the other European authorities for drone operation, and it has been adopted by most. Although it is similar to the FAA's waivers and exemptions process, the specific operations risk assessment process offers another perspective on assessing risk for UAS testing operations.

The ability to engage in joint research on AAM or UAS and the sharing of research results among international partners takes place through multiple avenues. Relationships between the FAA and other CAAs can be structured through formal bilateral or multilateral agreements with CAAs to formally work together to harmonize airspace regulations and safety requirements. Membership in international convening bodies such as the International Civil Aviation Organization or Joint Authorities for Rulemaking on Unmanned Systems is voluntary and allows the FAA to work with other CAAs to discuss issues that impact the members. Face-to-face engagement occurs through conferences, large international meetings, and smaller meetings between CAAs where research results and lessons learned can be exchanged among participants.

The FAA and CAAs are not required to share data and information resulting from UAS or AAM research. However, they voluntarily exchange research results and datasets when appropriate. In the international convening bodies, data is shared to support the organization's technical subcommittees and expert groups. Sharing data supports the common aim of harmonizing international standards.

**Observation 3.5:** CAA partners have few UAS and AAM research projects compared to the FAA. They do not regularly cosponsor research with the FAA. International partners often consume FAA research and, less regularly, support it through appropriate sharing of datasets, case studies, and other operational information.

opportunities with the European Organization for the Safety of Air Navigation and the Single European Sky Aviation Research Initiative.

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# Chapter 4: Utilization, Impact, and Funding of Research Partnerships

Today, there exists a large market for new entrant technologies and users across the country for which the FAA is authorized to establish regulations to ensure the safety and efficiency of the national airspace. The partnerships serve to provide input into the regulatory processes. Currently, there is a lack of adequate data and experience to inform decisions for safe operation of UAS and AAM in the NAS. The FAA utilizes partnerships to research, develop, test, and provide essential data for its regulatory needs. Through funding and research partnerships, like ASSURE, BEYOND, the UAS BAA, and the UAS Test Site Program, the FAA can investigate important UAS and AAM research topics that are not currently or adequately being addressed. Partnerships enable the FAA to more quickly develop and collect data for use in pursuing UAS and AAM integration.

## 4.1 Role of Research Partnerships to Advance UAS R&D

Given the size and continued growth of the population of UAS users and producers, the FAA would be unable to integrate all new entrants through COAs alone. Therefore, the FAA's approach is to establish iterative, performance-based rules, based on data and information from sponsored research, to advance the whole industry forward without endorsing one technology over another, and without exclusive reliance on waivers. Publishing a new rule allows UAS and AAM users and producers to test within the parameters of the new rule for activities that would have previously required a waiver.

New rules lead to the elimination of some research or testing waivers, allowing the industry to advance. Industry advancements in processes, technologies, or operations may require future users and producers to apply for COAs to continue advanced research and testing. A challenge for the FAA is how to share and aggregate all data sponsored by multiple FAA offices to inform COA decisions and, ultimately, develop the next iteration of a rule.

The FAA's partnership programs and external partners are building the information and data foundations for high-level integration decisions of UAS and AAM. A participant in the partnership programs may be one of the entities seeking a COA to test new technologies and systems. Each of the partnership programs has a project management plan that includes regular contact and discussions with FAA staff throughout the R&D projects. The projects are generally completed within the timeline of their agreements and within the scope determined by the partners and their project managers.

How the FAA prioritizes its research needs and directs these partnerships efforts, and the processes by which research is proposed and conducted, ultimately affects how quickly accurate and adequate datasets can be built for the FAA to consider when making decisions on UAS or AAM integration.

**Finding 4.1:** Overall, FAA R&D client requests (requirements) are adequately addressed by partnerships (ASSURE, BEYOND), with the data they produce being utilized to inform the FAA's rulemaking and technology transfer processes to include inputs to the waiver and certificate of authorization functions.

## 4.2 Lengthy and Inefficient Processes Hindering UAS Partnership Effectiveness

A key aspect of the FAA UAS R&D process is how the research requirements are identified, developed, prioritized, and addressed. Obtaining timely and relevant research data from partnerships and applying those data to the FAA's rulemaking, technology transfer, and other supporting processes, such as waiver and exemption, are critical to the FAA's success in integrating UAS into the NAS.

The FAA faces challenges that may hinder the timeliness and scope of the outcomes of current and future partnerships, primarily ASSURE and BEYOND, thus limiting their full utilization. This negatively affects the FAA's overarching goal to assimilate UAS into the NAS. The effectiveness of current and potential future partnerships to address the FAA's UAS rulemaking and technology transfer research needs are driven largely by the FAA's processes and working relationships with its partners. Partners, with few exceptions, conveyed that they have a good working relationship with the FAA.

### *Organizational Structure and Processes*

Factors contributing to the lengthy R&D process are the FAA's organizational structure, processes, and approach. Partnerships conveyed that the FAA organizational structure has many layers and a stovepipe alignment. FAA program managers are often risk-averse, and DOT senior management must approve new research. Additionally, program managers' roles and responsibilities, in many cases, are critical to partnership success. Furthermore, components within the FAA compete for resources and often have different priorities.

The FAA R&D process that informs rulemaking and technology transfer is lengthy because the identification, development, prioritization, and completion of requirements face a number of challenges, as outlined below. As stated previously, the FAA R&D process includes a period where the FAA studies the issue and then decides whether to proceed. The proposed rule phase extends from the initiation of rulemaking through publication in the *Federal Register* of a notice for proposed rulemaking to solicit public comments. This process is generally complex, requiring regulatory analysis and internal and interagency reviews. The rulemaking process often takes two to three years.

### *Research Requirements Provided in Agreements*

Partnership research tasks generally are codified in an agreement that provides for how requirements are to be addressed and data are to be provided. Depending on the research, additional requirements may include detailed risk assessments, pilot qualifications, and data collection protocols. The causes for additional challenges and process delays related to how partner requirements are conveyed in agreements include the following:

- Project proposals are not approved in a timely manner.

- Multiple requirements within task orders often are not prioritized.
- Requirements sometimes change in the middle of the process.
- Requirements (data needed) sometimes are not clearly defined.
- Agreements (e.g., master agreements, other transaction authorities, memorandums of understanding, and MOAs) are in some cases nine or more years old and provide limited guidance regarding what and how R&D should be conducted.

## *Waivers and Exemptions*

Within the research and development process, there are waiver and exemption procedures. If the partnership is conducting tests that do not comply with applicable regulations, then a waiver may be necessary. UAS operators requesting a COA for an aviation event or other advanced operations must complete the FAA 7711-2 COA form. The waiver is an official document issued by the FAA that approves certain operations of aircraft outside of the limitations of regulation. The COA application details the proposed research operation, including safety measures and airspace considerations, through the FAA's COA Application Processing System. The FAA then reviews the application to ensure it meets safety standards before granting approval to conduct the research. The FAA can take up to ninety days to process a waiver after the applicant has successfully completed the required documentation. Several interviewees described the documentation process as challenging, requiring previous experience to complete it in a timely manner. The following are the causes of challenges in the waiver and standards processes:

- Waivers and exemptions are either not granted or take a long time to be approved.
- The timeline for approval or disapproval of waivers varies.
- Completing the required waiver documentation is time consuming and difficult.
- There is limited guidance and no training on how to submit waiver requests.
- Standards are not current with technology because they generally take twelve to eighteen months to develop.

## *Effects of Lengthy and Inefficient Processes*

As a result of the lengthy processes within the FAA, partnerships struggle with staffing and profitability. UAS Test Sites depend on fee-for-service contracts to maintain operations. Delays or denials of COAs for customers wanting to use the UAS Test Sites negatively impacts a site's operational revenue. For ASSURE, university faculty and graduate students often transition out and have to be replaced during the project. The BEYOND program faces similar challenges as private companies encounter financial challenges during their long engagement with the program and sometimes go out of business before their products can be tested and validated. Ultimately, recruiting new industry members can be difficult due to the reluctance to work with the FAA because of how long the processes take and the uncertainty regarding waiver and exemption approvals.

R&D produced by partnerships to address critical needs may not be timely. The process, from formulation of requirements to receiving completed research from partnerships, generally takes at least two to three years. This results in delayed progress in addressing drone autonomy and legislative requirements, such as expanding counter-UAS efforts and tackling the threat of rogue drones. Although the average delay is difficult to measure, interviewees conveyed that the process takes exceedingly long, resulting in several challenges, including those described above.

**Finding 4.2:** The FAA's processes, organizational structure, and approach contribute to lengthy processes for the R&D that informs rulemaking and technology transfer.

**Recommendation 4.1:** Assess and address FAA UAS-related organizational concerns raised by partners. Concerns include multiple layers of review, stovepipe structure, high-level approvals for new research, and the need for a clear delineation of roles and responsibilities. If organizational structure and process challenges are not currently part of planned action, develop a process and timeline for addressing them.

**Recommendation 4.2:** The FAA and AUS should establish a repeatable process for reviewing and updating all UAS partnership agreements (i.e., ASSURE and BEYOND) that anticipates rulemaking and other future needs, including ensuring requirements within task orders are prioritized and clearly defined.

**Recommendation 4.3:** The FAA should refine the waiver and exemption process to reduce uncertainty and improve timeliness, to include standardizing the timeline for approval or disapproval, limiting paperwork, and providing training and guidance on how to submit requests.

**Recommendation 4.4:** To help identify and address UAS process challenges on an ongoing basis, the FAA and AUS should consider expanding utilization of the lessons learned process in place under AUS-400 to more broadly identify UAS challenges and steps to advance UAS partnerships.

One possible approach to identify and address challenges in real time is to expand utilization of the AUS-400's existing "lessons learned" process. The AUS-400 division focuses on integrating UAS into the national airspace through collecting data on operations and using the information to inform future regulations and safety standards for drone operations. Any entity working with AUS-400 has ongoing access to a platform to input knowledge gained that other research organizations could benefit from learning.

## 4.3 Lack of Data and Information Sharing

Numerous partners conveyed that information sharing is limited, and sometimes inconsistent, from the FAA to partnerships and between partnerships. The FAA does not have a process for identifying its specific crosscutting, long-term UAS data needs and communicating those to its partnerships. The REDAC and REB (described in section 3.2) do identify areas for future research; however, those processes do not provide partnerships with information specific to possible future research data requirements, including target dates or timeframes. The FAA is establishing an aviation safety research strategy that may add some structure to one aspect of its long-term UAS planning. Further, legislative direction provides some high-level context to what research data are needed. However, it also is not specific enough for partnerships to identify detailed future data requirements.

## *Partnership Agreements*

Current UAS partnership agreements do not adequately promote data sharing. The agreements and associated guidance generally outline only what data should be provided to the FAA; they do not express that other relevant data within the UAS community, especially within other FAA partnerships, should be considered to fully inform the requested tasks. Providing some direction and guidance on how data should be coordinated and shared within and across FAA partnerships would benefit all FAA R&D partnerships.

## *Project Managers*

The FAA drone research process involves partnerships evaluating and testing proposed drone operations. This process is overseen by an FAA project manager who has a great deal of input into the process, ideally applying his or her knowledge and experience with research and technology development and testing from other projects to the ongoing work. The project manager is thus a key influence on the direction and day-to-day workings of the project. Consistent direction, not only within a project but across all research projects, facilitates a coherent and uniform effort, as well as the sharing of crosscutting data and requirements.

Frequently changing FAA project managers who vary in experience and knowledge contributes to the lack of data sharing. Often these project managers lack knowledge of other FAA UAS research that has relevance but is conducted outside of their program. Ultimately, this results in a lack of coordination and clear direction for research and partnerships. Because partnerships are largely unaware of each other's research, UAS R&D is not fully informed.

## *Effects of a Lack of Data and Information Sharing*

As a result of a lack of data sharing across FAA UAS partnerships, the FAA may be unaware of R&D results that could benefit its mission. In addition, partnerships are unable to leverage all UAS R&D conducted by industry, identify gaps, and avoid possible duplication. Furthermore, requirements may not be detailed enough to monitor partners or lead to the generation of desired data. Industry partners often do not receive a response, or timely response, to research data provided to the FAA regarding relevance or sufficiency, further exacerbating not only overall timeliness but also the full utilization of industry R&D.

**Finding 4.3:** Information sharing is limited, and sometimes inconsistent, from the FAA to and between partnerships.

**Recommendation 4.5:** The FAA and AUS should develop a process for identifying its specific long-term, crosscutting UAS and AAM data needs, including timeframes, and conveying those needs to partners. This will increase partners' awareness of the FAA's long-term UAS and AAM strategies, goals, and requirements for research data, enabling them to align with FAA plans and appropriately resource their efforts in support of FAA data needs.

**Recommendation 4.6:** The FAA UAS partnership agreements should include provisions to require or encourage FAA partnership program participants to share their R&D data with other partnership programs, when contractually feasible, to fully inform the FAA's tasking and facilitate partners' ability to focus on specific data requirements and gaps. To enable this, the following are needed: provisions to eliminate the barriers to sharing that exist today; contractual language that requires and authorizes sharing; and agreements between partners that facilitate sharing and address responsibilities and liabilities on the part of the partners. Agreements should detail how the FAA intends to use the data to inform certification, rules, standards processes, and other regulatory activities.

**Recommendation 4.7:** The FAA should ensure that project managers for UAS partnership research projects are knowledgeable of ongoing FAA UAS research programs and outcomes and have the means to engage with other research partnership program managers to enable them to provide appropriate direction and coordination to their assigned research projects.

**Recommendation 4.8:** The FAA should more broadly leverage the data sharing already occurring among organizations contributing to the UAS standards and rules, when and if appropriate, to inform all R&D being conducted by UAS partnerships.

One such data source is the ASTM International committee members (e.g., there 547 members on the F 38 committee).[24] When developing a UAS standard, ASTM forms a group of relevant industry and government experts to inform the formulation of the standard. While only those deliberations that are documented for the public record may be utilized, the deliberations that occur in the formulation of UAS standards could be useful when shared more broadly with UAS industry members.

**Recommendation 4.9:** The FAA should utilize data on waivers and exemptions submitted for approval. The specific technologies identified for development in these waiver and exemption requests would provide the FAA with a wealth of information on what industry is working on. This data is currently considered, but not in a structured, intentional way. The FAA should develop a process to organize and analyze this data for subsequent use.

## 4.4 UAS and AAM Research Gaps and Duplication

The FAA can mitigate duplication within the programs themselves and has some mechanisms to identify duplication across the FAA, but it is unclear how formal and effective those processes are in identifying duplication across programs and across the FAA. The FAA also has taken steps to identify UAS research gaps and areas of interest, but the information on gaps is contained in different documents and does not completely align. There is no centralized and transparent effort to identify, address, and document UAS R&D gaps and duplication within the FAA.

### *Research Duplication*

AUS is responsible for coordinating the FAA's UAS activities. As an integration office, AUS is aware of the various UAS programs that are ongoing within the FAA and coordinates the programs to help ensure they are addressing relevant research needs. The FAA uses the NARP and the Annual Reviews to organize, coordinate, and review the agency's R&D portfolio. Until recently, AUS conducted the annual FAA UAS and AAM Integration Research Roundtable to prevent research duplication, identify research needs for the different FAA lines of business, and

[24] ASTM is a standards organization that develops and publishes voluntary consensus technical international standards for a wide range of materials, products, systems, and services, including for UAS.

validate research requests to ensure their relevancy.[25] Since November 2024, the roundtables are now hosted by the Aircraft Certification Service. These existing FAA mechanisms can be used to identify duplicative work; however, there is no guarantee that duplicative work does not exist because no mechanism is used to explicitly look for it.

**Internal Program Duplication**

Duplication is not likely to occur within individual FAA UAS partnership programs. In BEYOND and ASSURE, the lead or core partners meet throughout the year to present and discuss their ongoing work with other program participants. The lead or core participants are also required to develop annual reports and other deliverables for the FAA, in addition to frequently submitting data. The structure of each program ensures that participants have unique attributes (e.g., geography, drone use) that can produce diverse datasets to contribute to future FAA rules and regulations. While participants may appear to be doing similar work, there are unique conditions (e.g., location, weather, operations) that can further inform a research area and build the data pool to account for those conditions.

**Interprogram Duplication**

While there is no evidence of duplication, program participants reported a lack of awareness of the work being conducted by other FAA UAS research programs, which can lead to potential duplication of effort. The AUS monthly research roundtable, a forum for FAA program managers to discuss active research and activities, does not facilitate any communication between the different program participants themselves. Although ASSURE publicly shares their activities and reports, most research programs do not provide publicly available details on their active projects and, currently, there are no forums or opportunities within the FAA for program participants to meet, discuss, and coordinate across the programs. Typically, program participants are aware of each other's work through informal communications with participants in other programs. For example, a BEYOND partner might have a member of ASSURE within their partnership network, and that ASSURE member may also be a test site. The different program participants informally update each other on their ongoing work; however, the information sharing is only as good as a program participant's research network. There are only informal program-to-program interactions, and no official coordination by the FAA. This situation results in program participants being unaware of the activities of other programs, hindering their ability to coordinate effectively. Consequently, this may lead to research gaps and duplication of efforts.

**Federal Partnership Duplication**

Through coordinated efforts and established mechanisms, the FAA effectively minimizes duplication of UAS research with its federal partners. NASA and the FAA established research RTTs to move work from one agency to the other as the research turns to an operational focus. The RTTs enable the agencies to track their research and prevent duplication. The FAA also participates in the UAS Executive Committee and its two steering groups, which facilitate

[25] Federal Aviation Administration, *Report to Congress: Update of the FAA Comprehensive Plan and Unmanned Aircraft Systems (UAS) Program Alignment* (Federal Aviation Administration, February 3, 2022), 10–11, https://www.faa.gov/sites/faa.gov/files/2022-02/PL_115-254_Sec_342_UAS_Comprehensive_Plan_and_Program_Alignment.pdf.

coordination of UAS activities across federal departments and agencies; the steering groups are supported by agency research experts through the Science and Research Panel.[26] The FAA issues many COAs and waivers to other departments and agencies for UAS use; therefore, the FAA is generally aware of UAS research, testing, and operational use within the national airspace by other federal entities. Federal agencies also approach FAA program participants to advance their own research. Many ASSURE members noted they work with different government entities, like the Department of Homeland Security and DOD. By working with federal partners, the FAA can track some UAS research by other agencies.

## *Research Gaps*

The FAA lacks an updated research roadmap to detail and guide UAS research; thus, it has no method to systematically identify research gaps. The FAA and AUS have a variety of documents that outline a vision and goals for the safe integration of UAS into the NAS. The most recent official document outlining the FAA's UAS efforts is the third edition of the *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap,* published in 2020 as a follow on to the first edition published in 2013 and the second edition published in 2018.[27] The roadmap contains a long list of activities and accomplishments but does not provide clear direction or guidance regarding the FAA's UAS R&D plan. The Roadmap is also not periodically updated and does not contain the same level of detail nor the same content in each iteration. The FAA also has a UAS Implementation Plan that details how the FAA will execute the strategy laid out in the Roadmap, and a UAS Integration Research Plan that manages the FAA's UAS research activities.[28] Both documents are only available in their entirety internally to the FAA. Select portions of the UAS Integration Research Plan have been found in REDAC materials but they contain minimal detail and planning information.[29] The three documents provide some information on the FAA's approach but, overall, they are vague on the research scope, goals, and timeline. As noted by GAO in 2023, the various documents do not include elements that constitute

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[26] The congressionally established UAS Executive Committee is a focal point for federal departments and agencies to come together, coordinate, and guide UAS research and integration into the NAS. The Science and Research Panel "identifies and validates research gaps that impact UAS integration and coordinates and leads interagency resources and expertise to develop specific solutions and recommendations that address these gaps." Federal Aviation Administration, *Report to Congress: Update of the FAA Comprehensive Plan and Unmanned Aircraft Systems (UAS) Program Alignment*, 11.
[27] Federal Aviation Administration, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap,* 3rd ed. (Federal Aviation Administration, 2020), https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/2019_UAS_Civil_Integration_Roadmap_third_edition.pdf; Federal Aviation Administration, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap,* 1st ed. (Federal Aviation Administration, 2013), http://faa.gov/sites/faa.gov/files/uas/resources/policy_library/uas_roadmap_2013.pdf; and Federal Aviation Administration, *Integration of Civil Unmanned Aircraft Systems (UAS) in the National Airspace System (NAS) Roadmap,* 2nd ed. (Federal Aviation Administration, 2018), https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/Second_Edition_Integration_of_Civil_UAS_NAS_Roadmap_July%25202018.pdf.
[28] Federal Aviation Administration, *Report to Congress*, 11.
[29] Federal Aviation Administration, *FAA Unmanned Aircraft Systems (UAS) Integration Research Update* (Federal Aviation Administration, April 12, 2023), https://www.faa.gov/media/REDAC-04122023-FAA-UAS-Integration-Research-Update-to-REDAC-Full-Committee.

a comprehensive strategy, such as a mission statement, goals and objectives, and resources and investments, and only partly include other key elements.[30]

In addition to the Roadmap and plans, the FAA has produced diagrams outlining its approach to UAS and AAM.[31] None of the graphics illustrate how the FAA's current activities align with identified research topics, nor do they show how research and other activities will inform the FAA and advance rules and regulations to support UAS integration. The FAA also indicates its UAS research priorities through the UAS BAA, which identifies "Scope and Essential UAS Integration Interest Topics" (see section 3.2 for the list of topics). The same interest topics were a part of at least four of the five past UAS BAA calls (call 002 in 2020 to call 005 in 2023). The alignment of these different graphics and documents outlining research topics can be confusing to external stakeholders and partners because they are unclear and inconsistent in how the FAA plans to address these research areas and when. No documentation outlines how current FAA UAS programs align with the interest topics, but some can be assumed, such as BVLOS through the BEYOND program and UAS traffic management through the Dallas-Fort Worth Key Site and other UAS traffic management initiatives.

AUS conducts an annual intra-agency call to the lines of business to review, validate, and prioritize UAS research. As new and existing research requests are fielded, the FAA also evaluates them based on criticality. To determine the criticality, the lines of business executive leadership developed criteria, which include factors such as compliance with congressional mandates and impact on UAS and AAM integration and operations. The criteria can help the FAA connect ongoing and planned activities to FAA decision-making and apply the criteria to the UAS programs. By doing so, the FAA can ensure the programs are informing FAA decision-making, while also identifying research gaps, potential duplication, or centralized focus on a single criterion. The FAA does not publicize the criteria or how FAA partners' research informs the agency's decision-making. The lack of transparency in how UAS research supports and informs the agency's decision-making makes it difficult for partners and the public to understand what data and information the FAA needs.

With various documents and diagrams outlining UAS research and activities, it is not evident how they are used to inform current and future programs or how the areas and topics identified will translate to or guide UAS research efforts. Without a transparent and unified research roadmap, stakeholders are not aware of how they can best support the FAA as it works to safely integrate UAS into the NAS. There are many sectors that are interested in helping the FAA, but they do not know how, while others who work with the FAA do not clearly understand if and how their work

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[30] U.S. Government Accountability Office, *DRONES: FAA Should Improve Its Approach to Integrating Drones into the National Airspace System*, GAO-23-105189 (U.S. Government Accountability Office, January 2023), https://www.gao.gov/assets/gao-23-105189.pdf.

[31] In 2023, the FAA provided near-, mid-, and long-term outlooks on research to date and in the future. Federal Aviation Administration, *FAA Unmanned Aircraft Systems*, 2. The UAS Integration Office's 2020 presentation to REDAC on UAS integration research provides diagrams outlining the UAS integration strategy. It also outlines the FAA UAS integration research functional framework by showing an example of how UAS research activities inform operational capabilities (e.g., operations over people). Federal Aviation Administration, *Update on UAS Integration Research (Current & Planned)* (Federal Aviation Administration, February 25, 2020), https://www.faa.gov/sites/faa.gov/files/2022-06/508_REDAC_SAS_UAS_Research.pdf.

is used to inform the agency's UAS decision-making. As UAS and AAM continue to grow, it is unclear how the FAA plans to coordinate the research and operations, and the eventual integration of the emerging entrants into the NAS. The FAA established an AAM Integration Office in late 2024 with no communication on or plans as to how research coordination responsibilities will be divided between the UAS and AAM Integration Offices. There is no formal guiding documentation or process that identifies and prioritizes the FAA's UAS research gaps and needs.

**Finding 4.4:** There is no established formal process for continuous evaluation and identification of UAS partnership programs' research gaps and duplication.

**Recommendation 4.10:** The leaders of the UAS Integration Office, in coordination with the AAM Integration Office, should develop a UAS research roadmap that clearly identifies what research areas AUS, and the FAA overall, plan to focus on over the next three years to direct research and development and identify research gaps and duplication.

The roadmap should use the FAA's 2023 *Advanced Air Mobility (AAM) Implementation Plan* and the GAO's *FAA Should Improve Its Approach to Integrating Drones into the National Airspace System* to guide the development of the UAS roadmap. The AAM Implementation Plan concisely lays out definitions, areas of importance, specific rules that need to be developed and revised, and an integration schedule, while the GAO report identifies key elements of a comprehensive strategy.[32] Since UAS technology is at a more advanced stage than AAM, the UAS roadmap should contain a deeper level of detail than the AAM Implementation Plan.

## 4.5 Research Partnership Funding Challenges

The fast pace of innovation and historic proliferation of new types of aircraft within the categories of UAS and AAM complicate efforts to ensure research and regulation occur in a timely manner. The FAA's budget structure and plans for R&D, like the NARP, commit to many multiyear projects, but do not set aside dedicated resources for addressing emerging and short-term opportunities. This makes it difficult to incorporate emerging opportunities midyear and even between successive budget cycles.

### *BEYOND Program*

BEYOND participants have collaborated with the FAA by sharing data while pursuing their own activities and research on UAS. However, they have limited resources to focus directly on the FAA's research priorities. For this reason, the unfunded status of BEYOND hinders the FAA's efforts to broaden participation of local governments and their safety operations, in particular, such as police and fire departments. Phase 2 of BEYOND will involve more focused priorities and objectives, like infrastructure, scalability, safety, and automation, which would benefit from greater state, local, and tribal government participation; such participation could be facilitated by baseline funding from the FAA.

[32] Federal Aviation Administration, *Advanced Air Mobility (AAM) Implementation Plan: Near-term (Innovate28) Focus with an Eye on the Future of AAM*, Ver. 1.0 (Federal Aviation Administration, July 2023), https://www.faa.gov/sites/faa.gov/files/AAM-I28-Implementation-Plan.pdf.

### *UAS Test Sites*

As chapter 3 explains, the UAS Test Sites rely on soft money generated through customer user fees. These revenues help pay for facility maintenance and staff retention. Each of the test sites are unique, semiautonomous, and compete with one another for sources of operations and maintenance funding. This limits their ability to achieve their full potential to contribute to FAA objectives, especially when they need to secure and integrate multiple sources of funding to do so.

**Finding 4.5:** The FAA UAS budget resources do not provide sufficient flexibility to address short-term high priority requirements. Thus, the FAA is often unable to address the consistent advancements in UAS technology.

**Recommendation 4.11:** The FAA (AUS and Financial Services Office) should assess the need for an agile funding type that enables it to respond to current technological advancements, rather than committing funds to projects that may take three years to finish and be technologically outdated when complete.

One type of flexibility that could help the R&D function address such opportunities, if sufficient funding is appropriated, is a no-year duration of appropriation. That is, funding that the FAA is authorized to expend during current and future fiscal years, with any remaining amounts carried from one fiscal year to the next.[33]

**Finding 4.6:** BEYOND's lack of funding hinders the program's ability to include public institutions and industry members struggling to remain financially viable in addressing UAS R&D requirements.

**Recommendation 4.12:** The FAA should request from Congress appropriate baseline funding for the BEYOND program to support the cost of ensuring participation of public entities and their consortia.

**Finding 4.7:** The capacity of UAS Test Sites is limited by their lack of dedicated funding and reliance on inconsistent soft money revenue to operate.

**Recommendation 4.13:** The FAA should request appropriations for baseline funding to support the UAS Test Sites.

Dedicated funding would help the test sites lower costs for customers and retain their expertise amidst fluctuations in soft money funding.

## 4.6 Comparison to Peer Organizations

This section compares the FAA's approach to research partnerships to practices other organizations with a research focus or component use to engage with research performers. The analysis below does not support any clear recommendations for practices the FAA should adopt.

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[33] Drew C. Aherne, *Appropriations Duration of Availability: One-Year, Multi-Year, and No-Year Funds,* CRS Report No. R48087 (Congressional Research Service, June 7, 2024), https://www.congress.gov/crs_external_products/R/PDF/R48087/R48087.2.pdf.

Thus, the following discussion is intended to provide background the FAA could refer to should it choose to explore alternative methods of engagement in the future.[34]

The FAA's partnership structures are unique. Other agencies reviewed for this report have research partnerships and other engagements, while the FAA uses partnership programs. To illustrate, the FAA operates ASSURE over a ten-year time horizon, has cooperative agreements with each university partner, and provides matching grants to relevant partners for individual projects. The other federal research agencies reviewed for this report typically use cooperative agreements, grants, CRADAs, and other vehicles to collaborate with partners in a more piecemeal way.

Where ASSURE has a lead university responsible for coordination between the partner universities, other agencies partner with fewer universities, individuals, and other research groups per funding opportunity. Oftentimes, domestic agencies perform R&D and technology transfer through some combination of intramural and extramural efforts. Most agencies examined utilize a mix of funding models (e.g., fund matching, in-kind services) to get the best results out of their portfolios.

Comparable agencies' engagements with the research community do not closely resemble the FAA's robust programmatic umbrella supporting standing partnerships and COEs.[35] However, some support similar functions through research consortia. For example, the National Institutes of Health's National Cancer Institute supports the work of research consortia by making expertise and information, such as shared data repositories, available to the research community.[36] There is no funding model for research consortia as they are created independently of the National Institutes of Health and National Cancer Institute funding mechanisms.[37] However, this does not preclude consortia participants from working together to apply for specific National Institutes of Health grants or projects. Another example is DOE's Advanced Materials and Manufacturing Technologies Office, which provides funding to R&D consortia to advance US manufacturing competitiveness and promote sustainable national manufacturing through public-private partnerships. As of 2021, the six manufacturing institutes had 449 members from private firms,

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34 Peer organizations include the FAA's ASCENT research partnership, DOE Office of Technology Transitions, National Marine Fisheries Service, Agricultural Research Service, Environmental Protection Agency, as well as international aviation authorities. Previous Academy work and publicly available documents also inform this section.

35 Government research COEs examined as part of this and past Academy reports are typically intramural or intergovernmental. Other similar constructs include FFRDCs, like most of DOE's National Laboratories.

36 "Research Resources for Cancer Epidemiology and Genomics," National Cancer Institute Division of Cancer Control & Population Sciences, accessed March 27, 2025, https://epi.grants.cancer.gov/research-resources/; the Epidemiology and Genomics Research Program defines a consortium as a group of scientists from multiple institutions who have agreed to participate in cooperative research efforts, such as sharing information from multiple studies to facilitate combined analysis. "Consortia to Advance Collaboration in Epidemiologic and Cancer Research," National Cancer Institute Division of Cancer Control & Population Sciences, last modified August 30, 2024, https://epi.grants.cancer.gov/Consortia/#list.

37 National Cancer Institute Division of Cancer Control & Population Sciences, "Consortia to Advance Collaboration in Epidemiologic and Cancer Research"; National Cancer Institute, *Congressional Justification FY 2024* (National Institutes of Health, n.d.), https://www.cancer.gov/about-nci/budget/congressional-justification/fy2024-nci-congressional-justification.pdf.

academia, all levels of government, and nonprofit organizations. DOE made an initial five-year commitment of $420 million, matched by $498 million in nonfederal commitments. The Advanced Materials and Manufacturing Technologies Office provides funding for research at the institutes through cooperative agreements and maintains strong program management for the operation.[38]

The benchmark organizations take instructive approaches to organizing and planning their portfolios. These approaches encompass processes for collecting partner feedback on research priorities, including gaps and duplication. For example, the ASCENT Center of Excellence has an interagency working group to identify and address gaps and duplication, in addition collecting information from discussions among university partners. The FAA Reauthorization Act of 2024 calls for the National Science and Technology Council to establish an interagency working group that encompasses the equivalent scope for UAS and AAM.[39]

The Agriculture Research Service collects stakeholder input related to its intramural research agendas for its four national program areas and fifteen attendant national programs as part of its annual national program cycle. This structure and process facilitates the coalescence of external communities of practice around particular topics. The national program cycle itself is a robust model for integrating strategic planning for research with planning as part of the federal budget cycle.[40]

This assessment did not identify many notable practices for ensuring the work of research partners informs regulatory activities among the agencies sampled. Other regulatory agencies with a research component engage in scenario planning to better anticipate needs for future rulemaking and the research required to support it. The FAA has a similar function: its lines of business request and sponsor research through AUS. Another observed practice is establishing formal agreements between research and regulatory agencies within the same department. This practice would be unlikely to add much value if adopted by the FAA because of its unique focus on aviation, and because it has its own research portfolio within the agency.

**Finding 4.8:** The FAA's UAS and AAM research partners and partnership programs utilize multiple approaches that vary by participation and funding and are not easily compared to other federal agencies with regulatory and research functions.

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[38] Peter Winokur, et al., *An Innovation Foundation for DOE: Roles and Opportunities* (National Academy of Public Administration, January 2021), 57, https://s3.us-west-2.amazonaws.com/napa-2021/NAPA__DOE-Report-__-FINAL.pdf.
[39] FAA Reauthorization Act of 2024, Pub. L. No. 118-63, § 1042, 138 Stat. 1407.
[40] Sandra Archibald, et al., *Agricultural Research Service: Office of National Programs Revitalization* (National Academy of Public Administration, June 2020), 54, https://s3.us-west-2.amazonaws.com/napa-2021/studies/agricultural-research-service-office-of-national-programs-revitalization/NAPA_Final_Report_for_ARS_ONP.pdf.

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# Chapter 5: Effective Strategies for the FAA's Dissemination of Partnership Research Outcomes

As discussed in chapter 4, information sharing and data dissemination are essential components of the FAA's R&D process and, therefore, a priority for the FAA. Every day, the FAA utilizes substantial volumes of data and information to fulfill its mission. Data and information are enterprise assets that the agency relies upon. These data are also critically important to the FAA's informal network of partners, industry stakeholders, global stakeholders, and the public, including both commercial and research communities. This chapter describes information and data dissemination, describes the FAA's dissemination methods, and the strategies for doing so across a network of informal partners.

## 5.1 The FAA's Outcomes and Data Dissemination Strategy

Recipients of the FAA's research outcomes and data include FAA components, the public, industry, and research organizations. The FAA disseminates data and outcomes to these communities through a variety of mechanisms, some of which are statutorily required.

### *Recipients of Research Outcomes and Data Dissemination*

#### FAA Components

Within the FAA, information should be disseminated to the relevant entities that can utilize it. This task, while seemingly intuitive, necessitates a comprehensive understanding of each entity's specific data and information requirements. For instance, rulemaking, standards, and certification offices and committees benefit greatly from timely, accurate information to better assess their projects and initiatives. Ensuring a steady flow of communication and feedback among FAA offices is critical for keeping data and information needs current and relevant for those distributing the information.

Furthermore, a structured approach to dissemination is essential for maximizing the impact and utility of the shared data. By fostering continuous dialogue and collaboration, the FAA can ensure that all relevant offices are well equipped with the information they need to make informed decisions. This strategic dissemination not only enhances internal operations but also supports the FAA's overarching mission of maintaining safety and efficiency in aviation. Such an approach underscores the importance of aligning data dissemination practices with organizational goals and the dynamic needs of various FAA branches.

#### Public Access to FAA Data and Information

The FAA encourages its informal network of partners—such as those who are less directly involved in FAA program activities—to utilize or build upon the administration's research. Thus, the FAA recognizes the need for publicly available, discoverable, and usable data. Public access to FAA research outcomes, data, and information fosters awareness of research gaps, advancements, and mission-critical areas of research that require attention.[41]

## *Current Data Dissemination Requirements and Pathways*

Information sharing and data dissemination have many interpretations, as evidenced by the qualitative feedback from FAA stakeholders. The FAA's annual NARP review refers to information and data as a range of items to include formal reports, standards, software, technology transfer, patents, technical knowledge, innovative ideas, new processes and practices, and evidence from descriptive research studies.[42] Table 2 provides the FAA's definitions of key terms to ensure a uniform understanding of their use within a research framework.

*Table 2. Key FAA Terms Defined*

| Term | Definition |
|---|---|
| **Data** | Data is a representation of a fact, concept, or instruction in a form suitable for communication, interpretation, or processing by humans or automated systems. |
| **Information** | Information is data in context, or the meaning given to data or the interpretation of data based on its context. The finished product is a result of interpreting the data. |
| **Dissemination** | Dissemination is agency-initiated or sponsored distribution of data and information. |
| **Sharing** | Sharing is disseminating data and information to an individual/organization other than the steward |

Source: Data and Information Management Policy 1375.1F (Federal Aviation Administration)[43]

**Statutory Requirements to Share Information**

The FAA is statutorily required to share data and information, including research outcomes, with its partners and stakeholders. Statutory provisions include the following:

1. **49 U.S.C. § 40119 – Data and Research Dissemination**

   Authorizes the FAA to conduct and share research related to aviation safety, air traffic management, and environmental impacts, except where national security or proprietary concerns apply

2. **49 U.S.C. § 44505 – Research Advisory Committee & Data Sharing**

   Requires the FAA to consult with industry and academic experts on research programs and share findings that enhance aviation safety and efficiency

[41] Federal Aviation Administration, *Data and Information Management Policy*, Order 1375.1F (Federal Aviation Administration, November 4, 2021), https://www.faa.gov/documentLibrary/media/Order/FAA_1375.1F_(ADMIN_Update).pdf.
[42]Federal Aviation Administration, *2023 Research and Development Annual Review* (Federal Aviation Administration, June 2024), 59, https://www.faa.gov/sites/faa.gov/files/FY-2023-RD-Annual-Review.pdf.
[43] Federal Aviation Administration, *Data and Information Management Policy,* 19–23.

3. **49 U.S.C. § 44509 – Research and Development Grants and Agreements**

   Allows the FAA to enter into cooperative agreements and contracts with institutions for research and mandates the dissemination of research results

4. **FAA Reauthorization Acts (Various Years, e.g., 2018, 2023)**

   Includes provisions directing the FAA to publicly share research findings, particularly in areas like UAS, noise pollution, and aviation cybersecurity

**Data Governance Policy**

In addition to statutory requirements, the FAA has established standard policy requirements regarding the internal and external dissemination of data and the sharing of research outcomes that align with agency, departmental, and federal data and information management strategies and regulatory requirements. This policy applies to all FAA data and information, including those that are managed, generated, collected, or acquired by the FAA or by other parties under contract on behalf of the FAA.

Data and information created, collected, or acquired to support a program, service, application, product, capability, or to fulfill the business and mission of the FAA are considered enterprise assets. These assets have shared value across the agency and must be managed and governed strategically. While data and information may originate within or be maintained by a specific FAA organization, they may also provide value and utility to other FAA organizations in support of mission objectives. As part of its data governance structure, the FAA maintains an enterprise data and information strategy to enable data-driven decision-making, interoperability, innovation, and appropriate use of the FAA's data and information. In its effort to share data with the public and other network partners, the FAA must publish data and information that has been cleared for public release while protecting security, privacy, and confidentiality.

**External Sharing of Data with Partners**

The FAA is required to share data and establish information-sharing agreements with trusted partners that are compliant with the standards outlined in publications such as NIST Special Publication (SP) 800-47, to continuously improve, innovate, and promote safe and efficient air traffic operations or mission requirements. Trusted partners include both public and private, national and international organizations, such as the Air Navigation Service Providers (ANSP) and FFRDCs, with which the FAA benefits from sharing resources, technological advances, and expertise.

The implementation of external data and information-sharing agreements as part of trusted partnerships must fully comply with a range of policies, regulations, and processes and must consider the following:

1. Federal, departmental, and agency policies and regulations regarding the protection of sensitive, classified, private, and otherwise restricted data and information
2. Formal processes for external data release before sharing NAS data or information with a trusted partner

3. International data-sharing processes prior to establishing external data and information-sharing agreements or sharing NAS data and information with international entities through trusted partnerships

**Dissemination Pathways for Research Outcomes and Information**

The FAA has multiple distribution systems and pathways in place to share and disseminate research outcomes, data, and information to its informal partners. These products are packaged in many ways. In FY 2024, the FAA distributed over 550 technical products to the research community and its partnerships as part of its externally facing Technology Transfer (T2) Program. Figure 2 below provides the breakout for 2023.[44] These products include conference presentations, conference papers, published reports, and published journal articles.

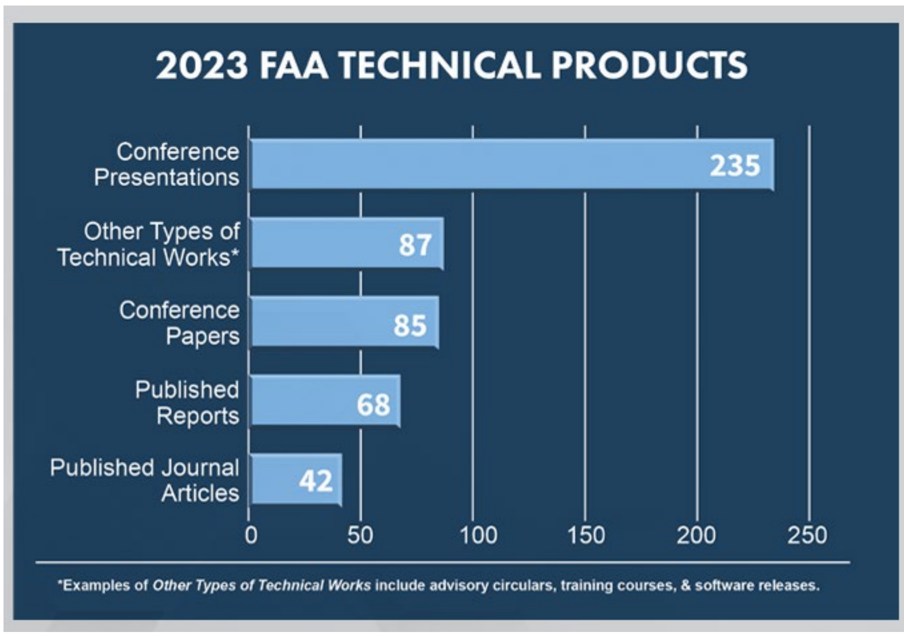


*Figure 2. 2023 FAA Technical Products (FAA 2023 Research and Development Annual Review)*

The FAA recognizes the need for publicly available, discoverable, and usable data. Public access to FAA research outcomes, data, and information fosters awareness of research gaps and advancements. For authorized public access to cleared data and information for release, the FAA uses several distribution systems, including the FAA Data Portal and the USDOT Research Hub.

The FAA Data Portal (data.faa.gov) serves as the FAA's clearinghouse for publicly available FAA data. The portal includes a data catalog of publicly available aviation data, metadata, and common terminology; a developer's portal for easy integration of data into software applications; the System Wide Information Management program, which facilitates access to aviation information; and aeronautical data produced by the FAA's Aeronautical Information Services.

The USDOT Research Hub is a web-based, searchable database of DOT-sponsored research, development, and technology project records. The database acts as a central repository for

[44] Federal Aviation Administration, *2023 Research and Development Annual Review*.

information on active and recently completed projects from DOT's operating administrations, providing a comprehensive account of the department's research portfolio at the project level.

**Effectiveness of Distribution Systems**

Evaluating the effectiveness of distribution systems involves gathering anecdotal feedback from the recipients of the information. It also includes monitoring the quantity of people viewing reports and results. Analyzing metrics such as user engagement and accessibility can provide insights into how well the information is being disseminated. By leveraging this data, improvements can be made to enhance the reach and usability of distribution systems.

## *Improvements to Information and Data Dissemination*

Improving coordination between the FAA and UAS partners can be achieved by more effectively leveraging existing distribution systems and pathways. Utilizing platforms like the FAA Data Portal and the USDOT Research Hub can enhance information accessibility and discoverability. These systems serve as central repositories for publicly available data and research outcomes, ensuring that all stakeholders can easily obtain the necessary information.

Additionally, the FAA can enhance the usability of these systems by regularly assessing their effectiveness. This includes gathering feedback from information recipients and analyzing metrics such as user engagement and accessibility. By understanding how well the information is being shared, the FAA can implement targeted improvements to ensure these distribution systems meet the needs of the research community and other stakeholders.

Cross modal collaboration between DOT agencies and external organizations offers another opportunity to improve coordination. By capitalizing on collaborative opportunities, the FAA can ensure that information sharing is more comprehensive and that research efforts are better aligned across different entities.

Ultimately, the FAA's commitment to making data publicly available and easily accessible is crucial for enhancing coordination with UAS partners. By continually refining its distribution systems and seeking collaborative opportunities, the FAA can improve the effectiveness and accessibility of information sharing, thereby fostering a more informed and connected research community.

**Finding 5.1:** Information dissemination to public, commercial, and research communities via technical products is an important component of the FAA's T2 Program. The FAA disseminates a broad range of products including published papers, technical reports, and conference presentations. Still, the agency lacks a formal written strategy for dissemination and information sharing, sharing of data, and research outcomes with its informal network partners.

**Recommendation 5.1:** The FAA should document the existing ends, ways, and means of information- and data-sharing methods from the FAA to its formal partnerships, informal network, and the broader public.

**Finding 5.2:** International partners, including foreign CAAs, share data with the FAA mainly through bilateral agreements and task groups of international institutions, such as the Joint Authorities for Rulemaking on Unmanned Systems and International Civil Aviation Organization.

Several foreign CAAs expressed an interest in deepening the cooperation with the FAA to include conducting joint research in areas of mutual interest to spread the cost of research and development.

**Recommendation 5.2:** The FAA should explore opportunities to deepen the level of cooperation with select foreign civil aviation authorities that share similar R&D priorities.

## 5.2 FAA Technology Transfer

As a federal regulatory agency, the FAA's top priority and statutory responsibility are to ensure the safety of the NAS. Consistent with the FAA's safety-centric mission, its research is primarily applied R&D designed to assist the agency's formulation of policies, regulations, certifications, guidance, and standards that increase safety and modernize the NAS. Similarly, the agency's focus on UAS and AAM R&D and technology transfer is principally on applied research to inform its regulatory activities and the safe integration of new entrants into the NAS.

The FAA considers technology transfer primarily as a knowledge transfer mechanism to support the NAS and its overarching safety mission. The agency's T2 Program defines technology transfer as "the process by which existing knowledge or innovations, developed at the FAA's federal laboratories with federal funding are transferred and utilized to fulfill other public and private economic needs."[45] Accordingly, most of the FAA's technology transfer activities are internally focused, supporting internal functions to support rulemaking (via UAS rulemaking committees), standards development, safety analysis, air traffic management, and the evaluation of concepts with UAS and AAM types of activities ( e.g. modelling and simulation).

The FAA maintains an active UAS and AAM T2 Program, primarily through its federal laboratory, the WJHTC. The core focus of the program is to advance the NAS and sustain its continued safe and efficient operation. Additionally, the FAA's CAMI engages in T2 activities and serves as the medical certification and research arm of the FAA's Office of Aerospace Medicine. CAMI's core focus is the human element in flight, specifically the factors that influence human performance in the aerospace environment.

### *Federal Context*

Since 1980, Congress has enacted several statutes that seek to maximize the benefits of national investment in R&D to the public, and the private sector.[46] Through the technology transfer process, federal laboratories share the benefits of this national investment with all segments of society. The summaries below provide information on three statutes that serve as the basis for the federal legislative framework for technology transfer.

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[45] "Technology Transfer (T2) Program," Federal Aviation Administration, last modified February 6, 2025, https://www.faa.gov/about/office_org/headquarters_offices/ang/offices/tc/activities/ttp.

[46] Federal Laboratory Consortium for Technology Transfer, *Technology Transfer Desk Reference: A Comprehensive Guide to Technology Transfer*, 7th ed. (Federal Laboratory Consortium for Technology Transfer, February 2023), https://federallabs.org/getmedia/375e2692-c0ea-4f1f-8ceb-9ca68824d5f9/FLC-Handbook-23_DIGITAL.pdf.

*The Stevenson-Wydler Tech Innovation Act of 1980*[47] is the first of a continuing series of laws to define and promote technology transfer. It made it easier for federal laboratories to transfer technology to nonfederal parties and provided outside organizations with a means to access federal laboratory developments. The primary foci of the Stevenson-Wydler Act were on disseminating information from the federal government and getting federal laboratories more involved in the technology transfer process. Finally, the law establishes an Office of Research and Technology Applications in each laboratory to coordinate and promote technology transfer.

*The Bayh-Dole Act & Trademark Clarification Act of 1984*[48] established more boundaries regarding patents and licenses for federally funded R&D and enabled small businesses, universities, and not-for-profit organizations to elect to retain titles to inventions developed with federal funds. The law also permitted government-owned and operated laboratories to grant exclusive patent licenses to commercial organizations.

*The Federal Technology Transfer Act of 1986* established that all federal laboratory scientists and engineers are required to consider technology transfer to be an individual responsibility, and technology transfer activities are to be considered in employee performance evaluations. In addition, the law enabled government-owned and -operated laboratories to enter into CRADAs and to negotiate licensing arrangements for patented inventions made at the laboratories. Further, the law provided for the exchange of personnel, services, and equipment among the laboratories and nonfederal partners.[49] Other specific requirements, incentives, and authorities were added, including permission for current and former federal employees to participate in commercial development, to the extent that there is no conflict of interest.[50]

Overall, the legislative framework centers activities that promote innovation and economic growth through knowledge sharing and technology commercialization and provides the means by which the nation would gain the full benefit of federal R&D expenditure. Technology transfer is also used to inform agencies as they undertake activities in the public's interest unrelated to technology commercialization, such as developing health and safety standards.

### Technology Transfer and Agency Mission

While the legislative framework, policies, and overall goals of technology transfer are consistent across the federal government, individual agencies define technology transfer based on their mission focus. (Subsection 5.2.5, below, explores other agencies' conception of technology transfer and how it shapes their practices.) The FAA focuses on a subset of internal technology transfer processes that enable it to advance its safety-focused regulatory mission while engaging in some external technology transfer activities, like technology commercialization and adoption, and STEM outreach and education. Agencies with regulatory missions, like the FAA, are more

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[47]Federal Laboratory Consortium for Technology Transfer, *Federal Technology Transfer Legislation and Policy: The Green Book* (Federal Laboratory Consortium for Technology Transfer, April 2024), 13, https://federallabs.org/getmedia/ae945151-ee25-4c1d-9eed-346d59dfbf5d/2024FLC-GreenBook.pdf.
[48]Federal Laboratory Consortium for Technology Transfer, *Federal Technology Transfer Legislation and Policy*, x.
[49] Federal Laboratory Consortium for Technology Transfer, *Federal Technology Transfer Legislation and Policy*, xi.
[50]Federal Laboratory Consortium for Technology Transfer, *Federal Technology Transfer Legislation and Policy*,14; 15 U.S.C. § 3710 (2018).

likely to focus on applied research that produces informational outputs, like reports. This focus is driven by their need to inform themselves about the future of their operating environment, as well as build their knowledge and evidence base for rules and standards that address changes resulting from the evolution of their operating environment.

The widely accepted concept of technology transfer has evolved over the past four decades and reflects a broad and inclusive understanding of the ways knowledge, facilities, and technologies are diffused, disseminated, and deployed for public benefit.[51] Consistent with the FAA's mission and role as a regulatory agency, this report uses a narrower conception of technology transfer to assess the FAA's activities in the context of advancing that mission.

## *FAA Technology Transfer Policies*

The FAA's T2 Program priorities, policies, and procedures build on the legislative framework discussed above.[52] They are outlined in several key documents, including the FAA National Policy on the Technology Transfer Program; the NARP; and provisions of the FAA Reauthorization Act of 2024.

*FAA National Policy on the Technology Transfer Program*

The policy establishes WJHTC's Office of Research and Technology Applications and assigns it the responsibility to manage the T2 Program, and tasks the T2 program manager with administering the program as defined. The policy provides the following additional guidance:[53]

- Defines the benefits to the FAA's federal labs as provided by federal legislation
- Articulates priorities, which include maximizing the national benefit from FAA scientific and technical efforts
- Facilitates the dissemination of scientific and technical information, data, and expertise developed by or for the FAA to state and local governments, academia, and the private sector, consistent with US national policy
- Promotes sharing of technology to advance science or that has commercial potential that would benefit the security and socioeconomic well-being of the United States
- Supports collaborative research with industry, academia, and other government entities
- Supports the establishment of Cooperative Research Centers
- Establishes a Technology Transfer Awards Program

*National Aviation Research Plan*

As discussed in chapter 3, the NARP creates a cohesive strategy for the FAA's R&D goals, identifies current and future research in support of each goal, and outlines how the FAA works with external partners to leverage R&D funding, including technology transfer. It serves as the link between the

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[51] Principal components of the broad concept of technology transfer include, but are not limited to, the existing knowledge, facilities, capabilities, scientific discoveries, and knowledge developed under federal research and development, which are utilized to fulfill public and private sector need.
[52] Examples of the legislative framework include the establishment of Office of Research and Technology Applications, and authority to enter into CRADAs, and share personnel, facilities, and other resources.
[53] Federal Aviation Administration, *Technology Transfer Program*, Order 9550.6B (Federal Aviation Administration, May 30, 2014), 1–2, https://www.faa.gov/documentLibrary/media/Order/9550.6B.pdf.

FAA's R&D activities and the national goals and research priorities as articulated by the Executive Office of the President and DOT.

*The FAA Reauthorization Act of 2024*

The FAA Reauthorization Act of 2024 enumerates seven key areas of research and technology transfer to facilitate the safe integration of AAM and UAS into the NAS: (1) BVLOS operations, (2) command and control link technologies, (3) development and integration of unmanned aircraft system traffic management into the national airspace system, (4) noise and other societal and environmental impacts, (5) the development of an industry consensus vehicle-to-vehicle standard, (6) safety, and (7) detect-and-avoid capabilities.[54]

## Program Description

The FAA conducts "internal" and "external" technology transfer activities to address the seven key areas of UAS and AAM research and technology transfer provided by the FAA Reauthorization Act of 2024 and abbreviated above. These categories are not mutually exclusive and simply identify differences in the primary purpose for, and intended use of, technology transfer.

Internal technology transfer activities refer to those activities that support the safety and integration of the NAS through the FAA informing itself. The FAA's line of business offices sponsor and coordinate requests for research in this category, which are allocated by NextGen to various performers, including WJHTC and ASSURE. Safety, a key research area identified in the FAA Reauthorization Act of 2024, is an example of a topic that is primarily supported by internal T2 Program activities. Internal technology transfer activities also respond to most congressional directions and line items because such priorities are mostly focused on safety and integration. Other examples of outputs that advance these priorities include knowledge and tools that enable the FAA to evaluate concepts related to UAS and AAM, such as modelling and simulation software.

External technology transfer activities focus on innovation in industry, as well as information dissemination to public, commercial, and research communities through a broad range of technical products. As defined by the FAA, its T2 Program performs three primary roles: (1) promoting and enabling government-industry collaboration, (2) sharing technical advances resulting from FAA research and development efforts, and (3) managing patent licenses and royalties.[55] External T2 Program activities include a small number of patents and licensing opportunities that provide benefits to industry, the public, and the FAA. The FAA currently lists four licensing opportunities on its website, with two that are specifically related to UAS and AAM or have relevant potential applications.[56] Participants in these collaborative partnerships with the FAA include private businesses, state and local governments, nonprofit entities, and academic institutions. Research partnerships like ASCENT, ASSURE, and BEYOND are examples of participants that contribute to both internal and external technology transfer activities.

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[54] FAA Reauthorization Act of 2024, Pub. L. No. 118-63, § 1044, 138 Stat. 1410.
[55] Federal Aviation Administration, *Annual Modal Research Plans*, 6.
[56] Federal Aviation Administration, "Technology Transfer (T2) Program.".

## Technology Transfer Performance Monitoring and Management

Performance-based management is a useful framework for assessing how effectively R&D and T2 Program activities are advancing the FAA's mission objectives, as well as identifying gaps, opportunities, and needs. Effective organizations use measures and metrics to monitor their outputs and outcomes. They use those data to adjust their strategic direction, develop tactics to enhance operations, and improve measures of performance in a cycle of continuous improvement. The following text explains how the FAA monitors the performance of its technology transfer efforts and how it uses that information to improve their performance.

### *Performance measures and metrics*

Below is a list of technology transfer measures and metrics from the FAA's research and development annual reviews.[57] Note that only one set of metrics is specific to R&D for UAS: the "number of active grants and fiscal year awards, and fiscal year award dollars by COE." Research for this report reveals that only one UAS CRADA and three AAM CRADAs were active during FY 2024. Such measures quantify important program outputs and demonstrate that the FAA monitors them on an ongoing basis. Output measures alone, or without a target value, are not sufficient to assess performance. For example, comparing the number of active CRADAs the FAA and other agencies have provides little to no indication as to whether the FAA's R&D and technology transfer activities are effective to advance its mission. Organizations must be able to match outputs with outcomes to assess performance.

*Number of Research Agreements*[58]

1. Center of excellence grants
2. Aviation research grants
3. Center of excellence grants
4. CRADAs
5. Interagency agreements
6. International agreements
7. Other

*Number of Active Grants and Fiscal Year Awards, and Fiscal Year Award Dollars by COE*

1. UAS
2. Alternative jet fuels & environment
3. Advanced materials
4. Technical training & human performance
5. General aviation

### *Outcomes*

Performance-based management necessitates matching measures of output with attendant outcomes to assess whether current activities are addressing organizational goals and objectives effectively. To illustrate by way of an example in the FAA context, the resultant outcomes of UAS and AAM-related CRADAs need to be understood to answer the principal question of whether the quantity of outputs (CRADAs) are sufficient to advance the FAA's goals and objectives.

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[57] Federal Aviation Administration, *2023 Research and Development Annual Review*, 39.
[58] Federal Aviation Administration, *2023 Research and Development Annual Review*, 41.

Outcome-based measures of performance assess, to a greater or lesser degree, the direct impact of activities.[59] The output-based measures discussed above, like number of CRADAs, might have outcome-based pairs. For example, both DOE and the FAA measure the number of patents and licenses that result from their research agreements and other partnership vehicles. However, such outcome-based metrics might be less useful in the FAA's mission context because the FAA requires greater focus on internal technology transfer activities rather than external technology transfer focused on commercialization. The following measures related to technical products from the FAA's research and development annual reviews are examples of outcome-based measures.

*Number of Technical Products*[60]

1. Conference presentations
2. Other types of technical works
3. Conference papers
4. Published reports
5. Published journal articles

In addition to publishing numbers on different types of technical products, the annual reviews provide select success stories and accomplishments with regard to the FAA's R&D and technology transfer efforts that demonstrate how those efforts have tangible impact.[61] While not empirical quantities, qualitative data on outcomes, like case studies, success stories, and lists of accomplishments, are important for interpreting quantitative measures, determining how much activity is needed, and setting a target.

*Technology Transfer Reporting Requirements*

The FAA is required to report its T2 Program activities for the prior fiscal year to the DOT Office of the Assistant Secretary for Research and Technology for inclusion in DOT's report to Congress. Activities the FAA is required to report include the following:[62]

- Patent applications filed
- Patents received
- Fully executed licenses receiving royalty income[63]
- Licenses terminated for cause
- Total earned royalty income
- Earned royalty income disposition
- Licenses terminated for cause

The FAA is also required to report any other parameters or discussion that the agency deems relevant or unique to its practice of technology transfer.

[59] Accomplishments reports, success stories, etc. are outcomes, but not measures. They can be indicators of direct and indirect impacts.
[60] Federal Aviation Administration, *2023 Research and Development Annual Review*, 59.
[61] For examples, see the Federal Aviation Administration, *2023 Research and Development Annual Review*, 15, 17, 22, 64–65, and 67.
[62] For more information, see 15 U.S.C. § 3710 (2018).
[63] They are categorized as exclusive, partially exclusive, and nonexclusive.

### *Continuous Improvement*

The FAA faces a difficult challenge inherent to aviation regulation, especially in the cases of UAS and AAM. That is, the need to adapt to rapidly emerging and evolving technologies while anticipating future developments and planning for research needs in the long-term. The range of future possibilities makes it difficult to evaluate whether the current types and amount of FAA research and technology transfer will meet future needs. Executing the feedback loop of lessons learned and opportunities identified is a crucial component of continuous improvement processes. However, attempts to engage in such a process could be challenging without at least some level of clarity on likely future developments in the operating environment.

The NARP addresses such challenges in the planning phase by considering a fifteen-year outlook that ties different timescales together with goals, and determines priorities and activities based on each research goal. The R&D annual review serves as one part of the feedback loop and integration portion of the continuous improvement process. While the FAA has made strides in improving coordination across the agency on developing strategies for research, its process for sharing outcomes internally to adjust priorities, activities, and performance measurement is an area in need of improvement, as discussed in chapter 4.

Finding 4.1 states that the FAA's technology transfer activities address R&D sponsor requirements adequately and on time through its partnerships and other work performers. Thus, the technology transfer activities are sufficient to provide data, information, and tools to inform the FAA's regulatory activities. Much of this success is attributable to the FAA's efforts to better integrate the R&D strategies of individual lines of business. However, as identified in chapter 4, there are opportunities for the FAA to improve sharing of research outputs, like data and results, with partners and between FAA internal components themselves. More collaboration on data sharing would also provide additional opportunities to enhance the FAA's approach to aspects of performance monitoring and measurement, such as the output and outcome measures in use.

## *Comparison with other Technology Transfer Programs*

Some of the technology transfer practices observed at other federal agencies are more applicable to the FAA than others, owing to differences in mission focus. One potential area of opportunity is programs and activities focused on promoting partnerships for innovation with small businesses. Many federal agencies, like the DOE and US Air Force, use the SBIR and STTR programs as vehicles for such activity. For example, the DOE used a pilot program for small business vouchers to help small businesses overcome challenges with prototyping, materials characterization, high-performance computations, and more by providing access to the expertise and capabilities of its National Laboratories.[64] The pilot succeeded and the voucher program was permanently authorized in 2020.[65] AFWERX, an innovation arm of the US Air Force, leverages SBIR and STTR funding to inform and equip itself to address its challenges, as well as promote industry innovation more broadly. One model it uses is the Open Topic, whereby commercial

[64] "Small Business Voucher Pilot Program," US Department of Energy, accessed March 26, 2025, https://www.energy.gov/eere/solar/small-business-voucher-pilot-program.
[65] "Voucher Program," US Department of Energy, accessed March 26, 2025, https://www.energy.gov/technologytransitions/voucher-program.

industry submits proposed solutions for AFWERX to consider for two-phase projects conducted by small businesses. Phase I is for feasibility studies, and Phase II is for prototyping.

Such activities within the SBIR/STTR umbrella resemble the FAA's efforts with opportunities like the UAS BAA that bring together test sites, ASSURE and BEYOND, and small businesses. In fact, the test sites, in partnership with industry, have accessed opportunities provided by other federal agencies' SBIR/STTR programs. They also pursue state and non-governmental sources of funding including small business vouchers and organizations like the Virginia Innovation Partnership Corporation.[66] However, the FAA does not participate in DOT-Volpe's SBIR/STTR program. Findings 4.6 and 4.7 also note challenges with funding for participants among the test sites and BEYOND. As noted in chapter 3, the test sites could only receive approximately 30 percent of the funding from UAS BAA contracts prior to the enactment of the FAA Reauthorization Act of 2024, and the change has yet to manifest in practice. Adding different sources of income could help the test sites increase participation of small businesses, fill gaps in funding, and increase opportunities for technology transfer to the FAA and to other public and private entities.

**Finding 5.3:** The FAA has made strides in integrating the R&D strategies of its lines of business offices. As identified in chapter 4, there are opportunities for the FAA to improve information sharing with partners and between FAA internal components themselves. More collaboration on data sharing would also provide additional opportunities to enhance aspects of the FAA's continuous improvement process for technology transfer, such as the output and outcome measures in use.

**Finding 5.4:** The FAA's T2 program utilizes both traditional technology transfer mechanisms such as CRADAs and patent licenses as well as broader information dissemination mechanisms to share research results. Reflecting the FAA's safety-centric mission and focus on applied research to inform its regulatory activities, there are few licensing opportunities as the FAA does not have a large portfolio of technologies for commercialization (four in total). While WJHTC maintains a portfolio of over forty CRADAs, only three relate to AAM and one to UAS.

**Finding 5.5:** The FAA does not participate in Volpe's SBIR program. Examination of other federal agencies' technology transfer programs suggests that alternative funding or support mechanisms for small businesses, such as state and federally funded small business vouchers could attract more private users to the test sites.

**Recommendation 5.3:** The FAA should explore opportunities to support technology transfer with small businesses such as the small business voucher program, model or partner with other agencies' SBIR/STTR programs, and collaborate with state and local organizations to increase private sector participation.

[66] "About," Virginia Innovation Partnership Corporation, accessed April 8, 2025, https://vipc.org/about/.

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# Chapter 6: Broadening UAS and AAM STEM Education and Outreach

According to FAA estimates, there will be a shortage of 350,000 UAS operators by 2028.[67] As UAS is one of the fastest growing and evolving aerospace industries, it is likely that workforce shortages will continue—and potentially grow—for several years into the future, and that new skills will be required.[68] While most agree on the need to expand the STEM talent pipeline to meet workforce needs, experts disagree on the best way to do that. Is it targeting kindergarten through twelfth (K-12) grade students with outreach and education, or does upskilling and reskilling adults in the workplace produce better outcomes? The dynamic environment requires government officials and industry to focus on the needs of today and anticipate the needs of five, ten, and fifteen years from now. The education and training that produced today's STEM workforce will not be sufficient to meet tomorrow's needs.

The federal government not only has an important role to play in developing the national STEM workforce, but it stands to benefit from an expanded talent pipeline. Given the need for STEM workers in both the public and private sectors, and the difficulty the government has in competing with industry to attract talent, the federal government cannot address its own needs by vying for scarce talent. In addition, federal agencies' reliance on contractors makes them dependent on the quality of the private sector STEM workforce.

As discussed in chapter 5, STEM education serves as an example of informal technology transfer that is critical to workforce development. As students graduate from high school and college STEM programs, the research and critical thinking skills immediately transfer into the job market. "University research provides an intellectual framework for training professionals who are then able to transfer what they have learned to their employers."[69]

The federal government is only one part of the overall solution. Developing STEM talent depends on the commitment not only of industry, but also educators, state and local governments, and nonprofit organizations. STEM requires a whole-of-nation effort, and the federal government's success will depend on its ability to partner effectively with a myriad of nongovernmental actors to develop tools and approaches to reach a greater portion of the population.

The FAA's UAS research partnerships play a pivotal role in supporting STEM education efforts designed to introduce the public to UAS technology and support workforce development. But the FAA has long held STEM education as a core component of its mission and purpose. Since 1976, the FAA's STEM Aviation and Space Education (AVSED) Program has been the primary means

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[67] Federal Aviation Administration, *FAA STEM AVSED Program* (Federal Aviation Administration, November 14, 2022), 5, archived December 3, 2024, at the Wayback Machine, https://web.archive.org/web/20241203050551/https://www.faa.gov/sites/faa.gov/files/STEM%20AVSED%20Program%20AOPA.pptx.

[68] Federal Aviation Administration, *FAA STEM AVSED Program: FY23 Annual Report*, (December 15, 2023), 4.

[69] Maryann Feldman et al., *Research To Renewal: Advancing University Tech Transfer* (Heartland Forward, May 2022), 21, https://heartlandforward.org/wp-content/uploads/2022/05/ResearchToRenewal.pdf.

by which the FAA engages in STEM outreach.[70] In addition, the FAA has established the Unmanned Aircraft Systems Collegiate Training Initiative (UAS-CTI) Program, which was established in 2020 as required by the FAA Reauthorization Act of 2018.[71]

## 6.1 AVSED and UAS-CTI

While AVSED and UAS-CTI are separate and distinct from the FAA partnership programs, it is important to understand how the UAS partnership programs fit into the broader context of FAA UAS-related STEM outreach. AVSED's mission is "to increase the general knowledge of the dynamics of aviation, the positive role of air and space transportation on the economic and social life for all, and address the future labor shortages across the aviation and space industries in the United States."[72] The program has four goals:[73]

- Create aerospace career pipelines and pathways
- Provide STEM education to every student
- Develop strategic partnerships to maximize benefits
- Enhance cross agency collaboration to optimize the program

In addition to contributing to broader STEM outreach that will also benefit UAS, AVSED carries out limited UAS-specific activities, like designing and supporting UAS challenges and contests.[74]

In April 2020, the FAA initiated the UAS Collegiate Training Initiative (UAS-CTI) in response to the FAA Reauthorization Act of 2018 provisions, which sought to expand and continue agreements between the FAA and institutes of higher education that prepare students for careers in UAS.[75] As of February 2025, 144 schools were recognized as UAS-CTI participants.[76] The initiative provides schools with access to FAA resources, including technical support and program promotion, while also supporting the FAA's efforts to expand the UAS workforce.[77]

The purpose of UAS-CTI is to "ensure that UAS-CTI school graduates have the knowledge and skills needed to pursue a successful career in a UAS-related field" by facilitating the development and sharing of best practices and fostering a continuous dialogue between colleges and

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70 Federal Aviation Administration, *FAA Science, Technology, Engineering and Math Aviation and Space Education Program (STEM AVSED),* Order 1250.2B (Federal Aviation Administration, November 5, 2021), 2, https://www.faa.gov/documentLibrary/media/Order/FAA_1250.2B.pdf.

71 "UAS Collegiate Training Initiative," Federal Aviation Administration, last modified March 13, 2025, https://www.faa.gov/uas/educational_users/collegiate_training_initiative.

72 Federal Aviation Administration, *FAA Science, Technology, Engineering and Math*, 1.

73 Federal Aviation Administration, *FAA Science, Technology, Engineering and Math*, 2.

74 Federal Aviation Administration, *FAA STEM AVSED Program: FY23 Annual Report*, 45.

75 FAA Reauthorization Act of 2018, Pub. L. No. 115-254, § 631-632, 132 Stat. 3416. https://www.congress.gov/115/plaws/publ254/PLAW-115publ254.pdf#page=232

76 "Approved Unmanned Aircraft Systems – Collegiate Training Initiative (UAS-CTI) Schools," Federal Aviation Administration, last modified February 2025, https://www.faa.gov/uas/educational_users/collegiate_training_initiative/UAS-CTI-School-Directory.

77 Federal Aviation Administration, *Unmanned Aircraft Systems – Collegiate Training Initiative*, (Federal Aviation Administration, April 30, 2020), archived December 26, 2024, at the Wayback Machine, https://web.archive.org/web/20241226001726/https:/www.faa.gov/sites/faa.gov/files/uas/educational_users/collegiate_training_initiative/UAS-CTI_2020_briefing_deck.pdf.

universities and general industry, local governments, law enforcement, and regional economic development entities. In addition, "UAS-CTI partners will support the FAA's efforts to expand the aviation workforce of the future while providing additional opportunities for [STEM] students."[78]

## 6.2 UAS STEM Education Outreach Efforts

The FAA's UAS STEM education outreach efforts occur primarily through three programs: ASSURE, BEYOND, and Know Before You Fly.

### *ASSURE*

There have been five ASSURE STEM outreach projects spanning 2016–24. ASSURE's STEM I-V projects are the FAA's largest K-12 educational program. Designed like all ASSURE projects, two or more core partner schools carry out STEM-related programs for a specific period of time, as defined by the contract. Each college or university provides matching funding and develops activities, camps, presentations, and other programming for K-12 students and educators. Since 2016, ASSURE core partners have carried out 339 events, reaching nearly forty thousand participants.[79] Over the course of the STEM III-V projects, more than thirty-four thousand students and approximately one thousand teachers actively participated in various events.[80] Table 3 identifies the core partners and provides brief descriptions of events and the total number of participants for each of the five STEM projects.

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[78] Federal Aviation Administration, "UAS Collegiate Training Initiative."

[79] Daniel Findley et al., *A73 STEM Outreach – Conduct Science Technology Engineering and Math (STEM) Outreach to Minority K-12 Students Using Unmanned Aircraft Systems (UAS) as a Learning Platform (STEM V)* (ASSURE, December 6, 2024), 20-22, https://www.assureuas.com/wp-content/uploads/2023/02/ASSURE_A73_Final_Report_v2.pdf.

[80] STEM I and II project data do not include a breakdown of participants by students and educators. Jerry Hendrix, et al., *A29 STEM Outreach – UAS as a STEM Outreach Learning Platform for K-12 Students and Educators (STEM III) Final Report* (ASSURE, September 30, 2022), 66, https://assure.msstate.edu/wp-content/uploads/2021/06/A29_STEM_III_Final_Report.pdf; Dan Findley, et al., *A61 STEM Outreach – Conduct Science Technology Engineering and Math (STEM) Outreach to Minority K-12 Students Using Unmanned Aircraft Systems (UAS) as a Learning Platform (STEM IV)* (ASSURE, December 4, 2023), 21, https://www.assureuas.org/wp-content/uploads/2022/02/A61-Final-Report.pdf; Daniel Findley, et al., *STEM V*.

*Table 3. Total Number of Events and Participants, STEM I - V*

| Phase | Performing School | Description of Events | Total Number of Participants |
|---|---|---|---|
| STEM I | Tuskegee University | 4 Roadshows and 1 Summer Camp | 225 |
| STEM I | New Mexico State University | 3 Roadshows and 2 Summer Camps | 1,010 |
| **STEM I Totals** | | | **1,235** |
| STEM II | University of Alaska Fairbanks | 3 Roadshows and 4 additional outreach events | Approx. 700 |
| STEM II | University of California Davis | 1 Summer Camp and 3 additional outreach events | Approx. 2,000 |
| STEM II | Montana State University | 2 outreach events and 2 additional apprenticeships supported | 102 |
| STEM II | New Mexico State University | 4 Summer camps, 1 outreach activity, and 5 speaking engagements | 520 |
| **STEM II Totals** | | | **3,337** |
| STEM III | University of Alabama Huntsville | 18 total outreach events | 765 |
| STEM III | University of Alaska Fairbanks | 29 total outreach events | 1,805 |
| STEM III | University of California Davis | 3 total outreach events | 39 |
| STEM III | Ohio State University | 4 total outreach events + additional online programs | 127 |
| STEM III | Sinclair College | 118 total outreach events | 9,198 |
| STEM III | New Mexico State University | 7 total outreach events | 580 |
| **STEM III Totals** | | | **12,514** |
| STEM IV | North Carolina State University | 21 total outreach events | 835 |
| STEM IV | Kansas State University | 39 total outreach events | 16,439 |
| STEM IV | Sinclair College | 37 total outreach events | 3,735 |
| **STEM IV Totals** | | | **21,009** |
| STEM V | North Carolina State University | 15 total outreach events | 586 |
| STEM V | Oregon State University | 10 total outreach events | 897 |
| STEM V | Virginia Tech | 4 total outreach events | 179 |
| **STEM V Totals** | | | **1,670** |
| **Cumulative ASSURE STEM Outreach** | | | **39,765** |

Source: FAA A73 STEM Outreach Final Report STEM V

Across all five STEM projects, students and educators engaged in a variety of activities, including roadshows, summer camps, after-school programs, in-school immersion experiences, and educator training programs. These events provided students and educators with background knowledge, hands-on skills training, and exposure to UAS careers. Programs introduced students to the physics of flight through interactive demonstrations with paper airplanes and smoke tunnels, while flight simulators and small unmanned aircraft systems flights allowed hands-on piloting experience under professional supervision. Additional activities—such as 3-D printing mission-specific tools, working with ground drones, and engaging in team research projects on UAS mission design—helped students apply their skills in real-world scenarios. These initiatives also extended beyond students, incorporating educators such as principals and STEM teachers and equipping them with resources to integrate UAS education into their schools.[81]

From 2019–22, STEM III focused on broadening outreach to rural communities and varying educational efforts through targeted programming. The initiative sought to "teach the teachers" by leveraging previously developed FAA STEM outreach materials and adapting them to fit the unique needs of student populations. The educational materials developed by this project were shared with the FAA, ensuring accessibility and continuity. Other universities, such as the University of Alabama in Huntsville, the University of Alaska Fairbanks, the University of California-Davis, and Ohio State University, contributed through specialized programs, including summer drone academies, airshows, and engineering design challenges. These programs emphasized active learning through drone simulations, hands-on flight experiences, and exposure to industry research. Some schools, like Sinclair College, originally focused on middle school outreach but expanded their audience to include elementary and high school students due to the COVID-19 pandemic. Their programs featured interactive UAS demonstrations and education on industry research topics such as UAS noise measurement, airborne collision severity evaluations, and detect-and-avoid requirements.[82]

Subsequently, STEM IV and STEM V programs further strengthened UAS education and career pipeline development. Universities, such as North Carolina State University, Kansas State University, and Sinclair College, implemented roadshows, summer camps, and educator training programs, reaching over twenty-one thousand participants. These programs emphasized hands-on learning, industry engagement, and practical skills building to engage a broad range of student groups. Kansas State University, for example, focused on helping educators integrate UAS education into their schools through professional development opportunities that enabled teachers to earn Remote Pilot Certificates.[83] Additionally, partnerships with organizations like the North Carolina Department of Transportation (NCDOT) introduced students to aviation careers, including pilots, air traffic controllers, and aircraft mechanics. Similarly, Oregon State University and Virginia Polytechnic Institute and State University tailored their outreach efforts to various student groups, offering activities like drone assembly, sensor spoofing challenges, and drone soccer. Programs like Virginia Tech's summer camp provided middle schoolers with opportunities

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[81] Henry Cathey, *Minority Outreach – UAS as a STEM Minority Outreach Learning Platform for K-12 Students Final Report* (ASSURE, November 30, 2017), https://www.assureuas.org/wp-content/uploads/2024/03/A15_STEM-Final-Report.pdf.
[82] Jerry Hendrix, et al., *STEM III*.
[83] Daniel Findley, et al., *STEM IV*.

to build drones, interact with industry professionals, and earn certification for recreational UAS operation.[84]

## *BEYOND Program*

The BEYOND Program's STEM education efforts are more limited than those of ASSURE. Given its lack of funding, there is no direct requirement by the FAA for BEYOND partners to conduct STEM education activities, specifically. As described in chapter 3, the BEYOND Program does require that partners engage with the community to capture and address feedback on drone use. For some lead participants, their community engagement does include STEM education activities. In 2023, for example, the Memphis Shelby County Airport Authority and the FedEx Express UAS Strategic Projects Team, under the auspices of the BEYOND Program, hosted a week-long Organization of Black Aerospace Professionals camp for fifty high school-aged students. Members of the FedEx UAS team provided support to the campers throughout the week.[85] For others, like Viriginia Tech, some of their STEM education activities initially resulted from the relationship with their BEYOND industry partner, but later transitioned to the ASSURE program, which allowed the school to receive funding to continue and expand their programming.[86] Other BEYOND lead participants, like the Choctaw Nation of Oklahoma, have STEM education activities that appear to be part of their broader mission and not specifically resulting from the BEYOND program. Prior to participating in the BEYOND Program, no schools on the Choctaw Nation Reservation had aviation programs, but since the program's implementation, it is reported that several schools have initiated aviation programs, including Aircraft Owners and Pilots Association You Can Fly programs and the addition of flight simulators in some schools.[87]

## *Know Before You Fly*

The Know Before You Fly campaign, focused on drone safety education, is a joint effort between the Academy of Model Aeronautics, the Association for Uncrewed Vehicle Systems International, the Consumer Technology Association, and the FAA.[88] Know Before You Fly has provided ninth through twelfth grade students in several schools around the nation with drone kits. Along with the drone itself, Know Before You Fly also provides educator resources, including a video on how to build the kit and a *Student Drone Kit Unit of Study* document that provides information on safety and regulator information, career pathways, and the science behind how drones fly.[89]

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[84] Daniel Findley, et al., *STEM V*.
[85] "BEYOND Drone Program," Memphis International Airport, accessed March 28, 2025, https://flymemphis.com/drones/.
[86] Virginia Tech Mid-Atlantic Aviation Partnership (MAAP). *REPORT: Analysis of Minimum Viable Infrastructure (MVI) to Support Advanced Aerial Mobility (AAM) Operations Across the Commonwealth of Virginia,* Ver. 2.0 (Virginia Department of Aviation, January 2024), 95, https://doav.virginia.gov/wp-content/uploads/Files/DocumentLibrary/DOAVMVI2024Reportv2.0.pdf.
[87] "AOPA "You Can Fly,"" Oklahoma Aerospace & Aeronautics, last modified September 6, 2023, https://oklahoma.gov/aerospace/aero-education/aopa_youcanfly.html.
[88] "About the Campaign," Know Before You Fly, accessed March 28, 2025, https://knowbeforeyoufly.org/about-us.
[89] Know Before You Fly, *Student Drone Kit Unit of Study* (Know Before You Fly, n.d.), http://auvsilink.org/KBYF/KBYF%20Unit%20of%20Study%20Pages%20HiRes%20Final.pdf.

**Finding 6.1:** The FAA's UAS STEM outreach primary focus on the long-term strategy of reaching K-12 students will not have a large enough impact quickly enough to fill current and growing UAS workforce gaps.

The majority of the FAA's STEM outreach focuses on K-12 education. Through ASSURE, BEYOND, and the Know Before You Fly campaign, the FAA engages its partnerships to expose school-aged children to UAS basics, education paths, and career opportunities.

Several federal agencies pursue STEM outreach and education strategies that target K-12 students based on social science research indicating that success depends on reaching students earlier rather than later.[90] However, it is unclear when the most effective time is to reach students. In addition, outcomes of K-12 strategies can take many years to realize. The long-term nature of K-12 strategies, combined with the difficulty of collecting information on K-12 students due to privacy concerns, makes it difficult to determine how effective these programs are.

Another challenge with K-12 education is scalability. Each STEM project can reach only a tiny fraction of the more than one hundred thousand elementary, middle, and high schools in the United States. Increasing the emphasis on educators rather than individual students can help overcome this challenge.

Considering the challenges and uncertainties of focusing on K-12 education, and the need to fill STEM positions in the short term, some experts are starting to shift attention and resources to post-secondary students and adult learners.

**Recommendation 6.1:** Prioritize increasing STEM outreach and education to audiences other than K-12 students, including educators, college students, and expanding efforts to include reskilling and upskilling adults already in the workforce.

Addressing the sizable current workforce gap will require a dramatic increase in the number of people choosing to pursue a career in UAS. Partners and industry stakeholders have identified middle school students (grades 6–8) as a critical demographic for initiating UAS education because they believe high school is too late to encourage students to pursue STEM. However, this approach represents a long-term investment with delayed impact on the workforce. As a result, it is essential to complement these and other K-12 efforts by expanding existing outreach to populations other than K-12 students, including educators and post-secondary students, and exploring ways to reach new populations, such as adults already in the workforce.

"The most effective way to support educators is through curricula, training, and resources."[91] Expanding the use of approaches such as train-the-trainer, where a small number of educators are trained, who then train many more teachers, along with introducing new methods, like online courses for educators, would make the focus on educators even more scalable. To reach more post-secondary students, FAA UAS should explore with UAS-CTI potential opportunities to leverage each other's efforts or jointly carry out initiatives. An example would be outreach to community college career counselors. FAA UAS should also work with agencies that focus on college students,

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[90] Joe Chase, et al., "STEAM Powered K-12 Cybersecurity Education," *Journal of The Colloquium for Information Systems, Security Education* 7, no. 1 (Summer 2020), https://cisse.info/journal/index.php/cisse/article/view/114.
[91] CYBER.ORG, "CYBER.ORG," accessed March 23, 2025, https://cyber.org/.

like NASA, to learn from their experiences. Successful actions to reach adults could include leveraging existing nonprofit networks for adult learners, such as the Council for Adult and Experiential Learning and the Graduate! Network to raise awareness of UAS career opportunities and provide additional support, such as mentoring, career services, and scholarships. The FAA could also encourage industry to provide paid internships and apprenticeships.

**Finding 6.2:** The FAA's approach of frequently relying on its partners to take the lead in designing curricula and programs for STEM education outreach has enabled the agency to reach tens of thousands of educators and students; however, the FAA's lack of centralized direction on setting goals, objectives, and performance metrics means that the programs might not be supporting the FAA's workforce development goals to the fullest extent possible.

UAS STEM education activities developed through the ASSURE and BEYOND programs are not created by FAA employees. Instead, they are developed by researchers working under each partnership program. As such, curriculum decisions and topics to be addressed are not determined by the FAA, but by outside entities. For example, private industry BEYOND partners have collaborated with the Virginia Space Grant Consortium to create DACUM (Developing a Curriculum) charts for various UAS positions, such as Small Unmanned Aircraft Systems Operations Technician.[92] These charts comprehensively outline the duties and tasks associated with each position, ensuring a clear understanding of the roles within the UAS field. The FAA's absence from these early-stage curriculum development efforts represents a missed opportunity to contribute valuable input and ensure alignment with industry standards, regulatory expectations, and FAA workforce goals.

The FAA's reliance on its partners to take the lead in designing curricula and programs for STEM education outreach efforts has significant implications. By leveraging the expertise and resources of its partners, the FAA can reach a broader audience and provide high-quality educational content. This collaborative approach allows the FAA to benefit from the specialized knowledge and innovative teaching methods of its partners, which can enhance the overall effectiveness of STEM education initiatives. However, this reliance also means that the FAA has limited direct control over the content and direction of these programs. As a result, the FAA must ensure that its partners' goals and objectives align with its own to maintain a cohesive and effective STEM outreach strategy.

Furthermore, the lack of direct control over UAS STEM education programs may impact the FAA's ability to address current and future workforce concerns effectively. While the FAA receives program descriptions, narratives of events, and data from its partners, it may not have the flexibility to quickly adapt to changing industry needs or emerging trends. This could potentially hinder the FAA's efforts to develop a workforce that is well prepared for the challenges of the future. Additionally, the FAA's dependence on partners for curriculum development may lead to inconsistencies in the quality and focus of educational materials, which could affect the overall impact of STEM outreach efforts.

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[92] *DACUM Research Chart: Small Unmanned Aircraft Systems Operations Technician* (Virginia Advanced Study Strategies, n.d.), https://vsgc.odu.edu/geoted-uas/wp-content/uploads/sites/13/2019/09/SUAS-DACUM-2.pdf.

**Recommendation 6.2:** Collaborate with research partnerships to create a standardized UAS STEM program, including goals and performance metrics, and with other FAA programs and federal agencies to avoid duplication and share best practices and lessons learned.

While the FAA's UAS STEM outreach approach maximizes the number of students who can be reached, more centralized direction would help ensure these projects are contributing to the maximum extent to the FAA's ability to reach its workforce development goals. Specifically, the FAA should utilize its partnerships to work together to develop STEM outreach goals and objectives, and metrics to measure progress towards reaching them. Recognizing that developing outcome-oriented metrics for outreach, especially to younger students, is difficult, the FAA should collaborate with AVSED and other agencies that conduct STEM outreach on developing some common metrics and sharing best practices.

**Recommendation 6.3:** Continuously evaluate the effectiveness of prior UAS STEM outreach initiatives to identify gaps and integrate lessons learned into future planning.

The evaluation process must begin with operational planning, where program leaders define evaluation criteria that include balancing the needs of stakeholders, such as funders, educators, and participants. There must also be clearly articulated, measurable outcomes, such as increased STEM knowledge or career interest. Longitudinal surveys of program participants can be used to determine if increased knowledge and interest ultimately results in students pursuing degrees and careers in UAS at a higher rate than students who did not participate. Evaluations can seek to both improve the program and assess its effectiveness. The chosen objective will determine the data collection methods, which may include quantitative approaches (e.g., surveys, tests) and qualitative approaches (e.g., interviews, focus groups).[93]

## 6.2 UAS STEM Education Outreach Funding

The outlook for federal funding of STEM outreach is uncertain. For example, as of April 2025, FY 2025 STEM outreach funds had not yet been disbursed; the RFP was pulled pending programmatic review. In other years, there is always the possibility that STEM education outreach funding could be delayed due to continuing resolutions or be subject to budget cuts.

UAS STEM outreach funding is already provided through a variety of sources. ASSURE partners are required to provide a 1:1 match; matching funds are primarily provided by state and local governments and industry. BEYOND STEM activities are funded by private industry. However, UAS camps and other outreach programs can be costly, especially if drone kits and other supplies and equipment are provided.

Partnership programs believe STEM outreach is an important tool for attracting students to UAS careers and have observed an increase in interest as a result of their outreach activities. Given the value of STEM outreach to partnerships, the FAA, and target communities, it is important to ensure STEM education outreach can be sustained or even expanded.

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[93] Joyce Malyn-Smith, *A Program Director's Guide to Evaluating STEM Education Programs: Lessons Learned from Local, State, and National Initiatives* (n.p., April 2013), https://stelar.edc.org/sites/default/files/A_Program_Directors_Guide_to_Evaluating_STEM_Eduation_Programs_links_updated.pdf.

**Finding 6.3**: Additional STEM education outreach funding from a broader variety of sources would enable continuity of effort when federal funds are delayed or cut.

**Recommendation 6.4:** The partnership programs should continue to leverage nonfederal funding sources for UAS and AAM STEM outreach through engagements with state and local governments, private philanthropic foundations, and industry.

# Chapter 7: Conclusion

As the FAA moves forward, it is essential that the agency builds upon ongoing efforts to advance partnerships by making organizational changes, refining regulations, enhancing data sharing, and supporting STEM education. These changes are necessary for the agency to keep pace with the evolving UAS and AAM environment. The FAA needs to engage a wide range of stakeholders to ensure it develops informed rules, regulations, and decisions and considers the impacts of the growing UAS and AAM industry. Additionally, the FAA must manage increasing numbers of stakeholders and information requests, and work toward workforce development goals.

The recommendations outlined in this report demonstrate how the agency can improve its research partnerships and underscore the importance of continued investment in research and development to maintain the FAA's leadership in aviation safety. These recommendations also aim to help the FAA improve its internal and external communication channels to ensure effective research coordination and data and information sharing. By implementing these recommendations, the FAA can coordinate and communicate with partners and stakeholders more effectively and efficiently, bolstering its existing partnerships and better supporting new ones to facilitate the effective, efficient, and safe integration of AAM and UAS activities in the NAS.

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# Appendices

## Appendix A: Panel and Study Team Member Biographies

### *Panel of Academy Fellows*

**Cornelius Kerwin, (Chair):** Dr. Kerwin is President Emeritus and Professor of Public Administration and Policy at American University and has held the positions of President and Provost of American University. Within American's School of Public Affairs, Dr. Kerwin has also held the position of Dean. Dr. Kerwin is a nationally recognized specialist in public policy and the regulatory process, and teaches courses in regulatory process and management.

**Patricia Cogswell:** Ms. Cogswell has led multiple organizations through strategy, policy, technology execution, and operations in support of national security missions. She led complex initiatives across the federal government and with international partners. She possesses substantive expertise in: aviation, maritime, and surface transportation security; US government and foreign partner screening and vetting programs; counter terrorism; transnational organized crime; intelligence; information sharing and associated technology architectures; and immigration and border processes. Ms. Cogswell served in a number of senior executive positions within the Department of Homeland Security, including as the Deputy Administrator of the Transportation Security Administration, Assistant Director for Intelligence at the US Immigration and Customs Enforcement, Acting Undersecretary within the Office of Intelligence and Analysis, Acting Assistant Secretary for Policy Integration and Implementation, and Deputy Assistant Secretary for Screening Coordination. She also previously served at the National Security Council as Acting Deputy Assistant to the President for Homeland Security and Counterterrorism, and as Special Assistant to the President for Transborder Security.

**James Cook:** Mr. Cook career has centered around bringing together nonprofits, the technology industry, academia and the government together to focus and adopt research and innovation that serves the public interest. He serves on boards; has led federally funded research and development centers (FFRDCs); created and chaired cross-sector collaborative bodies; and developed public-private partnerships to drive efficiencies, prevent fraud, and improve value to the public. Specifically, he has been serving as a Director on the Board of Directors at Melwood since 2023. In the same year, he also took on the role of Chair at the Center for Responsible AI and Quantum within the Potomac Quantum Innovation Center, an initiative of Connected DMV, a 501(c)(3) organization. Additionally, since 2019, Jim has been the Chair of the Institute for Innovation at ACT-IAC, a Center he helped to establish in 2011. In 2023, he became the CEO of Action for Impact LLC. Prior to these roles, Jim was the Vice President of Strategic Engagement and Partnerships at MITRE from 2018 to 2023. Before that, he served as the Vice President of the Center for Enterprise Modernization at MITRE from 2009 to 2018, and as the Executive Director of the same center from 2004 to 2009. Earlier in his career, Jim was a Partner in Consulting Services at IBM from 2002 to 2004, and a Partner in the Office of Government Services at PwC from 2000 to 2002. He also held the position of Senior Manager in the Washington Consulting Practice at PW from 1991 to 2000.

**Tina Sung:** Tina Sung was most recently at the Partnership for Public Service where she was the Vice President for Federal Executive Networks and prior to that, Vice President of Government Transformation and Agency Partnerships. In her 15+ years there she launched more than 20 products and services to help agencies become the "best place to work" by improving employee engagement, leadership, and operational excellence. She set the gold standard for convenings with the most senior leaders in government. She works extensively at the political-career interface and has years of multi-sector executive leadership experience, as well as a track record of innovation and accomplishment in every phase of her professional career. Her government experience includes key senior executive service positions in the Department of Health and Human Services overseeing regional human resource activities, the Social Security Administration in Operations, Systems, and Operations Analysis and Support, and as Executive Director of the Federal Quality Institute (FQI) at Treasury. Concurrent with her FQI service, she served as a Malcolm Baldrige National Quality Award senior examiner for seven years and on the Vice President's National Performance Review to Reinvent Government. She served as President and CEO of a global nonprofit with members in more than 100 countries. Her private sector experience includes launching two companies, Synergy Works LLC and Experience Matters, the Executive Transition Experts, and serving on the boards of Shambaugh, a women's leadership company, the National Academy of Public Administration, and the Institute for Pure and Applied Math at UCLA.

## *Study Team*

**Brenna Isman,** *Director of Academy Studies***:** Brenna oversees the Academy studies, providing strategic leadership, project oversight, and subject matter expertise to the professional study teams. Before this, she was a Project Director managing projects focused on organizational governance and management, strategic planning, and change management. Her research engagements have included working with the National Aeronautics and Space Administration, the Environmental Protection Agency, the Social Security Administration, the Department of Veterans Affairs, and multiple regulatory and Inspector General offices. Before joining the Academy, Brenna was a Senior Consultant for the Ambit Group and a Consultant with Mercer Human Resource Consulting. Brenna holds a Master of Business Administration (MBA) from American University and a Bachelor of Science (BS) in Human Resource Management from the University of Delaware.

**Mark Thorum,** *Project Director***:** Mark Thorum joined the Academy as a Senior Advisor and Project Director in May 2019. Dr. Thorum previously served as the Assistant Inspector General (AIG) for Inspections and Evaluations and the AIG for Management and Policy with the Office of Inspector General (OIG), Export-Import Bank of the United States. Dr. Thorum has more than 25 years of experience with independent evaluation, structured finance, risk mitigation, and capital markets advisory with both the federal government and international financial institutions. He holds a Ph.D. from the Virginia Polytechnic Institute and State University - School of Public and International Affairs. He received an M.A. from The Johns Hopkins University – School of Advanced International Studies and a D.E.A. from the Institut d'études politiques de Paris (Institute of Political Studies) Paris, France.

**Mark Hertko**, *Deputy Project Director*: Mark has served as a Project Director and Senior Analyst on several Academy projects, including the Federal Bureau of Investigation; Department of Homeland Security—US Coast Guard; Department of Interior—National Park Service; Environmental Protection Agency's National Center for Environmental Innovation, Office of Environmental Information, Office of Water, Office of Environmental Justice, Office of Air and Radiation; Corporation for National and Community Service; and Department of Energy's Office of Energy Efficiency and Renewable Energy. Mark holds a BA from The Monmouth College in Biology, an MA in Environmental Science from the University of Illinois Springfield, and an MST in Education from Pace University.

**Karen Hardy*,** *Senior Advisor*: Dr. Karen Hardy brings more than 30 years of federal experience from the NIH and Department of Commerce. She is the former Director of Risk Management and first Chief Risk Officer at the U.S. Department of Commerce where she led the Office of Program Evaluation and Risk Management. She spearheaded the Department's ERM initiative across 12 federal agencies with 47,000 employees and a budget of $7B. The initiative was recognized by the GAO as a federal Best Practice. Dr. Hardy is the former senior policy advisor working with the U.S. Controller at OMB in establishing government-wide risk policy. Her work and research have been recognized and credited for pioneering risk management literature across government. Dr. Hardy is an alumnus of the Federal Executive Institute and received 3 bronze medal awards for superior performance. She is a founding member of the Association for Federal Enterprise Risk Management. An accomplished speaker and award-winning author, Dr. Hardy has served as keynote at several events including at Harvard University and the United Nations Office of the Under-Secretary-General. Dr. Hardy holds a BA in Communication/Journalism from Hampton University, an MBA, as well as a Doctor of Education in Human Resource Development and Leadership from Nova Southeastern University.

**Maria Rapuano**, *Senior Advisor*: Maria has served as a Deputy Project Director and as a Senior Advisor for several Academy projects. Her areas of expertise include public policy, strategic planning, organizational design, and change management. She holds an MA in International Affairs from American University and a BA in Government from the College of William and Mary.

**Jesse Roth,** *Senior Advisor*: Mr. Roth has thirty-six years of program review experience in the federal government. He had responsibility for reviews of several large, sensitive programs/operations in the intelligence community and was able to achieve improved program efficiency and effectiveness on each. The programs he reviewed included personnel processes, field operations and activities, procurement, finance and information technology. Mr. Roth often had responsibility for briefing senior management on the results of his work including the Agency Director, Deputy Director, General Counsel as well as briefing senior members of Congress and testifying before congressional committees. Mr. Roth holds both a Bachelor's Degree in Business Administration from the University of Iowa and a Master's in Administration from Central Michigan University.

**Kate Connor,** *Senior Research Analyst*: Ms. Connor joined the Academy in 2018 and has served on several Academy studies, including work for the U.S. Department of Commerce Office of Inspector General and the Defense Nuclear Facilities Safety Board. Prior to joining the Academy, she served as a Public Policy and Government Relations Intern with the American Association of

University Women and as an intern on the U.S. Senate Committee on the Budget. Ms. Connor taught high school social studies for several years before graduating from Georgetown University with a Master's in Public Policy. Ms. Connor also holds a Bachelor of Arts in History and Political Science and a Master's in Teaching from the University of North Carolina at Chapel Hill.

**Miles Murphy,** *Senior Research Analyst:* Mr. Murphy joined the Academy in August 2021. He has worked on studies for numerous organizations, including the Pew Charitable Trusts, the Center for Accountability, Modernization, and Innovation, and the National Association of Counties. His focus areas include governance, intergovernmental systems, resilience, strategic planning, and workforce. His previously worked in local government as a senior community and environmental planner. He earned a Masters in Coastal and Ocean Policy (a blend of Environmental Science and Public Administration) from the University of North Carolina, Wilmington.

**Kyle Romano**, *Senior Research Analyst*: Kyle has provided research support for more than ten Academy studies, including work for the Department of Energy, National Park Service, and the National Oceanic and Atmospheric Administration. Kyle's focus areas include strategic planning, change management, research and development, and environmental policy. He graduated from the Indiana University School of Public and Environmental Affairs with a Master's in Public Administration. Kyle's graduate program also included client-based projects with local governments and programs. He attended the University of Central Florida for his undergraduate studies, where he earned a Bachelor's in Political Science and a Bachelor's in Legal Studies.

**James Higgins,** *Research Analyst*: Mr. Higgins currently supports the Academy's Strategic Initiatives including research for its Grand Challenges in Public Administration campaign and producing the Management Matters podcast. Mr. Higgins has previously worked on studies for the Bureau of Transportation Statistics, the United States Trade and Development Agency, and the project, Increasing the Agility of the Federal Government. James graduated with a B.A. in International Studies with a focus on Asia from Dickinson College, and an M.A. in Global Policy with a focus on Security and Foreign Policy from the University of Maine School of Policy and International Affairs.

**Nadia Faour,** *Senior Research Associate*: Ms. Faour has served on studies for numerous different federal agencies, including work for The National Science Foundation, The Bureau of Prisons, The Department of Health and Human Services Program Support Center, and the United States Agency for International Development Office of Inspector General. Ms. Faour's focus areas include organizational transformation and change management, healthcare quality assessment, human capital, and strategic planning. Ms. Faour earned a Bachelors Degree in Global Affairs from George Mason University.

**Sarah Jacobo,** *Senior Research Associate*: Sarah has served on studies for different federal entities, including work for the Department of Agriculture, Department of the Navy, Office of National Cyber Director, and National Science Foundation. Sarah earned a Master of Public Policy and a B.A. in Government and Politics, and Public Policy from the University of Maryland, College Park. Before joining the Academy, Sarah was an intern with the Academy's Study Team and worked on the Cybersecurity Workforce Study for the Cybersecurity and Infrastructure Security Agency.

**Jonas Yee,** *Senior Research Associate*: Mr. Yee has served on studies for many different federal agencies including studies for the Department of Health and Human Services Program Support Center, the Federal Judicial Center, and the Department of Agriculture Farm Production and Conservation. He previously helped conduct research on early voting policy as a research assistant at UCLA. He earned a B.A. in Political Science from the University of California Los Angeles.

# Appendix B: List of Interviewees

## *Department of Transportation*

- **Tim Klein,** Director, Office of Technology Policy and Outreach, Office of the Assistant Secretary for Research & Technology

**Federal Aviation Administration**

***UAS Integration Office***

- **Jeffrey Vincent,** Executive Director
- **Jennifer Audette,** Operational Programs Branch Manager, Safety and Integration Division
- **Jessica Brightman,** Implementation Branch Manager, Safety and Integration Division
- **Martha Christie,** Deputy Director, Safety and Integration Division
- **Pamela Gomez,** Director, Safety and Integration Division
- **Robert Henderson,** Principal Advisor, Safety and Integration Division
- **Sherita Jones,** Chief of Staff
- **Kim Merchant,** Special Projects Branch Manager, Safety and Integration Division
- **Jamie Metz,** Senior Advisor
- **Alexis Morgenthaler,** Special Projects Manager – BEYOND, Safety and Integration Division
- **Kerin Olson,** Deputy Director, Research, Engineering, and Analysis Division
- **Sabrina Saunders-Hodge,** Director, Research, Engineering, and Analysis Division
- **Adrienne Vanek,** Director, International Division

***NextGen Office***

- **Paul Fontaine,** Assistant Administrator
- **Beth Burkett,** Chief of Staff
- **Karen Davis,** Program Manager, Center of Excellence for UAS, ASSURE
- **Daniel Fumosa,** Branch Manager, William J. Hughes Technical Center
- **Joe Galushka,** Emerging Operations Program Manager, Office of Science and Technology Integration, William J. Hughes Technical Center
- **Vishal Gupta,** Senior Program Analyst, William J. Hughes Technical Center
- **Anton Koros,** Technology Transfer Program Manager, Research and Development Management Division, William J. Hughes Technical Center
- **Andras Kovacs,** Acting Manager, New Entrants Division, Portfolio Management and Technology Development Office
- **John Maffei,** Director, Portfolio Management & Technology Development Office
- **Eric Neiderman,** Acting Director, William J. Hughes Technical Center
- **Paula Nouragas,** Chief Scientist and Technical Advisor, William J. Hughes Technical Center
- **William Oehlschlager,** UAS Research and Development Portfolio Branch Manager, New Entrants Division, Portfolio Management and Technology Development Office

- **Amy Patel,** Deputy Director, William J. Hughes Technical Center
- **Jim Patterson,** Manager, Airport Safety Research and Development Section, William J. Hughes Technical Center
- **Jon Schleifer,** Manager, Research and Development Management Division, William J. Hughes Technical Center
- **Lisa Smith,** Manager, Research Portfolio Management Branch, Portfolio Management and Technology Development Office

***Office of Rulemaking***

- **Thuy Cooper,** Regulatory Planning Branch Manager
- **Michelle Ferritto,** Director, Airmen and Airspace Rules Division
- **Dan Ngo,** Part 11 Petitions Branch Manager

***Other FAA Offices***

- **Micah Campbell,** Executive Director, UAS & Emerging Entrants Security, Office of Security and Hazardous Materials Safety
- **Bruce DeCleene,** Director, Senior Technical Experts Office, Air Certification Service
- **Nick DeLotell,** International Agreements, Office of International Affairs
- **Maria DiPasquantonio,** Air Certification Service
- **Karina Espinosa,** Supervisory Contract Specialist/ Contracting Officer, Emerging Technologies and UAS Branch, Eastern Acquisitions Office
- **Kristin Frantz,** Team Lead and Contracting Officer, Emerging Technologies and UAS Branch, Eastern Acquisitions Office
- **Carla Hackworth,** Division Manager, Human Factors Research Division, Civil Aerospace Medical Institute, Office of Aerospace Medicine
- **Wendy O'Connor,** Executive Director, Advanced Air Mobility Integration Office
- **Brian Verna,** Designated Federal Officer, Commercial Space Transportation Advisory Committee, Office of Commercial Space Transportation

## *FAA Partnership Programs*

**ASSURE, UAS Center of Excellence Core Participants**

- **Mark Askelson,** Associate Vice President for Research - National Security, University of North Dakota
- **Paige Brochu,** Director, Spatial Analysis Lab, University of Vermont
- **Bryan Farrell,** Lead PI and Interim Director of Raspet Flight Research Lab, Mississippi State University
- **Stephen Luxion,** ASSURE Executive Director, Mississippi State University
- **Gerardo Olivares,** Senior Research Scientist and Director, Crash Dynamics and Virtual Engineering and Flight, Wichita State University
- **Kyle Ryker,** ASSURE Director of Research, Mississippi State University
- **Andrew Shepherd,** Chief Research Officer, Sinclair Community College
- **Paul Snyder,** Assistant Chair, Director of UAS Program, University of North Dakota

- **Hannah Thach,** ASSURE Deputy Director, Mississippi State University

**BEYOND Lead Participants**

- **Riley Beaman,** UAS Program Manager, Division of Aviation, North Carolina Department of Transportation
- **James Grimsley,** Executive Director, Advanced Technology Initiatives, Choctaw Nation of Oklahoma
- **Brian Kassin,** Strategic Planning and Programming, Division of Aviation, Kansas Department of Transportation
- **Joel Murdock,** Managing Director of Strategic Projects, FedEx
- **Jason Schronce,** Deputy Director, Division of Aviation, North Carolina Department of Transportation
- **Marshall Stevens,** Vice President of Operations/Chief Operating Officer, Memphis-Shelby County Airport Authority

**UAS Test Site Participants**

- **Edward Arcuri,** Airport Commissioner, Griffiss International Airport
- **Patricia Baskinger,** Co-Owner, AX Enterprize
- **Catherine Cahill,** Director, Alaska Center for Unmanned Aircraft Systems Integration (ACUASI), CEO, Pan-Pacific UAS Test Range Complex, University of Alaska Fairbanks
- **Carlos Cardillo,** Executive Director, Corporate Partnerships, State of Nevada
- **Henry Cathey, Jr.,** Test Site Director, New Mexico University
- **MC Chruscicki,** Co-Owner, AX Enterprize
- **Tombo Jones,** Director, Virginia Tech Mid-Atlantic Aviation Partnership
- **Zevi Rubin,** Lead Pilot, Systems Engineer, AX Enterprize
- **Michael Sanders,** Executive Director, Lone Star UAS Center of Excellence & Innovation, Texas A&M University Corpus Christi
- **Brian Shoemaker,** Chief of Safety, AX Enterprize
- **Trevor Woods,** Executive Director, North Dakota Department of Commerce

## *Congress*

- **Vishal Amin,** Senior Professional Staff, Subcommittee on Space and Aeronautics, House Committee on Science Space and Technology
- **Brain Bell,** Staff Director, Subcommittee on Aviation, House Committee on Transportation and Infrastructure
- **Brent Blevins,** Staff Director, Subcommittee on Space and Aeronautics, House Committee on Science Space and Technology
- **Tom Hammond,** Senior Policy Advisor, Subcommittee on Space and Aeronautics, House Committee on Science Space and Technology
- **Kelsey McBarron,** Professional Staff and Counsel, Subcommittee on Space and Aeronautics, House Committee on Science Space and Technology

- **Will Moore,** Legislative Assistant, Subcommittee on Aviation, House Committee on Transportation & Infrastructure
- **Charlie Scales,** Policy Assistant, Subcommittee on Space and Aeronautics, House Committee on Science Space and Technology
- **Alex Simpson,** Senior Counsel, Subcommittee on Aviation Safety, Operations, and Innovation, Senate Committee on Commerce, Science, and Transportation
- **Corey Sites,** Research Assistant, Subcommittee on Aviation, House Committee on Transportation and Infrastructure
- **Gabrielle Slais,** Professional Staff Member, Subcommittee on Aviation, Safety, Operations, and Innovation, Senate Committee on Commerce, Science, and Transportation
- **Amber Willitt,** FAA Detailee, Subcommittee on Aviation, Safety, Operations, and Innovation, Senate Committee on Commerce, Science, and Transportation

## *Federal Entities*

- **Jessica Bryant-Bertail,** Senior Analyst/Analyst-in-Charge, Government Accountability Office
- **Jean Cook,** Assistant Director, Government Accountability Office
- **Marcos Gonzales Harsha,** Principal Deputy Director, Office of Technology Transitions, Department of Energy
- **Brian Gullett,** Senior Research Engineer, Center for Environmental Measurement and Modeling, Office of Research and Development, Environmental Protection Agency
- **Adam Jacoff,** Robotics Research Engineer, National Institute of Standards and Technology
- **Alexandra Jeszeck,** Senior Analyst, Government Accountability Office
- **Aaron Kaminsky,** Senior Analyst/Analyst-in-Charge, Government Accountability Office
- **Bradley Koeckeritz,** Division Chief, Uncrewed Aircraft Systems, Department of Interior
- **Parimal Kopardekar,** Mission Integration Manager for Advanced Air Mobility Mission, NASA
- **Heather Krause,** Director, Physical Infrastructure Issues, Government Accountability Office
- **Patrick Lynch,** Chief, Assessment and Monitoring Division, Office of Science and Technology, National Marine Fisheries Service, National Oceanic and Atmospheric Administration
- **Shawn McDonald,** C-UAS Program Manager, Science and Technology Directorate, Department of Homeland Security
- **Maria Mercado,** Senior Analyst/Analyst-in-Charge, Government Accountability Office
- **Anthony Militello,** Deputy Director, Department of Defense Policy Board on Federal Aviation Secretariat
- **Cheryl Quinn,** Deputy Director, Airspace Operations and Safety Program, NASA
- **David Sausville,** Assistant Director, Government Accountability Office

- **Jeffrey Silverstein,** Associate Administrator, Office of National Programs, Agricultural Research Service, Department of Agriculture
- **Alison Snyder,** Senior Analyst/Analyst-in-Charge, Government Accountability Office
- **Akbar Sultan,** Director, Airspace Operations and Safety Program, NASA
- **Susan Zimmerman,** Assistant Director, Government Accountability Office

## *Industry Stakeholders*

- **Matt Clark,** Policy and Regulatory Advisor, Commercial Drone Alliance
- **Anna Dietrich,** Senior Policy Advisor, Association for Uncrewed Vehicle Systems International
- **Nick Devereux,** Federal Affairs Lead, Wing
- **Matt Dunlevy,** Founder, Aethero and SkySkopes
- **Lisa Ellman,** Executive Director, Commercial Drone Alliance
- **David Kovar,** Chief Executive Officer, URSA, Inc.
- **Catherine Lovett,** Local Policy and Community Affairs Manager, Wing
- **Roy Peshin,** Chief Technology Officer, Simlat
- **Aaron Pierce,** Chief Executive Officer, Pierce Aerospace
- **Jenn Player,** Vice President, Aviation Regulatory Affairs, Skydio
- **Kendal Prosack,** US Lead for Local Policy and Community Affairs, Wing
- **Michael Robbins,** President & Chief Executive Officer, Association for Uncrewed Vehicle Systems International
- **Max Rosen,** Associate Vice President, Government Affairs, Association for Uncrewed Vehicle Systems International
- **Scott Shtofman,** Associate Vice President & Counsel, Regulatory Affairs, Association for Uncrewed Vehicle Systems International

## *International Standards Bodies*

- **Christine Bernat,** Associate Director, Standards Facilitation, American National Standards Institute
- **Tom Bombaert,** Technical Officer Remotely Piloted Aircraft Systems. International Civil Aviation Organization
- **Giovanni Di Antonio,** Chair, Joint Authorities for Rulemaking on Unmanned Systems
- **Philip Kenul,** Chair, ASTM International F38 Committee on UAS, ASTM
- **Mary Mikolajewski,** Manager, Technical Committee Operations, ASTM International
- **Rebecca Morrison,** Program Director, RTCA
- **Matthew Pezzella,** Senior Manager, Government and Industry Affairs, ASTM International
- **Brandon Suarez,** Special Committee 228 Co-Chair, RTCA

## *MITRE*

- **Art Branch, Jr.,** Department Manager; Strategic Integration, Advanced Transportation Operations

- **Mike Girbert,** Lead Multi-Discipline Systems Engineer
- **Michael Guterres,** Senior Principal, Aviation
- **Trever Linn,** Group Leader, Emerging Entrants
- **Greg Orrell,** Lead Systems Engineer
- **Stacie Wilcox,** Principal Systems Engineer
- **Jim Wilson,** Safety Management, Principal

## *National Civil Aviation Authorities*

- **Darryl Abelscroft,** Future Safety and Innovation, Civil Aviation Authority, United Kingdom
- **Ryan Coates,** Executive Director of RPAS Task Force, Transport Canada
- **Ed Fitzpatrick,** Emerging Policy Specialist, Civil Aviation Authority, United Kingdom
- **Scott Griffith,** Deputy Director, Emerging Technologies Programme, Civil Aviation Authority of New Zealand
- **Larissa Haas,** UAS Policy Coordinator, Strategy and Innovation Unit, Federal Office of Civil Aviation, Switzerland
- **Stuart Lindsey,** Head of Airspace Modernization, Civil Aviation Authority, United Kingdom
- **Steve Smyth,** Director, Emerging Technologies Programme, Civil Aviation Authority of New Zealand
- **Andrew Ward,** Manager of Emerging Technology, Emerging Technology and Regulatory Change Branch, Civil Aviation Safety Authority, Australia

## *Subject Matter Experts*

- **Anne Aylward,*** Former Director, Volpe National Transportation Systems Center
- **Chris Carter,** Deputy Director, Virginia Space Grant Consortium
- **John Hansman,** Chair, FAA Research, Engineering, and Development Advisory Committee
- **Michael Wolcott,** ASCENT Center Director & Technical Lead for Alternative Jet Fuels Research, Washington State University

*Academy Fellow

# Appendix C: Consolidated List of Report Findings and Recommendations

## *Chapter 4: Utilization, Impact, and Funding of Research Partnerships*

### Findings

**Finding 4.1:** Overall, FAA R&D client requests (requirements) are adequately addressed by partnerships (ASSURE, BEYOND), with the data they produce being utilized to inform the FAA's rulemaking and technology transfer processes to include inputs to the waiver and certificate of authorization functions.

**Finding 4.2:** The FAA's processes, organizational structure, and approach contribute to lengthy processes for the R&D that informs rulemaking and technology transfer.

**Finding 4.3:** Information sharing is limited, and sometimes inconsistent, from the FAA to and between partnerships.

**Finding 4.4:** There is no established formal process for continuous evaluation and identification of UAS partnership programs' research gaps and duplication.

**Finding 4.5:** The FAA UAS budget resources do not provide sufficient flexibility to address short-term high priority requirements. Thus, the FAA is often unable to address the consistent advancements in UAS technology.

**Finding 4.6:** BEYOND's lack of funding hinders the program's ability to include public institutions and industry members struggling to remain financially viable in addressing UAS R&D requirements.

**Finding 4.7:** The capacity of UAS Test Sites is limited by their lack of dedicated funding and reliance on inconsistent soft money revenue to operate.

**Finding 4.8:** The FAA's UAS and AAM research partners and partnership programs utilize multiple approaches that vary by participation and funding and are not easily compared to other federal agencies with regulatory and research functions.

### Recommendations

**Recommendation 4.1:** Assess and address FAA UAS-related organizational concerns raised by partners. Concerns include multiple layers of review, stovepipe structure, high-level approvals for new research, and the need for a clear delineation of roles and responsibilities. If organizational structure and process challenges are not currently part of planned action, develop a process and timeline for addressing them.

**Recommendation 4.2:** The FAA and UAS Integration Office (AUS) should establish a repeatable process for reviewing and updating all UAS partnership agreements (i.e., ASSURE and BEYOND) that anticipates rulemaking and other future needs, including ensuring requirements within task orders are prioritized and clearly defined.

**Recommendation 4.3:** The FAA should refine the waiver and exemption process to reduce uncertainty and improve timeliness, to include standardizing the timeline for approval or disapproval, limiting paperwork, and providing training and guidance on how to submit requests.

**Recommendation 4.4:** To help identify and address UAS process challenges on an ongoing basis, the FAA and AUS should consider expanding utilization of the lessons learned process in place under AUS's Safety and Integration Division (AUS-400) to more broadly identify UAS challenges and steps to advance UAS partnerships.

**Recommendation 4.5:** The FAA and AUS should develop a process for identifying its specific long-term, crosscutting UAS and AAM data needs, including timeframes, and conveying those needs to partners. This will increase partners' awareness of the FAA's long-term UAS and AAM strategies, goals, and requirements for research data, enabling them to align with FAA plans and appropriately resource their efforts in support of FAA data needs.

**Recommendation 4.6:** The FAA UAS partnership agreements should include provisions to require or encourage FAA partnership program participants to share their R&D data with other partnership programs, when contractually feasible, to fully inform the FAA's tasking and facilitate partners' ability to focus on specific data requirements and gaps. To enable this, the following are needed: provisions to eliminate the barriers to sharing that exist today; contractual language that requires and authorizes sharing; and agreements between partners that facilitate sharing and address responsibilities and liabilities on the part of the partners. Agreements should detail how the FAA intends to use the data to inform certification, rules, standards processes, and other regulatory activities.

**Recommendation 4.7:** The FAA should ensure that project managers for UAS partnership research projects are knowledgeable of ongoing FAA UAS research programs and outcomes and have the means to engage with other research partnership program managers to enable them to provide appropriate direction and coordination to their assigned research projects.

**Recommendation 4.8:** The FAA should more broadly leverage the data sharing already occurring among organizations contributing to the UAS standards and rules, when and if appropriate, to inform all R&D being conducted by UAS partnerships.

**Recommendation 4.9:** The FAA should utilize data on waivers and exemptions submitted for approval. The specific technologies identified for development in these waiver and exemption requests would provide the FAA with a wealth of information on what industry is working on. This data is currently considered, but not in a structured, intentional way. The FAA should develop a process to organize and analyze this data for subsequent use.

**Recommendation 4.10:** The leaders of the UAS Integration Office, in coordination with the AAM Integration Office, should develop a UAS research roadmap that clearly identifies what research areas AUS, and the FAA overall, plan to focus on over the next three years to direct research and development and identify research gaps and duplication.

**Recommendation 4.11:** The FAA (AUS and Financial Services Office) should assess the need for an agile funding type that enables it to respond to current technological advancements, rather than committing funds to projects that may take three years to finish and be technologically outdated when complete.

**Recommendation 4.12:** The FAA should request from Congress appropriate baseline funding for the BEYOND program to support the cost of ensuring participation of public entities and their consortia.

**Recommendation 4.13:** The FAA should request appropriations for baseline funding to support the UAS Test Sites.

## *Chapter 5: Effective Strategies for the FAA's Dissemination of Partnership Research Outcomes*

### Findings

**Finding 5.1:** Information dissemination to public, commercial, and research communities via technical products is an important component of the FAA's T2 Program. The FAA disseminates a broad range of products including published papers, technical reports, and conference presentations. Still, the agency lacks a formal written strategy for dissemination and information sharing, sharing of data, and research outcomes with its informal network partners.

**Finding 5.2:** International partners, including foreign CAAs, share data with the FAA mainly through bilateral agreements and task groups of international institutions, such as the Joint Authorities for Rulemaking on Unmanned Systems and International Civil Aviation Organization. Several foreign CAAs expressed an interest in deepening the cooperation with the FAA to include conducting joint research in areas of mutual interest to spread the cost of research and development.

**Finding 5.3:** The FAA has made strides in integrating the R&D strategies of its lines of business offices. As identified in chapter 4, there are opportunities for the FAA to improve information sharing with partners and between FAA internal components themselves. More collaboration on data sharing would also provide additional opportunities to enhance aspects of the FAA's continuous improvement process for technology transfer, such as the output and outcome measures in use.

**Finding 5.4:** The FAA's T2 program utilizes both traditional technology transfer mechanisms such as CRADAs and patent licenses as well as broader information dissemination mechanisms to share research results. Reflecting the FAA's safety-centric mission and focus on applied research to inform its regulatory activities, there are few licensing opportunities as the FAA does not have a large portfolio of technologies for commercialization (four in total). While WJHTC maintains a portfolio of over forty CRADAs, only three relate to AAM and one to UAS.

**Finding 5.5:** The FAA does not participate in Volpe's SBIR program. Examination of other federal agencies' technology transfer programs suggests that alternative funding or support mechanisms for small businesses, such as state and federally funded small business vouchers could attract more private users to the test sites.

**Recommendations**

**Recommendation 5.1:** The FAA should document the existing ends, ways, and means of information- and data-sharing methods from the FAA to its formal partnerships, informal network, and the broader public.

**Recommendation 5.2:** The FAA should explore opportunities to deepen the level of cooperation with select foreign civil aviation authorities that share similar R&D priorities.

**Recommendation 5.3:** The FAA should explore opportunities to support technology transfer with small businesses such as the small business voucher program, model or partner with other agencies' SBIR/STTR programs, and collaborate with state and local organizations to increase private sector participation.

## *Chapter 6: Broadening UAS and AAM STEM Education and Outreach*

**Findings**

**Finding 6.1:** The FAA's UAS STEM outreach primary focus on the long-term strategy of reaching K-12 students will not have a large enough impact quickly enough to fill current and growing UAS workforce gaps.

**Finding 6.2:** The FAA's approach of frequently relying on its partners to take the lead in designing curricula and programs for STEM education outreach has enabled the agency to reach tens of thousands of educators and students; however, the FAA's lack of centralized direction on setting goals, objectives, and performance metrics means that the programs might not be supporting the FAA's workforce development goals to the fullest extent possible.

**Finding 6.3**: Additional STEM education outreach funding from a broader variety of sources would enable continuity of effort when federal funds are delayed or cut.

**Recommendations**

**Recommendation 6.1:** Prioritize increasing STEM outreach and education to audiences other than K-12 students, including educators, college students, and expanding efforts to include reskilling and upskilling adults already in the workforce.

**Recommendation 6.2:** Collaborate with research partnerships to create a standardized UAS STEM program, including goals and performance metrics, and with other FAA programs and federal agencies to avoid duplication and share best practices and lessons learned.

**Recommendation 6.3:** Continuously evaluate the effectiveness of prior UAS STEM outreach initiatives to identify gaps and integrate lessons learned into future planning.

**Recommendation 6.4:** The partnership programs should continue to leverage nonfederal funding sources for UAS and AAM STEM outreach through engagements with state and local governments, private philanthropic foundations, and industry.

# Appendix D: Bibliography

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