# United States Department of Transportation
# Annual Modal Research Plans FY 2023
# Program Outlook FY 2024

## Cover Page

### Federal Aviation Administration

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# Executive Summary

The Annual Modal Research Plan (AMRP) outlines planned research for fiscal year 2023 (FY 2023) and the outlook for fiscal year 2024 (FY 2024). All Department of Transportation (DOT) operating administrations, or modes, must submit this plan annually to the Assistant Secretary of Research and Technology for review and approval, as statutorily mandated.

The FAA uses Research and Development (R&D) to support policymaking and planning, regulation, certification, standards development, and national airspace system (NAS) modernization to fulfill its mission to provide the safest and most efficient aerospace system in the world. The FAA R&D portfolio supports the day-to-day operations of the NAS and balances near-term, mid-term, and far-term aviation research needs. The FAA has defined a research-planning framework to help align and plan its R&D portfolio to support this mission accordingly.

The FAA's System Planning and Resource Management (SPRM) Program leads portfolio planning, formulation, presentation, and review activities. The SPRM ensures that the FAA meets the President's criteria for R&D, aligns to agency and departmental strategic goals, and enables effective program review by the Research Engineering Development Advisory Committee (REDAC) and the Office of Research and Technology within the Secretary of Transportation's Office. In March of 2021, the FAA analyzed and realigned its research portfolio to correspond to the DOT's strategic goals of Safety, Economic Strength and Global Competitiveness, Equity, Climate and Sustainability, Transformation, and Organizational Excellence. The FAA continues to use this framework to ensure strategic goal alignment and maximize the safety, mobility, and efficiency of the U.S. transportation system.

## Critical R&D Programs

The FAA's R&D portfolio is critical and relevant to industry and the flying public. This section highlights a few examples of the important research conducted within the FAA's R&D portfolio.

**Aeromedical Research Program**

The Aeromedical Research Program is leading a safety risk assessment on communicable disease transmission onboard passenger aircraft. Researchers at the FAA's Civil Aerospace Medical Institute in Oklahoma City, OK will develop a modeling, simulation, and analysis framework that will allow researchers to estimate the transmission risk for respiratory diseases of potential public health significance, such as COVID-19, within transport aircraft cabins. Researchers will identify risk mitigation solutions, evaluate the associated supporting scientific data, and implement solutions in the modeling and simulation environment to evaluate the effect on disease transmission risk. The FAA will use knowledge gained from these research activities to create a cabin health safety response plan with an associated analytic tool kit.
This program is also investigating cabin air contaminants that may be linked to engine oil leaks or other fluids being ingested into the engine, drawn into the air supply, and distributed throughout the cabin and flight deck. This research will identify and measure contaminant levels in U.S. commercial aircraft cabins, assess potential health effects on passengers and flight crew, and create a more objective means for detecting contaminants, as required by the FAA Reauthorization Act of 2018, section 326.

**Weather Program**

The Weather Program is investigating several critical concepts to ensure the continued safety expected of U.S. aviation. For example, the Weather Program is working on a project to develop inflight icing diagnosis forecasts to combat the serious safety concerns that icing presents to aviation. There is a need for inflight icing information related to certification envelopes beyond historical information, which focuses only on the potential and general intensity of aircraft icing. This research will help transition current inflight icing diagnosis and forecast products into accurate and meaningful environmental characterizations based on aircraft certification levels.

The Weather Program is also executing research that aims to provide better turbulence information to commercial and general aviation aircraft. Aircraft frequently experience unexpected atmospheric turbulence and, although these incidents are rarely fatal, these encounters often result in flight reroutes and occasionally cause serious injuries to aircraft occupants. Turbulence is the second leading cause of disruptions to National Airspace System operations after thunderstorms, as airline pilots and dispatchers try to avoid routing aircraft through the unstable air. Processing turbulence information and forecasting operational impacts, as well as accurately translating this complex weather information into a user-friendly format is of critical importance to pilots, controllers, dispatchers, and aviation meteorologists, and their operational decision making.

Similarly, weather prediction models are the basis for nearly all aviation weather hazard forecasts, including turbulence, inflight icing, thunderstorms, low clouds, and visibility. Although the FAA uses National Weather Service (NWS) models for many of these needs, the FAA sponsors additional research and development of NWS weather prediction models to address aviation-specific requirements. The NWS is in the process of simplifying its complex suite of operational weather prediction models into a Unified Forecast System spanning local and global domains, and predictive time scales from sub-hourly analyses to seasonal predictions.

**Airport Technology Research Program**

The Airport Technology Research Program (ATRP) conducts the necessary research and development required to enhance the safety of operations at our nation's airports and to ensure the adequacy of engineering specifications and standards in all areas of the airport systems and, where necessary, develop data to support new standards.

An example of this important work is found in the agency's research on Aqueous Film Forming Foams (AFFF). Some of the chemicals used in AFFF such as fluorinated surfactants are among a class of manufactured chemicals known as perfluoroalkyl and polyfluoroalkyl substances (PFAS), which may be of concern for the environment and human health. This research supports the FAA Reauthorization Act of 2018, section 332, by seeking to identify PFAS-free alternatives that meet the same safety standards as AFFF. Related research will look at ways to improve firefighting techniques following a crash.

**Alternative Fuels for General Aviation Program**

This Alternative Fuels for General Aviation (GA) Program is looking at sustainable and renewable fuels, as well as other fuels and technologies, to reduce emissions and greenhouse gases. Currently aviation gas (AvGas), used by the roughly 170,000 current piston-engine GA aircraft, is the only remaining transportation fuel that contains lead. The lead additive in avgas creates the very high octane levels required to prevent detonation (engine knock) in high-power aircraft engines. Operating an aircraft with inadequate fuel octane can result in engine failure and aircraft accidents.

Due to a variety of environmental, regulatory, and market forces in the U.S. and worldwide, leaded avgas will be eliminated in the future. Finding a more climate and emission friendly solution is critical because the general aviation sector represents 1.2 million jobs directly or indirectly and contributes over $247 billion to the U.S. economy. This includes a $75 billion positive effect on the balance of trade (2020, General Aviation Manufacturers Association). The Alternative Fuels for GA Program will provide the critical data necessary for the FAA Administrator to authorize an unleaded replacement fuel in accordance with Section 565 of the 2018 Reauthorization Act, and to support the safe transition of the GA fleet to an unleaded aviation gasoline.

**NextGen Environmental Research – Aircraft Technologies and Fuels Program**

Through the Continuous Lower Energy, Emissions, and Noise (CLEEN) program, the FAA is working with industry to develop certifiable aircraft and engine technologies that increase fuel efficiency, while reducing noise, emissions, and aircraft operating costs. CLEEN is a cost-share partnership with aviation manufacturers that helps accelerate environmentally beneficial technologies.

The goal of CLEEN is to achieve environmental protection that enables sustained aviation growth. The program is implemented in five-year phases, each with specific improvement goals. In Phase III of the program, which began in 2021, research is focusing on reducing certification noise levels, community noise, nitrous oxide, and particulate matter emissions, as well as fuel burn for subsonic and supersonic aircraft. Researchers in the CLEEN program are also working with the Commercial Aviation Alternative Fuels Initiative and the Center of Excellence for Alternative Jet Fuels and Environment (ASCENT) to obtain critical information on sustainable aviation fuels to ensure they are safe for use. ASCENT researchers are working closely with the FAA to ensure these fuels are being adequately credited under international emissions standards.

Research in this program also supports the potential reintroduction of supersonic aircraft. Flying faster than the speed of sound, these aircraft may one day allow passengers to spend more time at their destination and less time traveling there. This research is critical to accelerating the reintroduction of these high-speed aircraft into the nation's fleet. Work in this program examines the impacts of supersonic aircraft on environmental factors, such as landing and takeoff noise, emissions, fuel burn, and sonic booms. The FAA will use the research results to develop policies and international standards, and support analytical methods development for noise mitigation technologies as directed by Congress in the FAA Reauthorization Act of 2018, section 181.

**Information Technology/Cybersecurity Program**

The FAA manages air traffic control operations through a complex network of computer and information systems. A cyber-attack could have devastating consequences on aviation operations and safety. The primary purpose of the Cybersecurity Data Science Program is to identify effective and innovative ways to apply artificial intelligence (AI), Machine Learning (ML), and data science technologies to enhance cybersecurity for aircraft, airlines, and airports. Researchers will work directly with the aviation industry to explore common cybersecurity concerns. This multi-year collaborative effort will better enable industry to utilize lessons learned from this research to strengthen their own cybersecurity, both individually and collectively, making the broader aviation ecosystem more resilient and safer for the flying public.

## Collaboration Efforts

In pursuit of our mission, the FAA maintains partnerships with over 300 stakeholders representing federal agencies, academia, industry, international entities, and technical organizations. Our partners include aircraft and parts manufacturers, design and engineering companies, external testing facilities, domestic and international organizations, and representatives of large and small businesses. Together these relationships support the DOT strategic mission goals promoting safety, infrastructure, innovation, and accountability. Our partnerships include the following groups, associations, and agencies.

| Category | Partnership Examples |
|---|---|
| Federal Agency / State / City | Department of Energy, Environmental Protection Agency, MIT Lincoln Labs, NASA Armstrong Flight Research Center, NASA Ames, NASA Glenn, NASA Johnson, NASA Langley, Port of Seattle, Smithsonian Institution, Transportation Security Administration Federal Air Marshal Service, U.S. Air Force Research Laboratory, U.S. Army, U.S. Marshals Service, U.S. Navy, U.S. Coast Guard, Department of Agriculture Forest Service, and Volpe. |
| Academia | Clarkson University, Rowan University, George Mason University, Rutgers University, Florida International University, University of California San Diego, University of Utah, University of Washington, Washington State University, Wichita State University, Massachusetts Institute of Technology, Stanford University, University of Colorado Boulder, University of Texas, Embry-Riddle Aeronautical University, Mississippi State University, Ohio State University, University of Alabama |

| | |
|---|---|
| | Huntsville, Purdue University, Pennsylvania State University, University of Dayton, and New Mexico State University. |
| Industry | Aircraft Owners and Pilots Association, Alaska Airlines, American Airlines, Boeing, Bombardier, Cirrus Aircraft, Delta Airlines, Embraer, FedEx, Garmin, General Electric, Harris, Honeywell, JetBlue, MOBIL, National Institute of Aerospace, NetJets, Raytheon, Rockwell, Society of Automotive Engineers, Southwest, Spirit, United, and UPS. |
| International | BlindSquare, CMC International, European Organization for the Safety of Air Navigation, International Civil Aviation Organization, Japan Civil Aviation Bureau, Single European Sky Air Traffic Management Research Joint Undertaking, Team Eagle, Thales, Transport Canada, and Warsaw Institute of Aviation. |
| Other | Aerospace Vehicle Systems Institute, American Helicopter Society, American Petroleum Institute, American Society of Mechanical Engineers, Battelle Memorial Institute, Flight Attendants Medical Research Institute, MITRE, National Air Transportation Association, National Business Aviation Association, National Fire Protection Association, National Institute for Aviation Research, National Institute of Aerospace and National Safety Council. |

**Research, Engineering, & Development Advisory Committee (REDAC)**

The REDAC is an important contributor in the FAA's R&D portfolio development process. The REDAC provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of the aviation research program.
REDAC members include aerospace professionals from industry, Federally Funded Research and Development Centers, and academia who are best positioned to identify aviation drivers, issues, requirements, and influencing technologies; and understand the level of research investment the aerospace industry is making or willing to make.

## Technology Transfer (T2)/Deployment Activities

The FAA is committed to building upon the already successful Technology Transfer (T2) program, which promotes the dissemination of federally-funded research and innovations to the commercial marketplace and American public. The agency achieves this by facilitating the exchange of the FAA's knowledge, facilities, and capabilities with industry, academia, and other federal partners. The program fulfills three primary roles:

- Promoting and enabling government-industry collaboration
- Managing intellectual property
- Sharing technical advances resulting from FAA research and development efforts.

The agency recognizes the importance of a robust T2 program to the FAA's mission as a federal laboratory and is motivated to expand the program. The program successfully manages CRADAs, intellectual property, and royalties.

The FAA will continue to implement policies reflecting standard operating procedures and add alternative technology transfer contract vehicles. The agency will expand workforce recognition for technology transfer accomplishments and increase engagement with the federal technology transfer community to identify and leverage lessons learned.

The Technology Transfer program office, with the assistance of the FAA's senior patent attorney, secures patents and manages both licenses and royalties. The agency encourages its workforce to patent new inventions and disclose new technology to the world. By utilizing the available FAA legal resources, the

workforce can gain valuable knowledge of, and assistance with, the patent filing process, understand his/her rights as an inventor and patent holder, learn the filing steps, and understand the benefits of a granted "exclusionary right" over a patented invention for a limited time.

Inventions patented by FAA inventors are also available for commercial licensing and can result in royalty revenue shared with the inventor and the agency. The FAA currently maintains a small number of active income-generating license agreements.

The FAA contributes to technical advancement through technical notes and reports, advisory circulars, regulatory guidance, technical findings, participation on technical society panels, membership in international advisory organizations, and several other forums. A key function of the program is tracking the significant near- and far-term advances accomplished through FAA research and development activities.

## Anticipated Outcomes

Detecting unauthorized UAS, or drone, activity at the nation's airports and removing that threat ensures the safety and security of the flying public. Research will identify regulations and standards necessary for the safe use of counter-UAS technologies that do not adversely affect or interfere with safe airport operations, air navigation, air traffic services, or the safe and efficient operation of the NAS — as directed by Congress in the FAA Reauthorization Act of 2018, section 383. The FAA will test drone detection and mitigation systems at five airports as part of this research and will develop a plan to certify and authorize deployment of counter-UAS technologies in the airport environment.

Additional research in Unmanned Aircraft Systems area will explore the real-time capabilities and versatile functions of drones and their ability to deploy rapidly. The ability to rapidly deploy makes drones a powerful tool that may be used during emergencies and for disaster preparedness and response – where they can improve these operations and help save lives. This effort will help by creating standards and requirements for operational procedures, training, and certification, while also identifying barriers to wide spread implementation and recommendations to overcome these barriers. This includes facilitating the coordination between local, state, and federal government agencies, as well as airports, to ensure proper coordination during emergencies. The FAA has been directed by Congress in the Omnibus Budgets of 2018 and 2019 to emphasize studying UAS use by fire departments and emergency management agencies.

As Commercial Space Transportation continues to evolve, the FAA has an obligation to understand how it will impact both the general population and the flying public. For example, the FAA is licensing new commercial space launch vehicles using a combination of liquid-oxygen and liquid-methane rocket propellant. An accident involving a large launch vehicle full of such propellant at or near a launch site could create a powerful explosion resulting in a public safety hazard. Explosions like this can break windows a significant distance away from a launch site during certain weather conditions.
The strength of the explosion, or explosive yield, is driven by several factors, such as total propellant mass in a given propellant combination of liquid oxygen-liquid methane. The only significant test database exists for Rocket Propellant-1 (a form of kerosene) and liquid hydrogen, both of which have been used for decades. Currently, almost no relevant test data exists to support modeling the strength of liquid oxygen-liquid methane explosions. This research will accomplish the dynamic testing of liquid oxygen-liquid methane (LOX/LCH4) with varying propellant mass and pressurization conditions resulting in an improved explosive yield curve for LOX/LCH4.

Airline pilots are trained using high fidelity, Level D full-flight simulators. Although these devices offer a realistic flight experience, they typically do not provide true-to-life air traffic control (ATC) interactions. Simulated ATC technologies are under development that use voice recognition, voice synthesis, and artificial intelligence to create realistic communications during simulator training.

While simulated ATC would offer an improvement over current training approaches, there is no method for certifying these new tools for pilot training. FAA researchers will evaluate these prototype systems to determine their effectiveness and identify their strengths and limitations. Using the findings of this research, the FAA can develop a path of certification for simulated ATC systems, improving the pilot training experience and possibly reducing the rate of accidents and incidents related to pilot-controller miscommunication.

## Evaluation/Performance Measurement Efforts

The FAA's Research and Development Management Division collects, analyzes, tracks, and measures FAA-conducted research performance in multiple ways. The FAA actively tracks ongoing and completed products (technical presentations, conference papers, publications, etc.), National Aviation Research Plan (NARP) outputs, and technology transfer activities. These products and activities are tracked and measured through various reporting mechanisms including the NARP, Annual Review (AR), and the Technology Transfer Annual Congressional Report.

The NARP presents a subset of critical research areas spread across more than 30 independent programs, while the Annual Review reports on the significant research accomplishments completed in a given year, and provides status on outputs previously identified in the NARP. The Technology Transfer (T2) Congressional Report provides T2 performance metrics including the number and status of CRADAs, invention disclosures, patent submittals, license agreements, COE grant awards, and associated funding.

## Reorganization

For FY 2023, the FAA's budget request of $18.6 billion represents an increase of 3.3 percent from the FY 2022 Continuing Resolution (CR) level. When combined with the $5 billion in advanced annual appropriations under the Bipartisan Infrastructure Law, the total FY 2023 funding for FAA is $23.6 billion. This funding level allows the FAA to make continued investments to safeguard the most complex airspace in the world while transforming our aviation infrastructure. The budget requests $1.0 billion to continue the operationalization of NextGen technologies, allowing the FAA to deliver the benefits of these innovations to the users of the nation's airspace. This proposal includes a more focused Research and Development organization to look ahead to the future, an Integration and Engagement Office to facilitate more rapid adoption of aviation industry innovation, and a Chief Technology Officer to drive the continued modernization of the airspace system. Brought together, these organizational elements will position the FAA to meet the challenges of tomorrow.

# FY 2023 RD&T Program Funding Details

| RD&T Program Name | FY 2023 President's Budget Request* ($000) | Applied ($000) | Technology Transfer ($000) | Facilities ($000) | Experimental Development ($000) | Major Equipment, R&D Equipment ($000) |
|---|---|---|---|---|---|---|
| Fire Research and Safety | 7,367 | 7,367 | | | | |
| Propulsion and Fuel Systems | 5,471 | 5,471 | | | | |
| Advanced Materials /Structural Safety | 2,886 | 2,886 | | | | |
| Aircraft Icing | 3,353 | 3,353 | | | | |
| Digital System Safety | 5,287 | 5,287 | | | | |
| Continued Air Worthiness | 12,430 | 12,430 | | | | |
| Flight Deck/Maintenance/System Integration Human Factors | 15,292 | 15,292 | | | | |
| System Safety Management/Terminal Area Safety | 10,111 | 10,111 | | | | |
| Air Traffic Control/Technical Operations Human Factors | 5,911 | 5,911 | | | | |
| Aeromedical Research | 10,000 | 10,000 | | | | |
| Weather Program | 16,178 | 16,178 | | | | |
| Unmanned Aircraft Systems | 14,935 | 14,935 | | | | |
| Alternative Fuels for General Aviation | 12,385 | 12,385 | | | | |
| Emerging Technology Accelerator (ETA) | 10,000 | 10,000 | | | | |
| Commercial Space Transportation Safety | 5,708 | 5,708 | | | | |
| Wake Turbulence | 3,728 | 3,728 | | | | |
| NextGen - Weather Technology in the Cockpit | 3,028 | 3,028 | | | | |
| Information/Cyber Security | 5,500 | 5,500 | | | | |
| Environment & Energy | 21,163 | 21,163 | | | | |
| NextGen – Environmental Research – Aircraft Technologies and Fuels | 73,976 | 73,976 | | | | |
| System Planning and Resource Management | 4,141 | 4,141 | | | | |
| Aviation Workforce Development - Section 625 | 6,169 | 6,169 | | | | |
| William J. Hughes Technical Center Laboratory Facilities | 5,481 | 5,481 | | | | |
| Advanced Technology Development & Prototyping | 25,300 | 25,300 | | | | |

| RD&T Program Name | FY 2023 President's Budget Request* ($000) | Applied ($000) | Technology Transfer ($000) | Facilities ($000) | Experimental Development ($000) | Major Equipment, R&D Equipment ($000) |
|---|---|---|---|---|---|---|
| William J. Hughes Technical Center Laboratory Sustainment | 16,900 | 16,900 | | | | |
| William J. Hughes Technical Center Infrastructure Sustainment | 15,000 | | | 15,000 | | |
| NextGen - Separation Management Portfolio | 18,000 | 18,000 | | | | |
| NextGen - Traffic Flow Management Portfolio | 21,000 | | | | 21,000 | |
| NextGen - On Demand NAS Portfolio | 8,500 | | | 8,500 | | |
| NextGen - NAS Support Portfolio | 5,000 | | | 5,000 | | |
| NextGen - NAS Infrastructure Portfolio | 25,500 | | | | 25,500 | |
| NextGen Unmanned Aircraft Systems | 15,000 | | | | 15,000 | |
| NextGen Enterprise, Concept Development, Human Factors, & Demonstrations | 11,000 | | | | 11,000 | |
| Center for Advanced Aviation System Development (CAASD) | 57,000 | | | | 57,000 | |
| Airport Technology Research Program | 40,828 | | | | 40,828 | |
| Airport Cooperative Research Program | 15,000 | | | | 15,000 | |
| Administrative | 17,154 | | | | 17,154 | |
| **Totals** | **551,682** | **320,700** | | **28,500** | **202,482** | |

**The AMRP reflects funding as found in the FY 2023 President's budget request per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning. The FY 2023 enacted numbers will be posted as part of the FY2024 President's budget request.**

# FY 2023 RD&T Program Budget Request by DOT Strategic Goal

| RD&T Program Name | FY 2023 President's Budget Request* ($000) | Safety ($000) | Economic Strength and Economic Competitiveness ($000) | Equity ($000) | Climate and Sustainability ($000) | Transformation ($000) | Organizational Excellence ($000) |
|---|---|---|---|---|---|---|---|
| Fire Research and Safety | 7,367 | 7,367 | | | | | |
| Propulsion and Fuel Systems | 5,471 | | | | 5,471 | | |
| Advanced Materials /Structural Safety | 2,886 | 2,886 | | | | | |
| Aircraft Icing | 3,353 | 3,353 | | | | | |
| Digital System Safety | 5,287 | | | | | 5,287 | |
| Continued Air Worthiness | 12,430 | 12,430 | | | | | |
| Flight Deck/Maintenance/System Integration Human Factors | 15,292 | 15,292 | | | | | |
| System Safety Management/Terminal Area Safety | 10,111 | 10,111 | | | | | |
| Air Traffic Control/Technical Operations Human Factors | 5,911 | 5,911 | | | | | |
| Aeromedical Research | 10,000 | 10,000 | | | | | |
| Weather Program | 16,178 | 16,178 | | | | | |
| Unmanned Aircraft Systems Research | 14,935 | 14,935 | | | | | |
| Alternative Fuels for General Aviation | 12,385 | | | | 12,385 | | |
| Emerging Technology Accelerator (ETA) | 10,000 | | 10,000 | | | | |
| Commercial Space Transportation Safety | 5,708 | | 5,708 | | | | |
| Wake Turbulence | 3,728 | 3,728 | | | | | |
| NextGen - Weather Technology in the Cockpit | 3,028 | 3,028 | | | | | |
| Information/Cyber Security | 5,500 | | | | | 5,500 | |
| Environment & Energy | 21,163 | | | | 21,163 | | |
| NextGen – Environmental Research – Aircraft Technologies and Fuels | 73,976 | | | | 73,976 | | |
| System Planning and Resource Management | 4,141 | | | | | | 4,141 |
| Aviation Workforce Development - Section 625 | 6,169 | | | 6,169 | | | |
| William J. Hughes Technical Center Laboratory Facilities | 5,481 | | | | | | 5,481 |

| RD&T Program Name | FY 2023 President's Budget Request* ($000) | Safety ($000) | Economic Strength and Economic Competitiveness ($000) | Equity ($000) | Climate and Sustainability ($000) | Transformation ($000) | Organizational Excellence ($000) |
|---|---|---|---|---|---|---|---|
| Advanced Technology Development & Prototyping | 25,300 | | | | | 25,300 | |
| William J. Hughes Technical Center Laboratory Sustainment | 16,900 | | | | | 16,900 | |
| William J. Hughes Technical Center Infrastructure Sustainment | 15,000 | | | | | 15,000 | |
| NextGen - Separation Management Portfolio | 18,000 | | | | | 18,000 | |
| NextGen - Traffic Flow Management Portfolio | 21,000 | | | | | 21,000 | |
| NextGen - On Demand NAS Portfolio | 8,500 | | | | | 8,500 | |
| NextGen - Support Portfolio | 5,000 | | | | | 5,000 | |
| NextGen - NAS Infrastructure Portfolio | 25,500 | | | | | 25,500 | |
| NextGen - Unmanned Aircraft Systems | 15,000 | | | | | 15,000 | |
| NextGen Enterprise, Concept Development, Human Factors, & Demonstrations | 11,000 | | | | | 11,000 | |
| Center for Advanced Aviation System Development (CAASD) | 57,000 | | 57,000 | | | | |
| Airport Technology Research Program | 40,828 | 12,525 | 8,825 | 3,600 | 7,250 | 8,628 | |
| Airport Cooperative Research Program | 15,000 | 6,000 | 1,500 | 750 | 750 | 6,000 | |
| Administrative | 17,154 | | | | | 17,154 | |
| **Totals** | **551,682** | **123,744** | **83,033** | **10,519** | **120,995** | **203,769** | **9,622** |

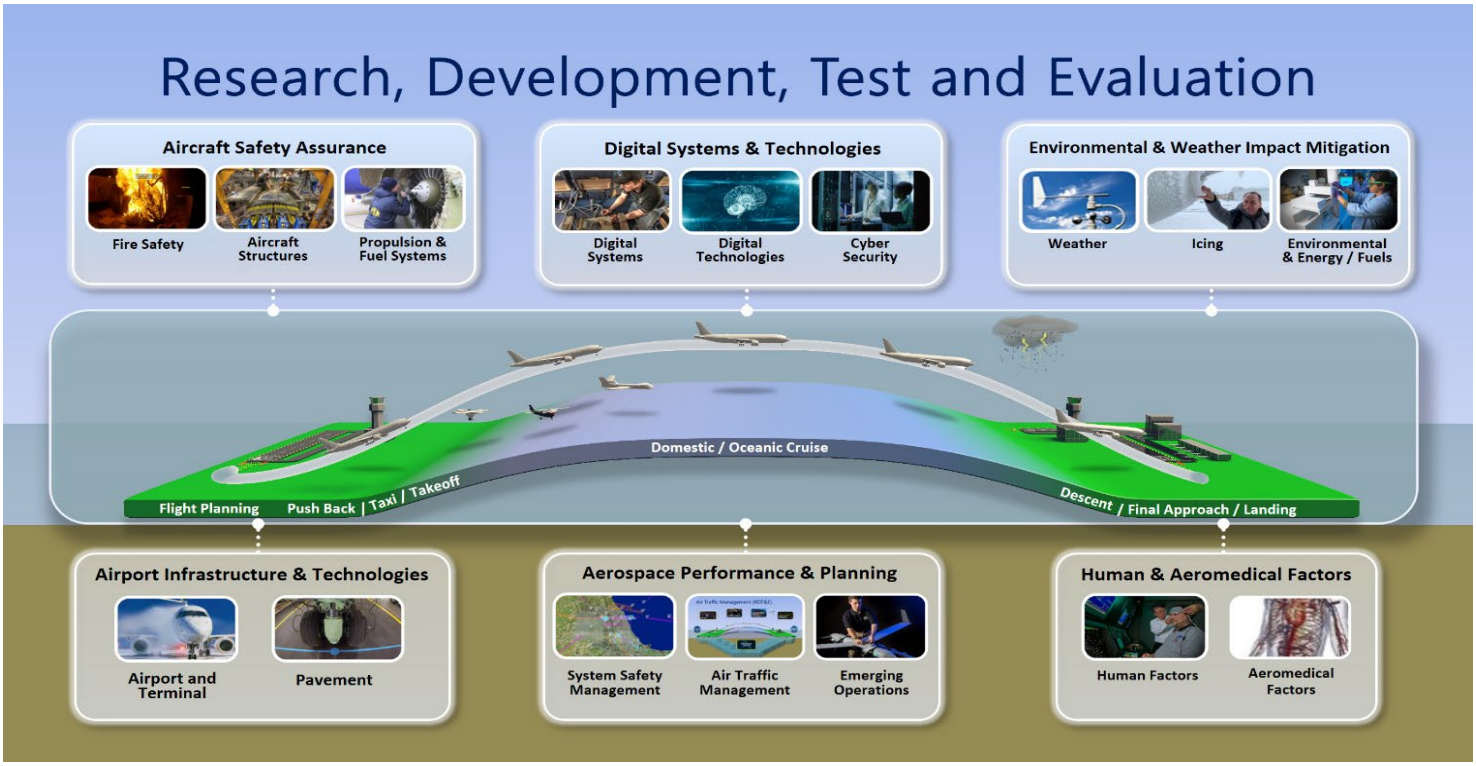
**The AMRP reflects funding as found in the FY 2023 President's budget request per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning. The FY 2023 enacted numbers will be posted as part of the FY2024 President's budget request.**

# Chapter 1 – FY 2023 RD&T Programs

# FAA RD&T Domains

FAA R&D goals address aviation and space research needs including air and space vehicles, airports and airport systems, spaceports, human operators, air traffic systems, air traffic information, and the customers they serve — the flying public. The goals span multiple research domains, a grouping of programs with a common focus area or body of knowledge. The research domains are:

- Airport Infrastructure and Technologies
- Aircraft Safety Assurance
- Digital Systems and Technologies
- Environmental and Weather Impact Mitigation
- Human and Aeromedical Factors
- Aerospace Performance and Planning



# Airport Infrastructure and Technologies

# United States Department of Transportation
# FY 2023 Annual Modal Research Plans

## Airports Cooperative Research Program
**Requested: ($15,000,000)**

**Program Description:**

The Airport Cooperative Research Program (ACRP) is designed to address needs that are not being addressed by other Federal research programs, and that cannot be undertaken cost-effectively by individual airports.

The ACRP is an industry-driven research program managed by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine. It was authorized by section 712 of Vision 100 – Century of Aviation Reauthorization Act. The Secretary of Transportation maintains a memorandum of agreement among DOT, FAA, and the National Academy of Sciences to implement the ACRP. The Secretary also appoints the 13 members of the ACRP Oversight Committee (AOC).

The ACRP is a national resource for the airport industry, providing valuable information, guidance and practical tools to airport owners and operators (as well as consultants and contractors) by performing industry-driven research identified as critical by airport operators, industry, and users.

ACRP advances safety, economic strength and competitiveness, equity, climate and sustainability, and transformation by providing applied research products to the airport industry that address these issues. Research continues in the use of sustainable airport operations and construction, carbon reduction/carbon capture, diversity/equity/inclusion in both airport staff and airport contracts, improved governance and transparency, and ensuring data privacy and cyber security of airport operations.

**Major Program Objectives:**

The ACRP's mission is to develop near-term, practical solutions to problems faced by airport operators. The ACRP uses contractors selected in a competitive process to conduct the research, which is overseen by industry experts and designated FAA subject matter experts (SMEs). The results of the research are published in the form of handbooks and best practices. To date, the vast library of publications includes areas of safety, airport management, airport financing, airport environmental quality, airport compliance, and airport planning. These publications are available to the public on the ACRP website and for purchase in hard copy.

The ACRP's main goal is to provide resources to support applied research on a wide variety of issues faced by airport practitioners, including all levels of professional staff within the airport community, from CEOs, airport managers, executive directors, to mid-level managers, nonsupervisory technical and professional staff, trainees, students, and interns. These professionals represent airports, suppliers, public safety agencies, airlines, airport tenants, local and regional government authorities, industry associations, and many other stakeholders in the airport community. Each of these practitioners has different interests and responsibilities, and each is an integral part of this cooperative research effort. Although the exact projects selected for research are chosen by an industry-led oversight committee, the committee endeavors to address topics that advance the policy objectives of the Department of Transportation. In addition, the National Academies of Science ensure that research conducted is done in a way that addresses the Department's goals and ensures that research is conducted in a transparent, objective, and academically sound manner.

**Anticipated Program Activities:**

- AOC will be selecting research projects for FY 2023 during the summer meeting this year. These projects will be focused on the research needs of the airports and aviation communities that are not addressed by the Federal research efforts.
- ACRP intends to conduct several "Insight Events" which are webinars and presentations that bring together thought leaders on specific topics to address industry issues, concerns, and opportunities. This year's events include events on Advanced Air Mobility and improving airport finance.

**Potential Program Outputs, Value Statement and Impacts:**

ACRP research results in a body of knowledge that is available to the public at no charge. Most research projects result in a report, synthesis, or legal digest that can be used to inform airport decision making on topics including airport operations, administration, planning, safety/security, design, finance, energy, and economics. Since program inception, 251 reports have been published and ACRP publications have been downloaded over one million times. 90% of airports believe that ACRP is valuable to the industry and conducts research that airports do not have the ability to conduct on their own.

ACRP research products are immensely valuable to the modification and modernization of regulations applicable to airports. While ACRP funded research does not directly result in regulations, the results of research are used by FAA staff to inform revisions to advisory circulars that provide the best means of compliance for airports. These regulations include those governing airport emergency services, emergency planning, and emergency response; compliance with equity programs such as Disadvantaged Business Enterprise and equality of access requirements; ensuring safe and sustainable airport infrastructure maintenance; and airport compliance with myriad of environmental regulations, policy, and best practices. ACRP products also form a useful adjunct to regulations, providing best industry practice where regulation is not appropriate.

**Potential Economic or Societal Impacts:**

The U.S. airport industry represents 11.5 million jobs and over $1.4 trillion in annual economic output. ACRP research is designed to be applicable to most – if not all – airports and provides best practices and research- and data-driven solutions for airport operators to address common problems throughout the industry. Over 90% of Americans live within 30 miles of an airport considered part of the National Airspace System, meaning that the impact of airports' economic decisions and environmental actions extend to nearly every American. Ensuring that these decisions are made in an informed, equitable, sustainable, and safe manner is a key feature of ACRP.

**Potential Progress Made Toward Achieving Strategic Goals:**

The ACRP intends to continually address the Department's strategic goals. Within FY 2023, four research projects were directed at safety; seven at economic strength and competitiveness; two at equity; five at climate and sustainability concerns; and six at transformation and future planning for the airport industry.

**Collaboration Partners:**

ACRP information regarding published reports, digests, and up-coming events (e.g., webinars, calls for research proposals, etc.) is provided to representatives in industry, academia, and the Federal Government via both the report postings and updates on the ACRP and FAA websites. It is also disseminated through the TRB newsletters and the ACRP LinkedIn and Facebook websites.

The Secretary of Transportation appoints the 13 members of the AOC. The AOC includes representatives from industry, academia, and national associations representing public airport operating agencies, airport executives, state aviation officials, and scheduled airlines. Representatives from both the FAA and the Environmental Protection Agency are participants in both the AOC and the project research panels. This enables members to understand the research initiatives and processes, and ensures awareness of the products and results. It also allows members to participate in the research proposal or problem statement drafting and voting. In addition, the representatives and stakeholder on the AOC are often the end users of the research products distributed.

The AOC shall initially be composed of 13 voting members and shall include seven members who are chief executive officers, managers, or members of the governing boards of airports (three from large hubs, two from medium-size hubs, and two from small hubs, non-hubs, or general aviation airports); five members who are officers or officials of universities, or private entities that are air carriers, shippers, suppliers, researchers, or consultants engaged in providing airport equipment or services; and the Administrator of the FAA or his/her designee , presently delegated to the Deputy Associate Administrator for Airports. Any such entity shall have no more than one member on AOC.

In addition, upon the request of the Secretary, the following individuals shall serve as "ex-officio," non-voting, members of AOC:

- The Administrator of the EPA or his/her designee;
- The Administrator of the National Aeronautics and Space Administration (NASA) or his/her designee;
- The chief executive of the Airports Council International–North America (ACI-NA) or his/her designee;
- The chief executive of the American Association of Airport Executives (AAAE) or his/her designee;
- The chief executive of the National Association of State Aviation Officials (NASAO) or his/her designee;
- The chief executive of the Airlines For America or his/her designee; and/or
- The Executive Director of the Transportation Research Board or his/her designee.

# United States Department of Transportation
# FY 2023 Annual Modal Research Plans

## Airports Technology Research Program
**Requested: ($40,828,000)**

**Program Description:**

The Airport Technology Research (ATR) Program supports the safe and efficient integration of new technologies into the airport environment through the development and updates of the FAA's Advisory Circulars (ACs).

The ATR program has a number of research program areas that directly support the DOT's strategic goals, namely Safety, Climate and Sustainability, Transformation, Equity and Economic Strength and Global Competitiveness. For instance, the ATR program supports the integration of UAS at airports, the development of new infrastructure design standards for Advanced Air Mobility (AAM), the search for newer more-environmentally-friendly firefighting agents, the testing and use of new emerging recycled/carbon neutral pavement materials for use at airports, as well as, the sustainability of extending airport pavement life past the current 20 year design life. It also funds research to quantify and mitigate aircraft noise near airports.

**Major Program Objectives:**

The ATR program directly supports the development and updates of the FAA's Airports ACs in airport safety and airport infrastructure. Research results and objectives from the ATR program are ultimately reflected in these AC's, which form the technical guidance used by airports across the nation.

On the infrastructure side, key objectives, in FY 2023, are the search, testing and applicability of various recycled and more environmentally-friendly pavement materials that may be integrated into the design of airport pavements and extending the life of the airport pavements so the use of new raw material will be reduced and made more sustainable. Since the construction and rehabilitation of airport pavements represent a very large annual capital investment at airports (over $ 2.5 Billion), the use of these non-traditional pavement materials will help lead to a more sustainable airport infrastructure.

On the airport safety side, in FY 2023, the ATR program will remain engaged in the performance testing of solar lighting, continued in-house testing of environmentally-friendly firefighting agents, improving airport noise, reducing the risk of wildlife strikes by aircraft, researching infrastructure needs of rapidly emerging Advanced Air Mobility vehicles, and integrating UAS operations at airports.

Of note, the program also provides an environment where companies of all sizes can test new ideas and products to meet FAA standards. This encourages companies to be innovative in their product development and competitive at the global level.

**Anticipated Program Activities:**

- Research recycled pavement materials and other pavement materials that are more carbon neutral
- Conduct performance studies to determine pavement surface treatment application and locations at the airfield
- Research and develop asphalt surface and base courses (FAA Specifications P401, P403 and P404) minimum material, and construction and acceptance recommendations

- Evaluate different optimization techniques including, but not limited to, reinforcement learning (one of three basic machine learning paradigms) for use in the FAA back calculation software BAKFAA, along with a finite element forward calculation model
- Research the field performance of solar powered lighting systems in various regions of the United States
- Research the impact and needs of AAM, including electric Vertical Take-Off (eVTOL) vehicles on existing and future airport infrastructures
- Perform full scale testing of various Aircraft Firefighting agents to investigate the reduction or elimination of Per- and polyfluoroalkyl substances (PFAS) at airports
- Assess and perform field testing for the use of UAS applications at airports for obstruction analysis, perimeter security, wildlife management, pavement inspections, and others uses
- Perform field testing of technologies for the detection of UAS at several airports
- Develop machine learning and artificial intelligence schemes to integrate runway and weather conditions that predict reduced aircraft braking capabilities on icy and wet runways
- Continue resilience study of Vulnerable National Plan of Integrated Airport Systems (NPIAS) Airports for Climate Change and severe weather
- Assess and initiate research with autonomous vehicles for various airport applications

**Potential Program Outputs, Value Statement and Impacts:**

Research outputs include the development of infrastructure standards for AAM vehicles, testing data of new environmentally-friendly firefighting agents, field performance assessment of solar technology for runway and taxiway lights, testing and evaluation of more resilient and environmentally-friendly pavement materials. Recent advancements in solar technology present an opportunity for airports to produce on-site electricity and reduce long-term energy costs. Aircraft noise is a concern related to equity and economic growth as it continues to be a principal obstacle to expanding and modernizing airport infrastructure due to community concerns about increases in aircraft operations and noise exposure. In FY 2023, the ATR program will continue to research the relationship of aircraft noise exposure and residential sleep disturbance, and ways to reduce community noise impacts. This will support the development of programs to help residents located in the vicinity of airports while letting airports further adapt to the needs of the aviation industry.

Overall the ATR program focuses on improving safety at airports, researching new technologies, materials and processes that lead to a more sustainable resilient airport infrastructure. The program also provides technical solutions to airports in their continuous modernization – directly supporting airports and aviation's economic growth.

**Potential Economic or Societal Impacts:**

In the areas of equity, economic growth and climate solutions, for FY 2023, ATR will continue research on the impact and needs of AAM, including electric Vertical Take-Off (eVTOL) vehicles, on existing and future airport infrastructure. This has the potential to open up aviation solutions to a larger segment of the population that typically has not benefited from recent developments in aviation.

**Potential Progress Made Toward Achieving Strategic Goals:**

The ATR research program directly supports Safety, Climate and Sustainability, Transformation, Equity and Economic Strength and Global Competitiveness. Progress in the ATR program areas is made continuously. This includes advancements in the mitigation of runway incursions, collecting field performance data for the use of solar powered lighting technologies at airports, and actively testing more environmentally pavement materials at the FAA's pavement research testing facilities.

**Collaboration Partners:**

In addition to the REDAC, the ATR program has direct interactions with airport consultants, airport authorities, academia, airport industry manufacturers and suppliers, the paving industry (e.g., Airport Concrete Paving Association, Asphalt Institute & National Asphalt Paving Association), as well as federal partners (e.g., DHS, DOJ, DOD). These stakeholders provide direct inputs into current needs, future trends, and FAA Advisory Circular deficiencies while helping to shape the ATR program's research needs today and into the future.

*Interagency Agreements:*

U.S. Army Engineer Research and Development Center (ERDC): This agreement enables collaboration and technical exchanges in airport and airfield pavement research. This collaboration benefits both organizations in the sharing of critical technical information.

Tyndall U.S. Air Force Base: This agreement enables collaboration between FAA and the U.S. Air Force on Aircraft Rescue Firefighting (ARRF) research, using the ARRF training facility located at Tyndall Air Force Base. This collaboration provides FAA with access to a state of the art facility.

United States Department of Agriculture (USDA): This agreement enables collaboration between FAA and USDA on the development of wildlife hazard assessment and risk mitigation plans at and near airports. This collaboration provides FAA with access to USDA expertise.

Smithsonian Institute: This agreement enables collaboration between FAA and Smithsonian Institute on the processing of bird remains that are collected after a collision with an aircraft. This collaboration supports a better understanding of bird strike risks near and on airports.

National Renewable Energy Laboratory (NREL): This agreement enables collaboration between FAA and NREL to research and determine the infrastructure needs for AAM vehicles.

*Cooperative Research and Development Agreements (CRADAs):*

ATECH Inc.: The FAA and ATECH Inc. have entered into a CRADA to share intellectual knowledge and perform research and development activities on the engineered material arresting system (EMAS) that safely arrests aircraft that overrun runways.

Council for Scientific and Industrial Research (CSIR) – South Africa: This CRADA supports technical information exchanges in materials research, pavement design and full scale pavement testing. This collaboration benefits both organizations in the sharing of critical technical information.

*Memoranda of Understanding (MOU):*

French Civil Aviation Authority (Direction Generale de l'Aviation Civil or DGAC): This MOU supports technical information exchanges in airport pavement design. This collaboration benefits both organizations in the sharing of critical technical information.

Federal Highway Administration (FHWA): This MOU supports technical information exchanges in full scale pavement testing, pavement instrumentation, pavement materials and pavement design. This collaboration benefits both organizations in the sharing of critical technical information.

UAS Detection and Mitigation Vendors: These agreements support participation in the FAA' s UAS Detection and Mitigation Research Program, which involves the deployment of technology at select US airports to enable the FAA to evaluate technologies in the operational environment. The goal of the program is to develop performance standards for these types of systems. This program is in direct support of Section 383 of the 2018 FAA Reauthorization Act.

*Other Transaction Authority (OTA):*

Boeing Company: The ATR program has an OTA with the Boeing Company to establish a mechanism for funding, studying, researching, planning, developing, demonstrating, evaluating, and implementing advanced concepts, technologies and methods in support of the U.S. National Air Transportation System. The emphasis of this work is operational safety at airports, and in particular, analyzing vast amounts of taxiway centerline deviation data from various aircraft. The overall goal is to consider revision of the numeric wingspan ranges for the existing airplane design groups, and separation standards, to re-align the aircraft wingspan ranges so that newer aircraft do not hit the upper limits of this allowed range.

# Aircraft Safety Assurance

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## Fire Research and Safety
**Requested: ($7,367,000)**

**Program Description:**

The purpose of this program is to conduct research to prevent accidents caused by in-flight fire and to improve survivability during a post-crash fire. The program supports the FAA's Associate Administrator for Aviation Safety, which is responsible for issuing regulations, standards, and guidance material to ensure the highest level of safety in commercial aviation. Research efforts specific to hazardous material transports are completed in coordination with DOT's Pipelines and Hazardous Materials Safety Administration (PHMSA) and the FAA Office of Hazardous Materials (AXH-1).

The program benefits the aviation industry by developing, validating, and transferring cost-effective aircraft fire safety technology. This program is necessary because of the catastrophic consequences of an uncontrollable aircraft fire, including loss of life and the destruction of the aircraft. An example of this program's efforts is demonstrated through the participation in the Society of Automotive Engineering's (SAE) G-27 committee. This is an international committee focused on efforts to develop a packaging standard for the safe shipment of lithium batteries on aircraft. The International Civil Aviation Organization (ICAO) requested this standard after the ban on the carriage of lithium batteries as cargo on passenger aircraft. Following this ban, the Fire Safety and Research program proposed a test standard and conducted extensive tests to understand the details and develop pass/fail criteria. The PHMSA is also participating in the standard development and, if adopted, would have the responsibility to change the hazardous materials shipping regulations to mandate its use.

**Major Program Objectives:**

The primary goal of this research is the prevention of catastrophic aircraft accidents caused by in-flight fires and increased survivability during a post-crash fire. Other benefits derived from this program include: 1) the introduction of enabling technologies to prevent accidents caused by a fire in freighter aircraft and hidden in-flight fires in passenger-carrying airplanes, and 2) the development, validation, and transfer of cost-effective aircraft fire safety technology to the aviation industry.

The Fire Safety Branch at the FAA WJHTC has unique aircraft fire testing capabilities that do not exist anywhere else in the world. The Commercial Aviation Safety Team (CAST) Safety Enhancement (SE) SE127 team recognized this fact, which recommended that the FAA Fire Safety Branch conduct the research. The FAA Associate Administrator for Aviation Safety relies on objective research results to make decisions on required changes to certification methods as aircraft manufacturing incorporates new materials and processes that may have unforeseen consequences with respect to aircraft fire safety. Global aircraft manufacturers have no incentive to conduct research that might limit the safe use of these new materials and processes.

Major Fire Research and Safety program objectives are consistent with the Department of Transportation's strategic research and policy objective to implement measures that mitigate or eliminate incidents among aviation operations and the traveling public. These efforts include testing and evaluation of new and emerging fire/smoke detection technologies; testing of new fire-resistant cargo container materials and their efficacy in containing cargo fires, including the hazards associated with the carriage of hazardous materials; and supporting the development of a safe packaging standard for lithium batteries on passenger aircraft.

**Anticipated Program Activities:**

- Component/Material Fire Testing
- Cargo Fire Protection
- Engine Fire Protection

**Potential Program Outputs, Value Statement and Impacts:**

The Fire Safety and Research program outputs valuable and impartial test data from laboratory and full-scale fire tests performed at the FAA Technical Center Fire Safety laboratories. Test data from aircraft materials and component flammability tests will provide insight for the revision of FAA aircraft materials flammability standards to address existing and emerging technologies and manufacturing processes including 3D printing of aircraft cabin interior components. Test data from aircraft cargo compartment fire tests will provide metrics for developing technical standards for new fire detection and suppression technologies and for fire resistant cargo containers, with the goal of enabling the safe shipment of lithium batteries. Data from engine and nacelle fire tests will provide a basis for the development of consensus-based fire test standards for engine components and for new, environmentally friendly fire suppression agents for engines.

The ultimate goal of the program is to reduce the risk of catastrophic in-flight fires and to improve occupant survivability in post-crash fires resulting from survivable aviation accidents. The data provided by the program will have an impact on aircraft certification regulations and guidance, thus affecting the design of components and systems to ensure an equivalent level of safety.

**Potential Economic or Societal Impacts:**

Economic benefits include the potential reduction in the cost of certification for flammability requirements due to proposed improved flammability standards based on the research to develop new flammability test methods while eliminating redundant requirements. Societal impacts include continued occupant safety from in-flight and post-crash fires as new technologies, systems, and materials are incorporated into modern aircraft designs.

**Potential Progress Made Toward Achieving Strategic Goals:**

The primary goal of this research is the prevention of catastrophic aircraft accidents caused by in-flight fires and increased survivability during a post-crash fire. This goal is aligned with the DOT strategic goal of Safety and directly contributes to the key performance indicator to maintain the commercial air carrier fatality rate at or below the target of 4.9 fatalities per 100 million persons on board.

**Collaboration Partners:**

The FAA Fire Safety Branch collaborates with domestic and international partners to coordinate aircraft fire safety forums and triennial conferences that are well attended by aircraft and aviation system manufacturers, operators, foreign regulatory authorities, and other research institutes and universities. Topics at the forums and conferences cover the full range of aircraft fire safety research, conducted by the FAA and other attendees.

The following are program partners for the Fire and Safety Research Program:

*International Civil Aviation Organization (ICAO):* Research conducted to document the fire hazards involved in the air transport of lithium batteries has been presented to the ICAO Dangerous Goods Panel and Airworthiness Panel as part of the decision making process that led to a ban on the shipment of these types

of batteries on passenger aircraft until a safe shipping method is developed. Research has also been conducted to support the development of a safe shipping method through contributions to the Society of Automotive Engineers, International (SAE) committee tasked with developing the new standard.

*European Aviation Safety Agency (EASA)*

*DOT Pipeline and Hazardous Materials Safety Administration (PHMSA)*

*Boeing Commercial Airplanes*: Testing has been conducted at the FAA Fire Safety Branch facilities in partnership with Boeing and fire suppression suppliers to evaluate proposed Halon replacement fire suppression systems for engines and cargo compartments. The benefit of this partnership is the data generated that will allow the certification of such a system to progress within the FAA.

*Airbus:* Testing has been conducted at the FAA Fire Safety Branch facilities in partnership with Airbus and fire suppression suppliers to evaluate proposed Halon replacement fire suppression systems for engines and cargo compartments. The benefit of this partnership is the data generated that will allow the certification of such a system to progress within the FAA.

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## Advanced Materials/Structural Safety
**Requested: ($2,886,000)**

**Program Description:**

Throughout most civil aviation history, aircraft have evolved slowly with little change to the basic aluminum materials or design concepts. A vast body of knowledge about such aircraft has been gained, often at the expense of fatal crashes. As this knowledge has grown, the safety record of civil aviation has steadily improved to the near-perfect record of the past few years. Over the decades, the pace of evolution of civil aircraft has increased dramatically. One of the most significant changes has been the widespread adoption of advanced composites in aviation products. This represents the first significant change in aircraft materials, design concepts, and fabrication techniques since the introduction of the first modern airliners in the 1930s.

This program conducts research to support FAA safety and regulatory activities in the technical areas of composites and other advanced materials and processes, and their impact on flight safety. The overall goal of this research is to support development of standardized certification protocols and safe maintenance practices for advanced materials and structural applications. While traditional composites have been used in aircraft structure for some time, non-traditional composites such as those with discontinuous fibers or thermoplastics, as well as other advanced materials and processes such as additive manufacturing, are increasingly being used in aviation products. All of these materials are expanding into new aircraft applications, with composites expanding to new critical shell and highly loaded beam structures to replace traditional metal construction, without commensurate standards and the existing service experience. By comparison, metal and composite additive manufacturing applications are just getting started in different areas that involve the challenges of numerous unique parts with complex geometry and loadings. As a result, the FAA must keep abreast with industry advances in all of these applications to support standards that ensure safe and efficient practices for the future.

This program supports the Department's strategic goal of safety. It coordinates its efforts with industry to provide data to support the FAA's oversight role of ensuring new technologies are adopted safely, as well as its mandate not to place an undue burden on industry. The program focuses on potential issues with material and structural performance, manufacturing quality control and assurance, and operational support/maintenance needs. The Advanced Materials and Structural Safety Program seeks to fill gaps in our knowledge related to these issues before they can cause catastrophic loss of aircraft and lives. This research program is a proactive approach to preventing accidents rather than the reactive approach to preventing the recurrence of accidents pursued in the past.

**Major Program Objectives:**

Advanced Materials and Structural Safety program objectives are driven by industry advancements in the construction of airframes and related components presented for certification. The FAA must ensure that the changes maintain an equivalent or improved level of safety for traveling public compared to that achieved with current operational aircraft. Requests from the aircraft certification offices and the aircraft manufacturers seeking "type certification" approval are major influences shaping research requirements. Additional requirements are developed from assessments of existing techniques, protocols, and service histories. These are examined to determine if modifications to certification compliance methods are required for novel materials, processes, and forms. The National Transportation Safety Board review of accidents

involving these structures provides additional impetus for research required to understand these emerging technologies. Sample reports can be viewed at:

- http://www.ntsb.gov/investigations/AccidentReports/Pages/AAR0404.aspx
- https://www.atsb.gov.au/publications/investigation_reports/2007/aair/aair200701625.aspx

In this context, major program objectives include:

- Development of guidelines for characterizing and controlling new material forms and assessing manufacturing maturity. Traditional composite materials may be considered those that are continuous fiber, and typically involve epoxy resin systems. Existing FAA guidance and industry standards for design, certification, manufacturing and maintenance tends to focus on behaviors associated with this class of materials. As new materials are introduced, the FAA, and industry as a whole, needs to characterize and control these materials in a way that produces a consistently sound structure to protect public from safety risks. This objective aligns with the DOT strategic research and policy objective of designing transportation systems to maintain and improve safety outcomes.

- Evaluation of fatigue, damage tolerance, and other aging behaviors of existing and new advanced materials. Many advances with manufacturing methods are inducing part-specific characteristics that require careful consideration for fatigue, aging, or other long-term effects. This supports the FAA strategic focus areas of continued passenger transport operations and to set standards for emerging materials. Additionally, it supports the DOT strategic research and policy objective of protecting travelers from safety risks and designing transportation systems to improve safety outcomes.

- Evaluation and characterization of dynamic or crashworthiness behavior of advanced structures to drive certification standards and guidelines. Current industry standards and test methods for dynamic applications such as seating systems and bird strike evaluations were developed assuming metallic structure in the load path. Composites are now being used in these applications; therefore current guidance material needs to be expanded to describe how certification test methodologies can be adapted. Another aspect of this research is investigating new applications, such as electric vertical takeoff and landing (eVTOL) aircraft that may be used for passenger carrying operations such as urban air mobility. These may require unique dynamic evaluation of advanced materials and structures, compared to existing vehicles, as they will have different design and impact requirements. This research aligns with the DOT strategic research and policy objective of protecting travelers from safety risks and designing transportation systems to improve safety outcomes.

- Development of efficient methods for characterizing composite and additively manufactured structural details and elements to tie to best practice design and certification principles. Advanced materials and structures are typically certified using a “building block approach” defined in FAA Advisory Circular AC 20-107B. The process involves a complex mix of test and analysis with test articles of varying complexity in order to predict and model full scale structural behavior. The building block is somewhat standardized at the lowest level of material coupon testing. The top of the building block “pyramid” is full scale testing required by regulations and is by necessity unique for each applicant. All configurations in the middle of the building block are currently also uniquely evaluated. The goal of this research is to standardize test methods for common mid-level building block details and elements for both composite and additive parts. This supports the FAA strategic focus areas of continued passenger transport operations and to set standards for emerging materials.

- Support development of industry handbooks and other standardization activities, and promote knowledge sharing for advanced materials and structures, including evaluation of emerging supporting technologies with the public as well as internally within the FAA. This objective helps

strengthen the use of informed data-driven decision-making and use of comprehensive approaches such as safety management systems, one of the DOT strategic policy objectives.

**Anticipated Program Activities:**

- Evaluate long-term aging behavior of advanced materials and associated maintenance practices
- Evaluate fatigue and damage tolerance behavior of bonded structure and associated maintenance practices
- Evaluate and characterize dynamic behavior of advanced structures to drive new test and certification standards and guidelines
- Develop guidelines for characterizing new material forms and assessing manufacturing maturity

**Potential Program Outputs, Value Statement and Impacts:**

A National Transportation Safety Board review of accidents provides additional impetus to understand advanced materials as new technologies emerge. The research performed by this program has identified and investigated many issues that were either unknown or poorly understood. By taking a proactive approach, it will ensure civil aircraft manufactured with these materials are safe and reliable. Without this program, some issues would almost certainly cause fatal crashes. This program saves lives by preventing accidents.

This program coordinates its efforts with industry to support the FAA's oversight role of ensuring new technologies are adopted safely, as well as meeting its mandate not to place an undue burden on industry. Output of this program is needed by FAA personnel to develop policy, guidance, and training, drive industry group engagement, and inform continued safety evaluations. Materials and structures are a common technology across all product types and new applications (e.g., urban air mobility). This program supports multiple FAA strategic plan objectives, including systemic safety approach, development of innovation, and regulatory reform.

**Potential Economic or Societal Impacts:**

The use of advanced materials is central to a vibrant aviation industry in the United States. As the methods of structural verification are being extended to new components and aircraft applications, it is important to understand acceptable design limits that have not been explored with composite materials and structures. This research addresses this gap in knowledge and supports standardization of industry practices to accelerate safe implementation of these technologies into aviation products, thereby maintaining the safety of the American flying public. Standardization also promotes efficiency by shortening the time and cost to introducing new structures made with advanced materials.

**Potential Progress Made Toward Achieving Strategic Goals:**

Data produced, testing protocols developed, and best practices documented by this program to evaluate structural behavior and characterize material properties of advanced materials are published by consensus based international standards organizations. This publically available information is currently used as guidance for industry in support of certification of existing and new aviation products. In this context, progress was made to develop a repeatable qualification framework including specifications and statistical allowables, generate substantial data for use in qualifying composites, and publish this data in shared/public databases and industry standards that ultimately help standardize certification of aviation products that use composite materials. For example, this program developed the first publically available material properties database for an additive material system that can be used in certification of aviation products, thereby bringing proprietary safety data to public domain through federally funded research.

**Collaboration Partners:**

In addition to the REDAC, public and stakeholder input is received through close research collaboration with the industry members that comprise the great majority of the program. Such input is inherent in identifying research areas that are of sufficient interest for industry to commit substantial research resources to the projects. In addition, the close collaboration affords extensive contacts and discussions on priorities, industry direction, and future plans.

The FAA Office of Aviation Safety (AVS) is a key stakeholder of this research program. AVS input is primarily elicited through monthly technical status review and coordination meetings between the AVS program sponsors, located at various certification offices including the FAA Chief Scientist and Technical Advisor on Composites, and the research program management team located at the FAA William J. Hughes Technical Center. The progress is tracked through the deliverables and due dates outlined by the AVS Composites Strategic Plan.

Internal program partners include the FAA Aircraft Certification Service Policy and Innovation Division (AIR-600), Airframe and Cabin Safety Section (AIR-675), and other interested AVS offices including Rotorcraft and Small Airplane Standards. These FAA offices are sponsors of various research projects performed under this this program. They are also the end user of the output produced by this research program.

- Other government entities include the National Aeronautics and Space Administration (NASA), the Department of Defense, Department of Interior, and other government laboratories.

- The majority of the research performed by this program is funded through the congressionally mandated Joint Center of Excellence (COE) for Advanced Materials and Structures (JAMS). Under the leadership of the University of Washington and Wichita State University, the following universities serve as core members of the COE JAMS and external partners of this research program: Edmonds Community College, Florida International University, Northwestern University, Oregon State University, Purdue University, University of California at Los Angeles, University of Delaware, University of Utah, Tuskegee University and the Washington State University. Mississippi State University is in the process of joining this list. The COE JAMS universities act as vehicles for workforce education and technology transfer as most students participating in the program research projects are offered engineering and technology positions in the aviation industry and continue working on composite design and manufacturing.

- Additional external partners include NASA, Wichita State University - National Institute for Aviation Research (NIAR), National Institute of Aerospace (NIA), and AmericaMakes, which includes 198 members giving the FAA access to more than $100 million worth of public and private research activities.

- This program includes a broad range of main aircraft and composite material OEMs including Boeing, Lockheed, 3M, Airbus, Bombardier, and Embraer, among others, who participate in this research program as external partners, matching funding and working closely with the individual projects and through various Composite Materials Handbook (CMH) industry steering committees. The technology transfer of the research output and data generated by this research program is achieved through direct communication, FAA reports, and the CMH.

**FAA Stakeholders:** Transport Airplane, Rotorcraft and Small Airplane Standards offices

**Industry Partners:** Boeing, America Makes, 3M, Toray Advanced Composites, Composite Materials Handbook, CMH-17 Steering Committee with contribution/collaboration from major OEMs, maintenance repair organizations and airlines across the aviation industry.

## Continued Airworthiness
**Requested: ($12,430,000)**

**Program Description:**

The Continued Airworthiness Program promotes the development of technologies, procedures, technical data, and performance models to prevent accidents and mitigate accident severity related to civil aircraft failures as a function of their continued operation and usage. The program focuses on longer-term maintenance of the structural integrity of fixed-wing aircraft and rotorcraft, continued safety of aircraft engines, development of inspection technologies, and the safety of electrical wiring interconnect systems and mechanical systems.

The quest for improved fuel, operational efficiency, and lower environmental impact is driving the evolution of aircraft at an unprecedented rate. Advances are being made in every aspect of aircraft design such as: additive manufacturing, composites and other new materials; structural technologies such as structural bonding and welding; propulsion systems such as battery, hydrogen, and hybrid powered electrical propulsion; and avionics. The FAA must ensure that these new technologies are safe, not only as they enter the airspace, but also throughout the life of the aircraft. This requires a deep understanding of the effects of aging, environmental exposure, and in-service damage to ensure that they are adequately addressed by the applicant during the certification process.

The Continued Airworthiness Program works with industry to perform the research required to develop such a body of knowledge. The data developed and insights gained are used to create and update guidance and policy, inform airworthiness directives, and create industry standards. The program focuses on longer-term maintenance of the structural integrity of fixed-wing aircraft and rotorcraft, continued safety of aircraft engines, development of inspection technologies, and the safety of electrical wiring interconnect systems and mechanical systems.

**Major Program Objectives:**

The Continued Airworthiness Program supports the FAA aviation safety oversight responsibility to ensure that aircraft maintain operational safety as they age. The FAA accomplishes this in two ways: first, by anticipating aging issues during the certification process and ensuring that they are adequately covered in the operations of the application; and second, by monitoring the in-service data as it is accumulating, finding issues at the earliest possible point, and ensuring that they are managed through advisories, directives, regulation, or other guidance.

Since its establishment, the program has led extensive studies on the in-service behavior of airframe structures and aircraft systems. The knowledge and information produced directly supported a wide range of FAA safety rulemaking, including the Aging Aircraft Safety Rule (AASR) 2005; the Widespread Fatigue Damage Rule (WFD) 2010, the Damage Tolerance Data for Repairs and Alterations rule under 14 CFR Part 26, 2007; Order 8110.104, Responsibilities and Requirements for Implementing Part 26 Safety Initiatives, 2007, as well as related guidance materials and advisory circulars.

**Anticipated Program Activities:**

- Develop a method of compliance to support certification of advanced flight controls in General Aviation and hybrid vehicles
- Metallic Materials Development and Standardization (MMPDS)
- Examine the effects that different platform materials have on the results of rotorcraft fuel system drop testing
- Large electric energy storage systems research
- Address structural integrity, fatigue, and damage tolerance of new metallic technologies including additive manufacturing and novel materials
- Assess structural health monitoring and advanced inspection technology to detect problems in the early stages of deterioration
- Develop methods to examine the applicability of the current operational load rules for electrical vertical takeoff and landing systems
- Obtain data and develop the methodology and nonlinear models required to establish safe and realistic freeplay limits to support the development of consensus-based standards for transport category aircraft
- Develop a probabilistic risk assessment and risk management tool to address the structural fatigue issues of the general aviation fleet

**Potential Program Outputs, Value Statement and Impacts:**

The program produces data on the safety reliability, and performance of large energy storage systems, emerging structural materials and technologies, and avionics. These data are used to create industry standards, FAA guidance, and develop airworthiness directives, and regulations. These documents are essential to the FAA's mission of ensuring the safety of the American Airspace System. The program also produces research to establish, determine, or verify the reliability, safety, and performance of large energy storage systems for electrically propelled aircraft.

**Potential Economic or Societal Impacts:**

This program serves both the effectiveness and efficiency of the FAA's certification process. It helps the FAA ensure that aircraft are safe when they enter service, remain safe during their operational life, and ensures that the FAA can do so without placing an undue burden on industry. By doing so, it both ensures the safety of the American flying public and supports vast improvements in the efficiency of the aviation industry that have been realized in recent years. The tension between the two goals of safety, (certification effectiveness) and speed (certification efficiency) has been increasing as aircraft have started to evolve at an unprecedented rate. The aviation industry is under increasing pressure from rising fuel prices, increasing demand for environmental responsibility, and ever-fiercer competition. To meet these demands, the industry is adopting new technologies in almost every facet of the aircraft including materials, structures, manufacturing, repair, propulsion, and avionics. The FAA must have the knowledge to ensure proper certification processes, issue and maintain guidance, and foster industry standards to improve both the effectiveness and the efficiency for both itself and for industry. In addition, the FAA must also meet issues that arise during operations through updates to guidance, airworthiness directives, and other means. This program works hand in hand with industry in its final stages of research and deployment of new technologies. By working with industry in this way, the FAA ensures that it meets industry at the finish line and has sufficient knowledge to adjudicate certification applications in a timely manner and ensures that that there is a common understanding of the safety issues. Also, working with industry in a cost sharing agreement both leverages the FAA research funds, allowing the program to do more and ensures that its research efforts are focused on those emerging technologies that will be placed in service and are not wasted on dead ends. This program also supports reduced carbon emissions and sound pollution, particularly as industry transitions to new and emerging aircraft types and missions.

**Potential Progress Made Toward Achieving Strategic Goals:**

This program is crucial to the FAA's effort to ensure that new technologies are safe as they enter operations and that they remain safe during their operational life. Therefore, it supports the operational goal of "Safety."

**Collaboration Partners:**

The main source of public and stakeholder input is from Technical Community Representative Groups (TCRG). TCRG members routinely participate in both FAA and industry activities, such as Aviation Rulemaking Advisory Committees (ARAC), Commercial Aviation Safety Team (CAST), SAE, Radio Technical Commission for Aeronautics (RTCA) and other aerospace standards organizations. Through these venues, the members gather input from those most affected by the research and present ongoing programs.

The Continued Airworthiness Program participates in various interagency groups that include NASA, DoD, and the Coast Guard. The Continued Airworthiness Program also teams with Original Equipment Manufacturers (OEM) and tier one manufactures such as Boeing, Bombardier, Bell, Sikorsky, AirBus, Gulf Stream, Dassault, Embraer Honeywell, Teledyne, Astronics, Ametek GE, and various others through direct contracts, cooperative research and development agreements (CRADAs), or through working groups in standards development organizations (SDO).

Collaborative research with industry includes the areas discussed below.

<u>Structural Integrity</u>

- The *Damage Tolerance and Durability Issues for Emerging Technologies* research is being conducted in close collaboration with industry through CRADAs. These cost-share agreements leverage resources to address areas of mutual interest that benefit all partners that include cost savings, utilization and sharing of available facilities, and expansion of general knowledge base. For each project, roles, responsibilities and tasking are identified, and a schedule of milestones and deliverables are monitored to track performance.

- Partnership with Bombardier, Arconic (formerly ALCOA), Constellium, and Embraer to assess emerging metallic structures technology (EMST) through testing and analysis of advanced fuselage configuration using the FAA's Full-Scale Aircraft Structural Test Evaluation and Research (FASTER) Lab. Industry contributions include material and fuselage panels for testing, engineering time for analysis, and providing supporting data.

- Partnership with Boeing, using the FAA's in-house Airframe Beam Structure Test (ABST) facility to assess bonded repair technology to composite panels representative of transport aircraft wings. Boeing contributions include funds to support in-house FAA staff, material and composite wing panels for testing, installation of repairs to test articles, engineering time for analysis, and testing equipment.

- Partnership with Bombardier and Constellium to characterize the durability and damage tolerance performance of advanced aluminum-lithium alloys. Industry contributions include material and panels for testing and engineering time for analysis.

- The *MMPDS Support and Design Values for Emerging Materials* project leverages FAA resources and funding through government-industry consortia in the development of the Metallic Materials Properties Development and Standardization (MMPDS) handbook, recognized worldwide as the

premier source of metallic allowables. The Government Steering Group includes FAA, NASA, and DoD while the Industry Steering Group consists of 35 companies representing the major material suppliers and users (manufacturers of aircraft/aerospace vehicles) worldwide.

- The *Development of Control Surface and Stabilizer Freeplay Limits* research is conducted in collaboration with academia, mainly, the University of Washington, which provides the FAA with access to graduate-level student and faculty expertise. The test model for this activity was designed and manufactured after a state-of-the-industry survey, which included direct inputs from representatives from Lockheed-Martin, NASA Armstrong Flight Test Center, NASA Langley Research Center, and the United States Air Force Research Laboratory.

- The *Probabilistic Damage Tolerance Based Fleet Risk Management for Small Airplanes* research is conducted under a partnership with University of Texas at San Antonio, St. Mary's University, and Textron Aviation. This has provided the FAA with academic and OEM expertise. The industry OEM partner is directly involved in development and validation of this tool.

Rotorcraft Systems

- The *Wire Strike Avoidance* prime research stakeholder is the rotorcraft directorate who, along with the industry partners under contract to the FAA, will benefit from this research. Industry partners include the Center of Excellence Partnership to Enhance General Aviation Safety, Accessibility and Sustainability (PEGASAS) which includes the following schools: Georgia Institute of Technology, Iowa State University, and Florida Institute of Technology. PEGASAS was leveraged based on the past experience with rotorcraft research at Georgia Institute of Technology and sensor development at Iowa State. This experience will provide a more cost effective program with reduced technical risks. No funding is received by the FAA from external partners, but cost sharing includes in-kind contributions from industry and academia as part of the collaborative research initiatives.

Flight Control and Mechanical Systems

- The major collaborative partners are the FAA Compliance & Airworthiness Division and the Policy & Innovation Division, Transport Standards Branch. Additional stakeholders include government, industry, and academia partners under contract with the FAA. Government partners include NASA Armstrong, NASA Ames, and NASA Langley. Industry partners currently include; the Adaptive Aerospace Group, Systems Technology Inc., National Test Pilot School, and Flight Level Engineering. Academia partners include Purdue University, The Florida Institute of Technology, and Georgia Tech. No funding is received by the FAA from external partners, but cost sharing includes in-kind contributions from other government agencies, industry, and academia as part of the collaborative research initiatives.

Electrical Systems

- The major collaborative partners are the FAA Policy & Innovation Division, Transport Standards Branch. Additional stakeholders include government, industry, and academia partners under contract with the FAA. Government partners include Air Force Research Laboratory (AFRL), NavAir, NASA Johnson, NASA Jet-Propulsion Labs (JPL), and NASA Glenn. Industry partners currently include; Boeing, Saft, Teledyne, Honeywell, Eagle Picher, University of Dayton Research Institute Systems, DNV-GL, Ametek, and Astronics. No funding is received by the FAA from external partners, but cost sharing includes in-kind contributions from other government agencies, industry and academia as part of the collaborative research initiatives.

## Propulsion and Fuel Systems
**Requested: ($5,471,000)**

**Program Description:**

The FAA establishes rules for the certification and operation of aircraft engines, fuels, and fuel management systems that enhance the airworthiness, reliability, and performance of aircraft propulsion and fuel systems. The Propulsion and Fuel Systems Program conducts research that provide the Office of Aviation Safety (AVS) with the basis for new or revised engine certification and continued airworthiness standards. This research also supports FAA actions in response to National Transportation Safety Board (NTSB) safety recommendations. It supports the preparation of Advisory Circulars (ACs) that provide the industry with technical information on acceptable means of compliance with regulations. Benefits accrue in the form of a reduced risk of engine failures and fewer accidents, leading to fewer injuries and fatalities. Finally, research in this program supports the U.S. DOT strategic goal of "Climate and Sustainability" by researching and performing experiments with electric propulsion systems. This supports the Strategic Objective of "Economy-wide Net-Zero Emissions by 2050."

**Major Program Objectives:**

To prevent uncontained engine failures, the FAA and the AIA formed the Rotor Integrity Steering Committee (RISC) to augment the traditional safe-life design approach with one that employs a probabilistic design methodology to account for extremely rare material and service induced anomalies. This revolutionary change resulted in the FAA issuing rule 33.70, which describes the certification of critical life-limited engine parts. In order for the FAA to ensure that the industry is able to comply with the new safety rule, a series of FAA advisory circulars and a publicly available probabilistic software code will be developed.

The objective of this research is to develop the damage tolerance framework and supporting data to provide a basis for the necessary advisory materials and a design software code called Design Assessment of Reliability With Inspection (DARWIN) in support of rule 33.70. A further objective of this research is to develop improved nondestructive evaluation (NDE) methods to characterize engine component material conditions that can compromise integrity. This need was highlighted by the NTSB in recommendations A-18-03 and A-18-04 resulting from the 2016 AA Flight 383 uncontained turbine failure event. Additionally, this research develops data and analysis methods for blade fragment impact and containment in support of rule 33.94 as well as uncontained debris vulnerability assessment tools necessary to minimize catastrophic risk in support of rule 25.901 and 25.903. To accomplish these objectives, research will be pursued through government and industry collaboration to ensure that a consistent level of safety is widely adopted by the engine industry.

Finally, as outlined in the U.S. DOT strategic plan, the research into electric propulsion will assist in the reduction of air pollution and greenhouse gas emissions from transportation and advance a sustainable transportation system while improving the resilience of at-risk infrastructure. Electric propulsion can accomplish this by utilizing renewable resources to supply onboard aircraft storage systems.

**Anticipated Program Activities:**

- Advanced Damage Tolerance and Risk Assessment Methods for Engine Life Limited Parts
- Improved Nondestructive Evaluation to Prevent Uncontained Engine Failures
- Advanced Analysis Methods for Impact of Aircraft Materials from Rotor Burst and Blade Release
- Engine Safety Event Prevention thru Engine Health Monitoring (EHM)

**Potential Program Outputs, Value Statement and Impacts:**

Activities from this research program are focused on the certification and continued airworthiness of aircraft propulsion systems including traditional gas turbine engines and innovative electric propulsion designs. Data from these activities will support the issuance of new regulations, standards, advisory materials, and software that could have broad applications across the FAA. Specific outputs include DARWIN engine design software, inspection standards, LS-DYNA engine fragment impact models, and UEDDAM uncontained vulnerability analysis software tool updates. This research will also facilitate the use of new "green" engine technologies that are more climate friendly and sustainable and help the aviation industry reduce and minimize fatalities and property damage due to aircraft engine failures.

**Potential Economic or Societal Impacts:**

Research conducted by this program will result in the continued safe operation of legacy engines and pave the way for the adoption of new propulsion solutions that will not depend solely on fossil fuels. Safe, reliable aviation propulsion systems that use viable, sustainable energy sources will enable aircraft of the future to provide convenient and cost-effective service to all communities. This expansion to previously underserved markets will present new opportunities for economic growth and prosperity.

**Potential Progress Made Toward Achieving Strategic Goals:**

One of the objectives of this program is to address climate and sustainability concerns through the research into electrically propelled aircraft. Future years, beginning in FY 2024, will include research in this area under this program. FY 2023 will be used for planning and gathering of information necessary to support future work such as research into electric engine durability and required maintenance to ensure designs are not only environmentally friendly, but safe as well.

**Collaboration Partners:**

FAA researchers work extensively with the major turbine engine manufacturers who comprise the Aerospace Industries Association (AIA) Rotor Integrity Steering Committee (RISC), and the Rotor Manufacturing (RoMan) team at periodic meetings. Both groups consist of stakeholders who review and guide the development of the Advisory Circulars that support 14 CFR 33.70 and who provide beta-site testing of the DARWIN software code. This program also coordinates with the Jet Engine Titanium Quality Committee (JETQC) and the Jet Engine Nickel Quality Committee (JENQC) to develop improved methods to produce these super alloys for premium quality critical rotating parts. Minutes and action items from these meetings are shared and tracked with all participants.

Program partners include:

- AIA RISC
- AIA RoMan Team
- AIA Inspection Team
- Jet Engine Titanium Quality Committee (JETQC)/Jet Engine Nickel Quality Committee (JENQC)
- Department of Defense (USAF, USN)

- NASA
- Foreign Regulators (EASA, Transport Canada)
- LS-DYNA Aerospace Working Group

# Digital Systems and Technologies

## Digital System Safety
**Requested: ($5,287,000)**

**Program Description:**

Airborne systems' designs have become increasingly dependent on highly integrated software and hardware architectures that share power, computing, networking, input/output, and other resources to support the needs of multiple aircraft functions. The main goal in Digital Safety Research is to analyze airworthiness and certification assurance aspects of highly integrated, complex digital aircraft systems, including systems development processes, requirements validation, and integration; use of Commercial Off The Shelf (COTS) devices; new and novel electronic hardware and software implementation techniques (such as Artificial Intelligence [AI] and/Machine Learning [ML]), tools, methods, and processes; streamlining approaches to development assurance and aircraft certification. Additionally, this research develops, validates, streamlines, and improves certification methods to reduce time and cost to both FAA and industry in certifying aircraft employing advanced digital airborne systems. Finally, research in this program supports the U.S. DOT strategic goal of safety to ensure that automation brings significant safety benefits; and pursue performance-based rather than prescriptive regulations.

**Major Program Objectives:**

The research conducted within this program differs from industry research. The program's main focus is considering new technology, materials, and procedures while maintaining or increasing current safety levels. The program's main sponsor is the regulatory community, which can be hindered by proprietary and intellectual property rights. The programs under this BLI provide the aviation community with publicly available data and insight for consistent aircraft certification safety.

The research requirement will provide additional insights into safety vulnerabilities of complex digital systems that are developed, integrated, or verified using unproven processes, techniques, and methodologies that could introduce a safety risk for undetected errors with failure manifested at the aircraft level. The Complex Digital Systems research will develop policy, guidance and training for new technologies and techniques to promote their safe use in aircraft systems; develop processes and training material used to streamline the certification of complex digital systems. Also, seeks to understand, address, and provide an annual measurement indicator of Safety Data Sheets (SDS)-related continued operational safety issues.

**Anticipated Program Activities:**

- Study of Assurance based approaches, and their adoption into aviation certification
- Explore the use of alternative approaches to deployment of AI/ML based systems, and establish criteria that will make this acceptable

**Potential Program Outputs, Value Statement and Impacts:**

The research will provide better understanding and trust of AI and ML based systems. The research will also provide clarity to enable guidance to be developed to permit alternative means by which highly complex electronic systems can be approved.

- Research reports identifying software assurance techniques and the evaluation of those techniques

- Research output will include reports identifying safety issues related to AI/ML implementations, risk mitigation techniques, and validating efficacy of such techniques.

**Potential Economic or Societal Impacts:**

The potential economic or societal impacts can be realized by improving safety of airborne systems. The research efforts supported by this program will position the FAA to develop the requisite assurance criteria and methods and thus enable the timely and safe introduction of advanced digital technologies for air transportation.

**Potential Progress Made Toward Achieving Strategic Goals:**

Advances in electronic hardware and software implementation techniques (such as AI and ML) have the potential to transform the aviation industry. These powerful tools allow evolving, highly integrated systems to leverage the increased volume, velocity, and veracity of data across the aviation ecosystem. The research products of this program will facilitate the safe integration of these innovations in order to support the needs of the future air transportation system.

**Collaboration Partners:**

The main source of public and stakeholder input is from FAA Subject Matter Experts (SME) on the BLI Planning Teams. These SMEs routinely participate in both FAA and industry activities, such as Aviation Rulemaking Advisory Committees (ARAC), Commercial Aviation Safety Team (CAST), SAE, RTCA and other aerospace standard organizations. Through these venues, the members gather input from those most affected by the research and present ongoing programs.

Industry, academia, and other agencies are actively involved in cooperative research tasks to conduct research and develop consensus standards for digital systems assurance of software and hardware. Work is also done with NASA Langley, National Resource Council of Canada, Aerospace Vehicle Systems Institute (a consortium of industry OEMs such as Boeing, Airbus, Embraer, Honeywell, GE, and Collins Aerospace), other government agencies, and academia, RTCA, SAE International, and Carnegie Mellon University. This research will benefit the safety initiatives of incorporating complex digital systems as we move towards more electric aircraft and will provide the FAA with a unique capability that protects industry's Intellectual Property (IP), does not duplicate test facilities that already exist in the US, and can leverage the results across industry, government, and academia.

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## Information/Cyber Security
**Requested: ($5,500,000)**

**Program Description:**

This program researches cyber data science methodologies using Machine Learning (ML) and Artificial Intelligence (AI), addressing cyber security parameters such as data volume, data velocity, data variety, data veracity, behavioral data, and various other parameters. This helps to prevent disruptive cyber incidents that may affect NextGen air traffic operational data, which includes the NAS, R&D, and mission support domains. The research consists of Air Traffic Management Operations, Net-Centric Operations, and NAS Infrastructure. The big data research will include various communications such as Internet Protocol (IP) traffic, big data in the cloud (public, private, community, and hybrid), and various application data within FAA systems and external aviation partners' systems communicating with FAA systems. The long-term goal is to help prevent disruptive cyber incidents within NextGen future traffic that will include digital and flexible communication in future Air Traffic Control (ATC) missions and improve big data cyber security within Air Traffic Management Operations, Net-Centric Operations, and NAS Infrastructure (communication, and information management) resilience through:

- Big Data Cyber Analytics – to effectively compile and correlate data volume, data velocity, data variety, data veracity, behavioral data, large volumes of data, new technologies, and algorithms
- Visualization tools – related to big data to develop visualization techniques: creative visual presentations of data that quickly differentiate warning signs from normal operating behaviors
- Exploratory research topics – Self-Adaptive Networks and Systems and Design Assurance Methods for Mixed Trust Environments

The past decade has seen an exponential increase in cyberattacks that threaten several components of the aviation ecosystem. To address these needs, the FAA NextGen Organization (ANG) has established the Cybersecurity Data Science (CSDS) research program with emphasis on discovery, assessment, adaptation, demonstration and transfer of cyber technology in the form of concepts and guidance - to enhance information cybersecurity for elements of the aviation ecosystem. Specifically, this research program will focus on identifying breakthrough discoveries in core research areas, and applying the resulting information to help create a more resilient and sustainable aviation ecosystem. Emphasis on Artificial Intelligence and Machine Learning (AI/ML), data science, and collaboration across industry segments will address these aviation ecosystem cybersecurity threats.

This includes working closely with the industry to refine and mature a CSDS Aviation Architecture Framework (AAF) and developing use cases that express specific interests of designated industry collaborators that will reduce the cybersecurity safety threats to the flying public.. This includes technology exploration studies, market surveys, Proof-of-Concept experimental software prototyping, and Advanced Technology Demonstrations. The applied research is targeted toward use case development, technology concept exploration, Proof-of- Concept demonstrations, and development of documented guidance materials, through close work with industry stakeholders.

Core research will be performed to enable breakthrough discoveries and new knowledge in research areas that include:

- Vulnerability and Risk Assessment (V&RA)
- Lateral Movement Defense (LMD)
- Predictive Analytics (PA)
- Context Aware AI

Applied research will lead to technology transfer through the development of Relative Research Environments to evaluate the concepts of the core research in conjunction with industry applications. The transfer of the technology will be accomplished through the development of industry documentation and guidance.

**Major Program Objectives:**

The NextGen Information Security R&D objective is to prevent and predictively determine the potential of cyber events such as unauthorized access, destruction, disclosure, modification of information or data, and/or denial of service. In addition to increases in traditional air traffic, the aviation ecosystem will undergo significant changes to mission requirements over time. Examples of significant potential changes to the aviation ecosystem include, emerging technologies, open architectures, cloud computing, and shared aviation information. Other changes that may happen at the run time include potential increases in communications traffic due to malicious activity, and network and resource availability changes. As the aviation ecosystem grows in mission and complexity, the cost of making changes requiring human interaction becomes prohibitively expensive. In addition, in the case of run-time changing conditions, humans cannot keep up with the pace of system operational changes.

The main goal of the NextGen Information Security program is the prevention and deterrence of disruptive cyber incidents that affect various components of the aviation ecosystem. The program directly supports the FAA Cyber Security Strategic Plan to research advanced tools, techniques, and processes adapted for use in the transfer of new cybersecurity technologies. It will also enable critical research and development leading to enhanced industry capabilities for a more resilient, safe, and secure aviation ecosystem.

Furthermore, this program is designed to address the following guidance:

- OMB Memorandum M-20-29 (14 Aug 2020), prioritizes AI/ML. Additionally, two "priority crosscutting actions" that "underpin the five R&D priorities" include #3 "facilitate multisector partnerships and technology transfer" and #4 "leverage the power of data."
- The National Strategy for Aviation Security (Dec 2018), broadens the scope of potential threats to, or disruption of, the aviation ecosystem with emphasis on cybersecurity to include emerging threats such as malicious cyber actors. The national strategy directs a holistic and adaptive approach to securing the aviation ecosystem.

EO 13800 (11 May 2017) directs the strengthening of cybersecurity for the nation's critical infrastructure. It emphasizes identification of capabilities that agencies could employ to support the cybersecurity efforts of critical infrastructure entities at greatest risk of attacks that could reasonably result in catastrophic regional or national effects on public health or safety, economic security, or national security.

**Anticipated Program Activities:**

- Predictive analytics prototype development and demonstration
- Context Aware Behavioral AI Algorithm Adaptation and Initial Software Prototype Development
- Explainable AI- Stakeholder requirements and Use case development

**Potential Program Outputs, Value Statement and Impacts:**

**Potential Economic or Societal Impacts:**

The aviation ecosystem is in a constant state of change and enhancement, increasing in connectivity and complexity, continually opening more avenues to cyber threats. These advanced persistent threats (APTs) come from numerous malicious individual and state/political actors that are deliberately working to develop new methods of cyber-attacks to control and destroy aviation systems.

Cyber-attacks on any of aircraft, airlines or airports could lead to devastating results across the aviation ecosystem and jeopardize passenger and personnel safety. System outages could occur, threat actors may have an operational impact on the aviation ecosystem including aircraft, or lead to the worst-case scenario of weaponizing ecosystem components.

Specific guidance for industry cybersecurity standardization, architecture/system designs and cybersecurity best practices will accelerate the adoption and adaptation of CSDS AI/ML products to enhance the aviation ecosystem's ability to better counter these evolving threats. Therefore, these CSDS program research outcomes are crucial for a more resilient, safe, and secure aviation ecosystem.

**Potential Progress Made Toward Achieving Strategic Goals:**

Cyber security threats are continuously evolving in technological complexity and ability to circumvent existing threat detection techniques. In order to maintain security of the aviation ecosystem, the algorithms, processes and technologies must continuously evolve faster than that of the threat actors, and transform existing technologies to predict and mitigate future threats. One success of this program has been the evolvement of Lateral Movement Defense (LMD). Research and evolvement in this area could mitigate future attacks like the solar winds cyber incident in 2020, along with other types of threats. Additional progress in the transformation of cyber security protections will include the standards and guidance that can help industry stakeholders through the use of LMD, PA, V&RA and other Data Science and AI/ML technologies. Other progress includes establishment of relationships with industry stakeholders' that have already shown interest in the results of LMD and V&RA.

**Collaboration Partners:**

The program will take a proactive and collaborative approach to work with other Federal agencies, aviation stakeholders, and academic institutions to identify, develop, and implement methods, tools, and technologies to meet the research requirements, goals, and objectives of the FAA Cyber-Security Strategic Plan. Industry stakeholders that have expressed an interest in collaborating with ANG to date include aircraft integrators, Avionics Manufacturers, industry consortium groups, and several research universities.

Collaborators include:

- Information Sharing and Analysis Center (A-ISAC) – Consortium for research evaluation and requirements
- Cyber Safety Commercial Aviation Team (CS CAT) – Consortium for research evaluation and requirements
- Airline Industries Association (AIA) – Consortium for research evaluation and requirements
- Airlines, including a major domestic commercial carrier– Industry collaboration and research partners

- Major US Aircraft Component Manufacturer – Industry collaboration and research partners
- Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL) – Cyber data science methodologies using Machine Learning and Artificial Intelligence;
- Embry Riddle Aeronautical University (ERAU) – Aviation architecture framework and industry collaboration
- National Renewable Energy Laboratory (NREL) – Information sharing for cyber research
- International Civil Aviation Organization (ICAO) – Standards and guidelines
- Radio Technical Commission for Aeronautics (RTCA) – Standards and guidelines

# Environmental and Weather Impact Mitigation

# United States Department of Transportation
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## Aircraft Icing
**Requested: ($3,353,000)**

**Program Description:**

The FAA establishes rules for the certification and operation of aircraft in icing conditions. The agency uses research results to generate Advisory Circulars (ACs) and other forms of technical information to guide certification and airworthiness specialists and inspectors on acceptable means for meeting requirements. This research and the guidance materials generated from this research help to reduce aircraft accidents and incidents caused by aircraft icing, which meets the Department's strategic goal of safety.

**Major Program Objectives:**

The Aircraft Icing program will improve existing capabilities and develop new engineering tools to support improved means of compliance and new guidance material for engine and airframe certification and operations in super cooled small and large drops, mixed-phase, and ice crystal icing conditions. The outputs will support improved safety through the issuance of new guidance materials for ACs.

The main goal in Aircraft Icing research is to improve aviation safety related to aircraft icing. This includes developing a better understanding of the effects of environmental icing, the development of data in support of new regulations and guidance materials, the support for improvements to engineering tools for certification and operations, and improving icing weather information for decision-making in terminal areas and in-flight avoidance of high ice water content ice crystal conditions.

The Aircraft Icing Program focuses primarily on providing the information needed by the FAA to ensure that the industry complies with certification and operational requirements. Much of this information is also useful to the industry in its efforts to ensure safety. The Aircraft Icing Program seeks and receives valuable input and insights from the industry through meeting with industry working groups and committees and participation in national and international conferences.

**Anticipated Program Activities:**

- Ice protection of vertical stabilizer prior to takeoff
- Deicing and anti-icing fluid protection time for mixed phase ground icing conditions

**Potential Program Outputs, Value Statement and Impacts:**

Provide information for the annual ground icing notice issued by the FAA's Flight Standards organization, improve aircraft dispatch efficiency, and improved environmental impact through more efficient use of deicing/anti-icing fluid.

**Potential Economic or Societal Impacts:**

Research conducted by this program will result in the continued safe operation of aircraft in icing conditions and a reduction in aircraft icing accidents and incidents. The testing of deicing and anti-icing fluids also provides an economic impact due to the ability to takeoff without undergoing a wing inspection and reducing the amount of fluid required which has a positive benefit on the environment.

**Potential Progress Made Toward Achieving Strategic Goals:**

The primary goal of this research is the reduction of aircraft accidents and incidents caused by aircraft icing. This goal is aligned with the DOT strategic goal of safety and results in a positive benefit on the environment through the reduced use of fluids.

**Collaboration Partners:**

The Aircraft Icing Program attends industry working groups and committees in order to get input directly from those most affected by the issues it is researching. In addition, it meets regularly with Flight Standards and industry representatives at meetings arranged by Flight Standards, often in response to requests from industry representatives.

The Aircraft Icing Program partners with aircraft manufacturers and airline operations. Manufacturers contribute mainly through expert input, and sometimes by the participation of company personnel in projects. For example, Boeing personnel played a very important role in the planning and conduct of the vertical tail test campaigns.

In cooperation with Flight Standards, the Aircraft Icing Program meets regularly with airline representatives, receiving their expert input. In addition, some airlines have made their own aircraft available for recent testing.

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## Weather Program
**Requested: ($16,178,000)**

**Program Description:**

The Weather Program performs applied research to minimize the impact of weather on the National Airspace System (NAS). It facilitates the transition of legacy capabilities to meet NextGen requirements, often through collaborative and complementary initiatives with the National Weather Service (NWS); as well as focused initiatives to help mitigate safety and/or efficiency issues associated with well-documented weather problems. These initiatives include the development of the Visibility Estimation through Image Analysis (VEIA) algorithm which estimates visibility by processing views through weather cameras in remote locations and can be utilized directly by pilots or integrated into automated weather products. This initiative in collaboration with the FAA Aviation Weather Cameras Program is a huge step forward in support of aviation safety in Alaska, where it can be difficult to obtain accurate current visibility conditions. The Weather Program partners with the National Oceanic and Atmospheric Administration (NOAA) Global Systems Laboratory (GSL) and the NOAA National Centers for Environmental Prediction (NCEP) Environmental Modeling Center to develop high resolution, rapidly updating models that have and continue to be implemented operationally into NOAA/NWS operations. These modeling efforts result in enhanced NAS safety via diagnosis and forecasts of weather hazardous to aviation, including en route turbulence, convective weather, ground and in-flight icing, and more.

The program leverages advances in meteorological science to enhance observation methods, improve weather prediction models, and produce increasingly accurate forecasts of convective weather, turbulence, icing, and low ceiling and visibility conditions. The NOAA/NWS platforms and forecasters use algorithms developed by the Weather Program to provide regulatory forecast products and NAS decision aids. The timely dissemination and presentation of such information provides decision support input to enable traffic flow managers, controllers, pilots, and airline operations personnel to implement tactical and strategic traffic management initiatives to avoid encounters with severe weather, reduce delays and mitigate safety risks.

**Major Program Objectives:**

The main goals of the FAA's Weather Program are to mitigate the impact of weather on the NAS; mitigate weather related NAS safety and/or traffic flow efficiency issues; support the evolution of legacy weather capabilities into the capabilities developed and deployed as NextGen decision-support weather processes; improve the accuracy and relevancy of legacy weather products and services mandated by FAA regulatory guidance and/or international agreements; and support the achievement of the NextGen weather vision.

In many cases aviation is the only transportation method available to reach rural communities and villages in Alaska. A Weather Program objective includes projects to improve cloud ceiling and visibility observations and forecasts used by General Aviation pilots flying in these remote regions, including mountain passes, valleys and landing strips where little or no weather observations are currently available. Commercial and general aviation aircraft frequently encounter unexpected atmospheric turbulence. Though rarely fatal, these encounters often result in serious injuries to aircrews and passengers. In addition, the cost to air carriers of these injuries (medical attention and lawsuits), equipment damage and maintenance/inspection, or rerouting is substantial. Another Weather Program objective includes projects to develop high resolution global detection and probabilistic forecasts of turbulence as well as the translation of predicted weather information into operational decision making information to support Air Traffic Management (ATM)

decision support processes and dispatchers and pilots. This results improved safety, increased capacity, and reduced atmospheric emissions within the NAS.

Market surveys conducted by the Weather Program have shown that the industry has little experience, expertise, and incentive to perform applied aviation weather research. The investment (computer processing equipment, data retrieval, specialized personnel, etc.) required upfront, and the fact that airlines and other users have limited budgets to spend on weather information leads to a low return of investment (ROI) that is not enough to initiate or sustain an industry effort. In cases where the industry does develop new products, data, or techniques, the resulting output is usually proprietary. Without oversight and the ability to test the output for accuracy and conformity to standards and safety regulations, it is generally not suitable for use by NextGen or the NWS. Therefore, the only viable option is for the Weather Program to conduct and manage research to meet FAA requirements.

**Anticipated Program Activities:**

- Improve Convective Weather Global Forecasts
- Improve Frequency of Cloud Ceiling and Visibility (C&V) Forecast Guidance
- Turbulence Forecast Enhancements
- Inflight Icing Forecast Enhancements
- Obtain Solar Radiation Measurements at En route Altitudes

**Potential Program Outputs, Value Statement and Impacts:**

- Gridded and station-based forecasts of high-impact C&V and flight categories for CONUS every 15 minutes out to 3-6 hours resulting in improved safety for helicopters, drones, and other small aircraft through the availability of improved and more frequent weather information

- High resolution turbulence avoidance mitigation products and decision support aids resulting in more precise turbulence avoidance capability that will alert pilots and controllers of the location and severity of turbulent conditions, enhancing aircrew and passenger safety

- Focus on onset, duration, dissipation, and location assessment of convective weather hazards in NAS sensitive/high demand regions that will result in improving convective weather forecasts that will enhance efficiency and the safety of aircrews and passengers

- High resolution inflight icing forecast products to alert pilots, dispatchers, controllers, and meteorologists of the location and severity of inflight icing, enhancing aircrew and passenger safety

**Potential Economic or Societal Impacts:**

The Weather Program has and will continue to develop and enhance analysis and forecast capabilities that will benefit the American public. This has and will include applied research in naturally occurring atmospheric hazards including turbulence, convective activity, icing, and restricted ceiling and visibility. As these capabilities are transitioned onto new or existing FAA platforms and systems, or by transition to NWS platforms or procedures that deliver aviation weather services required by FAA regulation, greater benefits to the American public will continue to accrue. These benefits include:

- Increased General Aviation (GA) safety in Alaska, as focused efforts will continue to target enhancements to in-flight icing, turbulence, and restricted ceilings and visibility diagnosis and forecasts
- Enhancements to convective weather forecasts that will minimize gate-to-gate delays and improve efficiency of flights

- Enhancements to turbulence analyses and forecasts to increase passenger comfort, safety of passengers and crew, safety of GA operations, and increased capacity in the NAS
- Enhancements to icing analyses and forecasts to increase safety and decrease flight times especially for GA and commuter passengers

**Potential Progress Made Toward Achieving Strategic Goals:**

Weather Program research results, including advanced weather prediction models with high resolution and rapid updates, as well as radar applications that enhance the forecast of aviation weather hazards, continue to be transferred for implementation into NWS operations. Additionally, enhanced forecast capabilities in the areas of turbulence, in-flight icing, and ceiling and visibility continue to be transferred to the NWS Aviation Weather Center where they are being disseminated for use by NWS weather forecasters, airlines, GA, aircraft dispatchers, and FAA ATM. Weather Program convective weather research capabilities continue to be transitioned to FAA platforms for operational utilization by ATM. The operational implementation of these capabilities contributes to enhancing NAS safety.

**Collaboration Partners:**

Annual weather research workshops are conducted and recommendations from attendees including, airlines, GA, NWS, and FAA ATM, are considered in developing the Weather Program research portfolio. Guidance from research evolution plans developed with inputs from airlines, NOAA, and FAA ATM have also been utilized to facilitate the identification and selection of research in the Weather Program portfolio. Finally, Weather Program personnel attend scientific conferences and symposia to learn about the latest aviation weather advances, new techniques, shortfalls in weather support and services, and emerging concerns, as well as to meet with other aviation and weather subject matter experts for exposure to discuss and gather inputs from both national and international user and research perspectives.

Program partners include:
- NOAA
- NASA
- USAF
- Australia Bureau of Meteorology
- Environmental and Climate Change Canada
- National Research Council of Canada
- Airlines

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## NextGen - Weather Technology in the Cockpit
**Requested: ($3,028,000)**

**Program Description:**

The Weather Technology in the Cockpit (WTIC) program addresses NextGen Implementation Plan (NGIP) weather-related goals. This includes reducing weather delays in adverse weather conditions, enhancing air traffic management (ATM) and aircraft re-routing flexibility to avoid adverse weather, enhancing safety in and around areas of adverse weather (i.e., reducing the number of weather-related accidents and incidents), and reducing greenhouse gas emissions through lower fuel consumption resulting from optimized routing and rerouting during adverse weather.

WTIC research projects are conducted to develop, verify, and validate recommendations for incorporation into Minimum Weather Service (MinWxSvc) standards and guidance documents to enhance the safety and efficiency of commercial, business, and general aviation operations. For the WTIC program, a MinWxSvc is defined as:

- Minimum cockpit meteorological (MET) information
- Minimum performance standards (e.g., accuracy) of the MET information
- Minimum rendering standards
- Enhanced weather training
- Minimum cockpit technology capability recommendations

WTIC Program research projects continue to excel at identifying innovative techniques to successfully resolve safety-related weather information gaps in cockpits, and to fulfill safety requirements originated by any combination of the following sources:

- National Transportation Safety Board (NTSB) 2014 Most Wanted List to improve transportation safety in the category: “General Aviation: Identify and communicate hazardous weather”
- Aircraft Operators and Pilots Association (AOPA) which identifies critical gaps for a resolution to enhance General Aviation safety
- NTSB safety alerts identify critical gaps that were causal factors in accidents that require research to resolve
- Alaska Air Carriers Association identifies weather-related gaps to enhance safe Instrument Flight Rules (IFR) and VFR flight operations in Alaska
- Flight Service Stations need objective criteria to consistently determine ‘Visual Flight Rules (VFR) Flight Not Recommended (VNR)’ conditions
- NEXTGEN Segment Implementation Plan (NSIP)
- Federal and private weather providers and pilots’ needs for increases in the quantity and accuracy of pilot reports (PIREPs) and airborne observations to enhance weather forecasts, nowcasts, and adverse weather avoidance decision-making

- National Association of Flight Instructors (NAFI) and commercial flight training schools that identify needs for enhanced pilot weather training materials, experiential learning software, weather training courseware, and current aviation-specific weather knowledge test questions

**Major Program Objectives:**

To accomplish the program objectives, the WTIC program performs research to identify causal factors in weather-related safety hazards/risks and NAS operational inefficiencies. The program then conducts applied research to resolve the identified causal factors or gaps. The WTIC program also develops enhanced training materials and courseware as part of gap resolution.

The main goal of the WTIC research program is to develop MinWxSvc recommendations that address the need for additional or improved MET information in the cockpit or integrated with decision support tools (DSTs) as identified in the NAS mid-term Concept of Operations. This MET information will enable NextGen operations and performance-based navigation to achieve planned benefits in adverse weather conditions for all part-type aircraft.

The WTIC Program is tasked with developing cockpit-related standards and guidance that detail innovative techniques to integrate new weather products and information in cockpits to resolve gaps that degrade safety and operational efficiency, and accomplish the following major program objectives:

- Enhance aviation safety by resolving gaps in cockpit weather information and technology that are causal factors in prior accidents/incidents or have the potential to be a causal factor in future accidents/incidents. The numerous gaps being resolved by the WTIC Program have been identified by WTIC gap analyses, NTSB accident investigations, stakeholder inputs, and research experiments. Past gap resolutions included MinWxSvc recommendations for additional weather observation data in cockpits, enhanced human factors for weather information interfaces and integration, and increased use of cockpit weather automation.

- Increase aviation access to rural communities that rely on aviation for food, medical services, tourism, and transportation by improving safe adverse weather avoidance decisions when flying under Visual Flight Rules (VFR), and by providing weather information to enable flight under Instrument Meteorological Conditions (IMC). Many rural areas lack the weather infrastructure to support safe VFR flight or to enable flying in IMC, so the WTIC Program is doing research to produce low-cost techniques to resolve these information gaps. Innovative techniques being researched include crowd sourcing observation data, using ADS-B outputs to produce turbulence observations, and downlinking cockpit photos that can provide information on winds, cloud tops, cloud heights, and other weather observations used for safe adverse weather avoidance.

- Enhance pilot weather knowledge and experience in flight under adverse weather conditions to enhance their safety and the safety of passengers. The WTIC Program is continuing to develop weather training using augmented, virtual, and mixed reality that can be presented on personal computers with minimal additional technology to safely replicate adverse weather encounter scenarios that enhances pilot weather knowledge as well as their experience with adverse weather encounters. The WTIC Program is explore the applicability of this methodology to evaluate the benefits of new weather products, technology, and information.

- Increase the quality of cockpit weather automation and information by developing techniques for enabling pilots to easily monitor automation performance and the quality of weather data inputs. The WTIC Program is performing research on using crowd sourcing to cross check weather observations from traditional and non-traditional sources to establish confidence or quality metrics. The research

will also enable automation to output a cockpit notification of atypical weather conditions or rapidly changing weather conditions.

- Enhance the weather infrastructure for aviation by using non-traditional sources to gather the information that provides utility to pilots in making adverse weather avoidance decisions. The WTIC Program is improving the weather infrastructure by making use of existing web-based cameras, wind socks, phone apps, and other non-traditional sources of weather information. Though the quality of these sources has historically been too uncertain for aviation, the WTIC Program is using crowd sourcing algorithms, artificial intelligence, machine learning, and big data to recognize outlier data and to converge on accurate observation data.

- Reduce gaseous emissions by enabling more effective reroute decisions relative to adverse weather avoidance. Adverse weather is a primary causal factor in excess emissions due to the difficulty in optimizing hazardous weather avoidance. By addressing weather information gaps in the cockpit and more effectively using weather information, WTIC research will enable more efficient reroute decisions. As an example, a recently completed demonstration of satellite weather information provided to cockpits flying oceanic routes resulted in a calculated annualized reduction of 48.3 million kilograms of carbon dioxide emissions. WTIC's ongoing research to increase turbulence observations by orders of magnitude using the vertical rate information in ADS-B reports has the potential for another significant reduction in gaseous emissions.

**Anticipated Program Activities:**

- Improving Turbulence Avoidance Phase 4 – Producing turbulence observation data from the vertical rate information in downlinked ADS-B reports from any ADS-B equipped aircraft
- Resolving Cockpit Weather Information Gaps - ADS-B and Hands-Free Pilot Report (PIREP) Submittals
- Cockpit Decision Support Tools – Identification of the Most Representative Weather Information Sources in Remote Areas
- Weather Observation Date Quality/Confidence Metrics – Develop a methodology and process to produce quality or confidence metrics for weather observation data
- Cockpit Weather Automation – Enhance the FAA's Digital Copilot to respond to verbal weather questions to enable pilots to cross check their understanding of cockpit weather information
- Pilot Weather Training - Use virtual, augmented, and mixed reality to enhance pilot weather knowledge and provide experiential training that provides pilots with the ability to "experience" different weather phenomena
- New Observation Weather Data – Develop innovative techniques, such as crowd sourcing, apps, and webcams, to produce new observation weather data to resolve weather information gaps in the cockpit

**Potential Program Outputs, Value Statement and Impacts:**

The outputs of WTIC research are anticipated to increase safety in adverse weather for all part type aircraft, enhance reroute efficiency resulting in reducing carbon dioxide emission, increase weather observation data via innovative techniques to supplement the current weather infrastructure, and enhance pilot weather training to increase pilot weather knowledge and experience in adverse weather conditions via the use of augmented, virtual, and mixed reality. Since WTIC produces standards, guidance, technical transfer packages, and white papers, the research results will foster competition in industry as well as stimulate the economy as the research is incorporated into industry products for use in cockpits.

Based on prior demonstrations, the WTIC Program estimates that the technical transfer package for incorporating convective information from satellites, and the increase in turbulence information from the

vertical rate information in downlinked ADS-B reports, will conservatively reduce carbon dioxide emissions by approximately 100 million kilograms annually. This equates to a social cost savings of approximately $5 million dollars. In addition to reductions in carbon emission, increases in route efficiency during adverse weather conditions will reduce flights delays. For example, the convective satellite information provided in oceanic routes demonstrated an average reduction in flight times of 1.8 minutes per flight. Reducing or eliminating gaps in cockpit weather information has the potential to reduce weather related injuries, deaths, and disruption of service. Based on the demonstration results from providing convective products in the cockpit in oceanic flights, the savings from reduced incidents and injuries due to convection were projected as $5.54 million in the Atlantic Ocean and $1.35 million in the Pacific Ocean. Increased observation data will also significantly increase access and safety for rural communities that rely heavily on aviation for basic goods and services.

**Potential Economic or Societal Impacts:**

Since WTIC Program research is focused on integrating and using enhanced weather information from traditional and non-traditional sources, the research has a direct social and economic benefit. WTIC research directly complements industry research and is intended for use by industry to enhance the utility of their cockpit weather products and information to make aviation safer and more environmentally friendly. The areas of research performed by the WTIC Program are developed based on inputs from industry safety groups, pilot unions, general aviation, business aviation, and other aviation stakeholders. This approach has ensured that successful research is used by stakeholders, and it enables feedback to assess its benefits. WTIC Program research is unique to the FAA in that it is primarily transitioned to commercial products and procedures versus FAA systems and procedures, thus it has a greater benefit to stimulate the economy and to foster competition.

**Potential Progress Made Toward Achieving Strategic Goals:**

WTIC Program research results have been incorporated into various standards and guidance documents through industry and FAA standards development organizations including RTCA. WTIC received the 2019 FAA Administrator's Safety Award, in part, due to its exceptional outreach of its research products and its ability to transition the research for use by industry and pilots. These successes and processes are established in the WTIC Program, so there are strong expectations for this trend to continue. WTIC has numerous research projects in progress that are anticipated to be transitioned to third parties over the next one to five years. In addition, as a research program, much of the WTIC research is also positioning the program for longer-term research and greater innovation.

**Collaboration Partners:**

A metric of the utilization of REDAC inputs and alignment with their views can be noted in the minutes from NAS Ops REDAC reviews which emphasized that the WTIC program is of high value and a beneficial activity as it successfully transitions research into commercial applications. The WTIC Program accomplishes successful outreach and transition of research results and products to third parties including commercial airlines, avionics manufacturers, and weather service providers.

WTIC Program personnel attend scientific conferences, symposia, and general aviation events/fly-ins to learn about the latest aviation weather advances, new techniques, shortfalls in weather support and services, and emerging concerns; as well as to meet with stakeholders and weather subject matter experts to discuss and gather inputs from both national and international users, industry, and research perspectives.

Rockwell Collins: The WTIC program performs research with Rockwell Collins through an agreement where research is jointly performed by the WTIC program. Rockwell Collins, contractor support is provided at a reduced rate resulting in increased resources. This collaboration has been performing crowd sourcing

research that has identified methods to produce ceiling and visibility information using camera images and commercial crowd sourcing resources. It has also demonstrated the capability to produce weather radar outputs from photos of commercial aircraft weather radar, processing them through commercial optical character recognition software to digitize the information, and then recreating a georeferenced image. These innovative techniques have the potential to produce critical MET information in remote and rural areas without the need for new and costly infrastructure. In the past year, a demonstration was successfully completed that used a hybrid combination of edge detection software, crowd sourcing, and machine learning software to produce site and sector visibility information from webcam images.

FAA Future Flight Services: Future Flight Services is working to lower the cost of providing their services by increasing the use of automation and pilot self-assisted services. The WTIC program performs research to ensure that the resulting services still meet MinWxSvc recommendations and identifies methods to automate the process while still meeting pilot needs. Flight Services personnel will be supporting the research to develop a cockpit-based decision support tool based off the FAA's digital copilot to enable the automation to address questions currently handled by Flight Services. Flight Services is also supporting the effort in anticipation of their specialists using the same tool to support their services relative to weather.

Aircraft Owners and Pilot's Association (AOPA): The partnership with AOPA has two benefits. First, AOPA provides gaps and issues identified by their membership. Gaps identified by AOPA include the reduced utility of VNR and the number of Pilot Reports (PIREPS) generated and their accuracy. WTIC uses these inputs to identify gaps and operational shortfalls that need to be resolved and then performs the research to resolve them. The second benefit is that AOPA assists with the outreach of the research results that reduce/resolve issues that their membership has identified. In addition, due to their large membership, AOPA is positioned to encourage manufacturers to implement WTIC recommendations to resolve the issues. AOPA is highly motivated to support WTIC recommendations since they recognize that the cost to implement these recommendations is much lower if driven by the market versus excessive standards and regulations. AOPA also publishes recommendations for their pilots to make them educated consumers. This ultimately drives the market to incorporate WTIC recommended enhancements.

National Association of Flight Instructors (NAFI): participates in WTIC research to assess the quality of their instructors in teaching aviation weather. Based on WTIC research that showed private pilots scores on weather knowledge exams ranged from approximately 50% to 60%, they want to enhance their weather training and ensure that their instructors are also satisfactorily knowledgeable in aviation weather. NAFI has also requested that the WTIC program personnel provide seminars to their instructors on ways to enhance weather training, weather areas that research has shown are deficient, and provide information on WTIC MinWxSvc recommendations. NAFI instructors are also able to provide inputs to WTIC research by identifying weather-related issues they observe with their students.

FAA Flight Standards: FAA Flight Standards works with WTIC on a number of research projects to identify safety issues. They also are a consumer of WTIC MinWxSvc recommendations by incorporating them into standards, guidance documents, and handbooks.

FAA GA Center of Excellence (PEGASAS): The GA COE performs much of the WTIC GA-related research with in-kind matching for each dollar in the grant resulting in significant savings in the cost of doing the research. In addition, the industry partners of the COE provide efficient transition paths to implementation.

Embry Riddle (ERAU): ERAU is performing research to enhance pilot training and identify pilot deficiencies in weather knowledge. Under the terms of the grant, ERAU provides in-kind matching for each dollar in the grant resulting in significant cost savings when executing the research.

National Transportation Safety Board (NTSB): The NTSB provides inputs to the WTIC program by assisting with identifying causal factors in aviation accidents. These details highlight gaps that require resolution to

enhance safety. NTSB also reviews and provides inputs on WTIC research projects to resolve these gaps based on their expertise and knowledge of accident casual factors.

NASA: NASA maintains the Aviation Safety and Reporting System (ASRS) and performs callbacks to pilots on weather-related accidents and incidents that are reported to ASRS. These detailed callbacks provide insights into gaps, risks, and other attributable factors to the reported accident/incident. This work is funded and being performed under an interagency agreement with the WTIC program.

United, Delta, and American Airlines: These commercial airlines perform operational demonstrations of WTIC MinWxSvc recommendations under Other Transactional Agreements (OTAs) where the WTIC program is only charged for WTIC specific activities so the demonstrations "piggyback" on airline operations to reduce costs. In addition to reduced costs in performing the demonstrations, having airline participation has enhanced the ability to transition research to implementation and the ability of the airlines to internally plan to be aligned with the WTIC MinWxSvc recommendations and associated NextGen concepts. As an example, Delta Airlines incorporated up-linking EDR and the EDR viewer immediately after the successful demonstration and benefits analysis.

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## Alternative Fuels for General Aviation
**Requested: ($12,385,000)**

**Program Description:**

Due to various environmental, regulatory, and market forces in the U.S. and worldwide, leaded avgas will be eliminated at a future point in time. The Alternative Fuels for General Aviation research program operates as part of the Piston Aviation Fuel Initiative (PAFI). PAFI was established at the request of a broad cross-section of the aviation and petroleum industries and consumer representatives to develop a path forward for identifying, evaluating, and deploying the most promising unleaded replacements for 100 low lead aviation gasoline. Unfortunately, in concert with existing government regulations and policies, the aviation and petroleum marketplace does not support a safe, orderly, and economically viable fleet-wide transition to a new fuel or fuels, hence the need for the joint government and industry collaborative initiative known as PAFI. The Alternative Fuels program collaborates with 40 different entities in this program, as further detailed below.

This program supports the DOT's strategic goal of Climate and Sustainability and also Executive Order 14008 "Tackling the Climate Crisis at Home and Abroad" by conducting research to mitigate climate pollution using multiple cleaner alternatives to current general aviation gasoline. More specifically, as part of the FAA EAGLE (Eliminate Aviation Gasoline Lead Emissions) initiative, this research supports addressing current and historical environmental injustices from aviation, particularly lead emissions. The EAGLE stated program timeline is to eliminate lead emissions from general aviation by 2030.

There is no known safe exposure level of lead, and multiple studies have documented the health impacts to urban and other disadvantaged communities of lead exposure. Current leaded aviation gasoline (avgas) is the only remaining transportation fuel in the U.S. that contains lead additives. These additives protect piston engines against damaging detonation, or engine 'knock'. The Environmental Protection Agency (EPA) reports that GA aircraft contribute approximately 70 percent of total airborne lead emissions and is currently evaluating lead emissions from piston aircraft and their impact. The EPA plans to issue a proposal on lead in aviation gasoline for public review and comment in 2022 and take final action in 2023. In addition, the European Chemicals Agency (ECHA) has also proposed restrictions on the form of lead used in aviation gasoline. Market forces, along with national/international regulatory actions will eliminate the availability of leaded avgas in the near future. Safe alternatives must be in place before the end of leaded gasoline availability.

**Major Program Objectives:**

The Alternative Fuels program will support the EAGLE Initiative as it leverages and builds upon a continuing collaboration with industry through the PAFI. The program objectives are to enhance and accelerate research in the areas of unleaded, sustainable, and other fuel alternatives for use in piston-engine aircraft; aircraft and engine modifications to allow safe operation on reduced octane unleaded fuels; and innovative aircraft technologies that safely reduce emissions. Additionally, the program will support the accelerated development of fuel efficient, low-emissions aircraft technologies, including electric, and electric hybrid propulsion, and support collaborative research on other leading edge and next generation technologies that will also reduce harmful emissions. These all will address the broader goals of reducing air pollution, and addressing the historical, negative impacts on disadvantaged communities from aviation, particularly due to lead emissions.

For more information on the EAGLE Program, please see https://www.faa.gov/about/initiatives/avgas. For more information on FAA/EPA collaboration, please see https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-lead-emissions-aircraft. For more information on FAA sustainability initiatives, please see https://www.faa.gov/sustainability.

**Anticipated Program Activities:**

- Engine testing of prospective fuels in fleet representative models
- Flight-testing on final candidate fuel formulations in fleet representative aircraft models
- Conduct laboratory analysis on candidate fuels and lubricating oils
- Research and test technologies that could have transformative impact in reducing harmful emissions from the GA fleet of aircraft
- Research and test sustainable and renewable fuels and components for the first time for general aviation fuels
- Evaluate key certification considerations for electric propulsion systems, including development of energy reserve requirements, environmental effects, electromagnetic compatibility, and other requirements

**Potential Program Outputs, Value Statement and Impacts:**

The program outputs will include an extensive array of technical reports and data on the testing of unleaded fuels in a variety of fleet representative test articles, testing of technologies that could have transformative impacts in reducing harmful emissions, as well as the evaluation of key certification considerations for electric propulsion systems. This will include data on engine performance, engine detonation, and engine durability characteristics; safety of flight in different aircraft models under differing weather conditions (normal day, hot day, cold day); the safety of renewable / sustainable aviation fuels and fuel components; and data to establish, determine, or verify reliability rates for safety-critical features and functions of electrical propulsion systems.

The value and impacts of this information are that it will serve to support authorization and certification of safe unleaded fuels that will eliminate lead emissions, as well as new technologies will produce fuel burn, emissions, and climate impact benefits throughout the fleet over many years. In addition, the data will enable the general aviation industry to reduce emissions through the use of renewable and/or sustainable aviation fuels. Last, this data will support the establishment of standardized testing criteria to evaluate safety of electric engines to be used for propulsion and control surfaces in electric and electric-hybrid aircraft.

**Potential Economic or Societal Impacts:**

The general aviation fleet of aircraft is a significant and integral element of the National Airspace System (NAS) and of the U.S. economy. Directly or indirectly, general aviation supported 1.2 million jobs and contributed over $247 billion to the U.S. economy making a positive $75B impact on the U.S. balance of trade (GAMA, 2020). The general aviation industry, its economic contributions, and other benefits are at risk unless the fleet can transition to unleaded fuels before market and/or regulatory forces eliminate the availability of leaded fuel. In addition, the availability of well-vetted unleaded replacement fuels will eliminate the need for operators to seek less safe alternative fuels that could potentially cause safety of flight issues for the NAS. The general aviation community has access to over 16,000 public and private airports and landing facilities nationwide. Elimination of lead, and reductions in emissions from research into sustainable / renewable fuels, and other safe emission reduction technologies, will improve the environment for at-risk children and all Americans. Lastly, research into electrical propulsion technologies will accelerate the development of highly efficient, environmentally friendly, next generation aircraft, as well as enhance U.S. competitiveness in the global aviation industry.

**Potential Progress Made Toward Achieving Strategic Goals:**

As of the end of 2022, the program will have completed pre-qualification testing on two candidate unleaded fuels. Engine testing will be completed in engine test cells at ground level and using altitude simulation capabilities to measure engine performance, detonation, durability and other operating characteristics showing if unleaded candidates meet the pre-screening requirements of FAA 14 CFR Parts 33.45, 33.47, 33.49, 33.55, 33.57 and PAFI criteria. Screening tests for fuel chemistry compatibility with aircraft and engine materials will have been completed in accordance with the certification office (AIR-600) requirements based on specific fuel chemistries. In addition, we will have completed laboratory analysis of submitted fuel formulations for chemical and physical properties to verify fuel conformity with proposed ASTM specifications. Upon successful pre-qualification testing, fuels will proceed into full-scale testing meant to lead to a fleet-wide authorization in accordance with Section 565 of the 2018 FAA Reauthorization Act.

**Collaboration Partners:**

The Alternative Fuels program has always been a collaborative effort between the FAA, GA community stakeholders, fuel industry partners, other government agencies, and educational intuitions including Centers of Excellence (COEs). Under EAGLE we will continue with, and expand the list of collaborating partners as we work towards the program goal of lead free general aviation by 2030.

The current list of partners includes over 45 corporations, industry standards bodies, government agencies, and other organizations as listed below. This list is expected to grow as EAGLE stands up its four pillar work groups.

- Afton Chemical
- Air BP
- Air Repair
- Aircraft Owners and Pilots Association (AOPA)
- American Association of Airport Executives (AAAE)
- American Petroleum Institute (API)
- ASTM
- AVFUEL Corp
- Calumet Specialty Products
- Cape Air
- Chevron
- Cirrus Aircraft
- Commemorative Air Force
- Continental Motors
- Embry Riddle Aeronautical University
- Enstrom Helicopter
- EPA (US EPA)
- Epic Aviation
- Ethyl Corp
- Everts Air
- Experimental Aircraft Association (EAA)
- Exxon Mobil
- General Aviation Manufacturers Association (GAMA)
- Haltermann Solutions
- Hartzell Propeller
- Helicopter Association International (HAI)

- Innospec
- Lycoming Engines
- Lyondell Chemical Company
- McCauley Propeller
- Meggitt Polymers & Composites
- Mooney Aircraft
- National Air Transportation Association (NATA)
- National Business Aviation Association (NBAA)
- National Research Council Canada (NRC)
- Phillips 66
- Piper Aircraft
- Precision Airmotive
- Precision Engines
- Purdue University-PEGASAS Center of Excellence
- Robinson Helicopter Company
- Rotax Engines
- Shell Oil Products US
- Swift Fuels LLC
- Textron Aviation
- TOTAL
- Transport Canada

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## Environment and Energy
**Requested: ($21,163,000)**

**Program Description:**

The FAA's long-term vision is to remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation. This program supports this vision by advancing our understanding of civil aviation noise and emissions at their source, how noise and emissions propagate and are modified in the atmosphere, and their ultimate health and welfare impacts. A central part of the program is the continued development of an integrated aviation environmental tools suite that can be used to evaluate a wide range of environmental mitigation solutions. The suite is built upon a sound scientific understanding of aviation noise and emissions as well as their environmental, health, and welfare impacts. The tools analyze and inform decision-making on technology development, operational procedures, regulatory compliance, and international and domestic standards and policies relating to civil aviation's energy use and environmental impacts. The FAA's long-term vision is to remove environmental constraints on aviation growth by achieving quiet and fuel-efficient operations. Understanding of the root causes and the interactions of these pollutants with the environment is the fundamental step in developing the technologies and strategies necessary to reduce their impacts on people, their environment, and climate.

**Major Program Objectives:**

Aviation noise and emissions are a considerable challenge to the continued growth of aviation. Despite the technological advancements achieved during the last four decades, and the resultant 95 percent reduction in the population exposure to significant noise, the impact of aircraft noise demands considerable Federal resources and is a constraint on aviation growth. Since 1982, the FAA has provided over $11 billion for sound insulation of houses and schools around U.S. airports through the Part 150 Program. Environmental impacts, especially aircraft noise, are often the number one cause of opposition to airport capacity expansion and airspace redesign (http://www.gao.gov/assets/310/309622.pdf). Concerns about the impacts of aircraft emissions on climate change could limit the growth of international aviation. The implementation of precision navigation over the last few years has contributed to increased airport community concerns regarding noise. This challenge is anticipated to grow with new entrants such as unmanned aerial systems, urban air mobility, and civil supersonic aircraft. The ability to manage this growth will partly depend on the extent to which we address the effects of noise and emissions. Technologies that reduce noise and emissions are regulated at the vehicle level as a part of airworthiness certification.

These environmental standards are harmonized internationally through the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP). A significant portion of this Program is devoted to informing decision making at ICAO CAEP. Further, this program supports domestic policy and regulatory considerations in the absence of timely consensus on international policies and standards. This research supports the Administration's vision as outlined in Executive Order 14008 to put the United States on a path to achieve net-zero carbon dioxide emissions, economy-wide, by no later than 2050. The research in this budget line item also addresses local environmental concerns that are a result of aviation noise and emissions that impact local communities in the vicinity of airports. This includes the need for environmental justice in line with Executive Order 12898. This program's research efforts support the development of technological innovations for the current fleet of aircraft that will mitigate climate change and address local environmental concerns. Furthermore, the program will coordinate efforts with federal

partners to ensure that knowledge is shared broadly thus increasing the benefits provided by the supported efforts.

**Anticipated Program Activities:**

- Advance Scientific Understanding of Environmental Impacts of Noise and Emissions
- Aviation Environmental Design Tool (AEDT) Development
- Decision Making on Standard Setting, Certification, and Policy

**Potential Program Outputs, Value Statement and Impacts:**

The program has three primary outputs that are linked together and provide the key knowledge, data, and information necessary to address and mitigate the environmental and climate challenges facing aviation. The knowledge and data on the environmental impacts of noise and emissions that are generated by this program provide the understanding of the issues on which technological and operational solutions can be developed, and helps the agency and industry identify where limited resources should be directed. This knowledge also supports the continued development and improvement of the analytical tools used to assess and explore solutions to the environmental and climate challenge. Continually improving AEDT's analytical capabilities is of particular importance as domestically it is the mandated tool for performing environmental reviews and the resource used for the development of policy and standards. Internationally the tools supported by this program are used to perform analyses and provide data to support decision making. AEDT is the primary tool used by ICAO CAEP to develop the data and information needed to support decision making on international environmental standards.

**Potential Economic or Societal Impacts:**

Continued improvements in our fundamental understanding of aviation noise and emissions and their effects on people and the environment is the key to reducing their impacts and associated costs to the public and society. The development of ever more accurate tools provides the backbone of data on which cost effective solutions can be developed. The information on the current state and future scenarios these tools provide ensures that decision makers have what they need to make informed, data-driven choices that take into account both the short and long term benefits and costs to guide aviation towards an environmentally sustainable economic engine for growth.

**Potential Progress Made Toward Achieving Strategic Goals:**

The program continues to advance the steady progress towards an environmentally sustainable aviation system. The industry understanding of the impacts of aviation on people has been expanding with some of the latest research addressing the impacts of aircraft noise to cardiovascular health as well as reassessing the standard for describing noise exposure-annoyance relationships to reflect societal changes since the last revision 30 years ago. A new version of AEDT continues to be released annually, with the latest version providing updates to several aspects of its Local Air Quality computation capabilities and its aircraft performance modeling implementation. AEDT was also successfully used for providing the data that informed the ICAO development of a long term aspirational goal for international aviation CO2emissions, critical support to development of Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the data foundation for the ICAO CAEP Aircraft CO2 Standard being promulgated domestically.

**Collaboration Partners:**

The program incorporates inputs received from stakeholders, such as industry and non-governmental organizations, as well as those from other agencies, including NASA, Department of Energy (DOE), Environmental Protection Agency (EPA), and Department of Defense (DOD), most of which are collected

during formal review processes conducted during rulemaking comment periods, program reviews, and interagency processing of agency positions and decision documents. The program also takes into consideration the input received from experts, such as the members of the Center of Excellence for Alternative Jet Fuels and Environment (ASCENT), CLEEN Consortium, ICAO CAEP meetings, and those that participate at FAA and industry events such as the annual Aviation Emissions Characterization Roadmap meeting and other FAA-hosted environmental research meetings. Those involved in the program are heavily engaged internationally and seek input from overseas stakeholders. The program relies on the input and feedback provided by the Research, Engineering, & Development Advisory Committee (REDAC). Finally, direct feedback on the AEDT software from its user base is obtained through the AEDT support website.

The program has many partners and stakeholders including industry, airport communities, environmental non-governmental organizations, foreign governments, ICAO CAEP, the ASCENT COE, and the DOT Volpe Center. The program benefits from these varied partners by ensuring that the research is well-balanced, relevant, and addresses the needs of a broad range of stakeholders. Specific partnerships are listed below.

The Aviation Noise Research Roadmap effort is coordinated through the Federal Interagency Committee on Aviation Noise (FICAN), which includes the DOD, Department of the Interior (DOI), DOT, EPA, NASA, and the Department of Housing and Urban Development (HUD). The National Institutes of Health (NIH) are co-funding the research to quantify the health impacts of aviation noise that is being done by the ASCENT COE. The Airport Cooperation Research Program (ACRP) of the National Academies funded research on the impacts of aviation noise on children's learning. The FAA was a part of the ACRP Panel overseeing the work. ACRP funded the pilot study on community annoyance to aircraft noise, which led to a subsequent FAA-funded project. NASA is co-funding efforts to measure helicopter noise with the FAA and supporting the development of reduced noise procedures. Entities in Europe are funding work on the impact of noise on sleep that is also aligned with this FAA work. Massachusetts Port Authority (Massport) is contributing support to the development of new reduced noise procedures for subsonic aircraft at Boston Logan Airport.

Work on emissions is coordinated through the Aviation Emissions Characterization Roadmap effort, which includes many participants from the private sector and Government Agencies as well as Transport Canada. ACRP funded research on emissions from commercial space vehicles. NASA is co-funding efforts to measure emissions from aircraft operations during cruise. Entities in Europe are funding work to measure the emissions from aircraft engines.

NASA is developing analytical tools to evaluate aircraft performance, including fuel burn and noise. These tools have been integrated through FAA funding into the Environmental Design Space, which is used by both NASA and the FAA to evaluate aircraft and engine technologies.

As mentioned, the program works closely with the ASCENT COE, which is comprised of 16 Universities plus five affiliate universities. The center is supported by 57 industry partners, which provide the one-to-one matching contribution that is legislatively required for all COE research. These private sector stakeholders are also members of the ASCENT Advisory Committee, which reviews the center's research program and progress twice per year.

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## NextGen Environmental Research – Aircraft Technologies and Fuels
**Requested: ($73,976,000)**

**Program Description:**

The NextGen Environmental Research – Aircraft Technologies and Fuels Program supports efforts to develop new aircraft and engine technologies, and advance sustainable aviation fuels in line with the Administration's commitments on climate change and the environment. Technologies developed by this program will result in a fleet of aircraft that have lower noise, use less fuel, and produce fewer emissions. This program also provides test data, analyses, and methodologies to support the development and deployment of sustainable aviation fuels. Funds from this program ensure novel jet fuels are drop-in compatible with today's fleet of aircraft and are certified as being safe for use. They also ensure that Sustainable Aviation Fuels (SAF), produced from renewable and waste feedstocks, and lower carbon aviation fuels, produced from fossil feedstocks, are appropriately credited under the International Civil Aviation Organization (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Through the Continuous Lower Energy Emissions and Noise (CLEEN) program,[1] which is supported by this project, the FAA and industry are working together to develop technologies that will enable manufacturers to create aircraft and engines with lower noise and emissions, as well as improved fuel efficiency. Technologies accelerated by the CLEEN program have relatively large technological risk. Government resources help mitigate this risk and incentivize aviation manufacturers to invest in developing these technologies. By cost sharing the development with the FAA, industry is willing to accept the greater risk. Once entered into service, the CLEEN technologies will produce noise, fuel burn, and emissions benefits throughout the fleet for years to come.

Funding from this program also supports efforts by ASCENT — the FAA's Center of Excellence (COE) for Alternative Jet Fuels and Environment — to develop innovative technological solutions to reduce noise, emissions, and fuel burn from subsonic and supersonic aircraft. Aircraft technology development projects under ASCENT complement the CLEEN Program's industry partnership approach by providing a venue for University-led research to expand knowledge broadly across the industry and develop technologies at all levels of maturity that will reduce noise, emissions, and fuel burn. The program also provides funding for alternative jet fuel testing and analysis efforts by ASCENT, which aims to accelerate the development and approval of SAF. This cooperative aviation research organization is co-led by Washington State University and Massachusetts Institute of Technology.[2]

This program also supports the Commercial Aviation Alternative Fuels Initiative (CAAFI) in its efforts to engage with commercial aviation and emerging alternative fuels industries.[3]

**Major Program Objectives:**

The main goal of the NextGen Environmental Research – Aircraft Technologies and Fuels program is the development of aircraft and engine technologies and sustainable aviation fuels that collectively will reduce noise, fuel burn, and emissions. Technologies developed by this program result in a fleet of aircraft that have

[1] For more information on the CLEEN Program, please see http://faa.gov/go/cleen
[2] For more on the ASCENT COE, please see http://ascent.aero
[3] For more on the Commercial Aviation Alternative Fuels Initiative (CAAFI), please see http://caafi.org

lower noise, use less fuel and produce fewer emissions, thus supporting the overarching environmental performance goal for NextGen to achieve environmental protection that allows sustainable aviation growth. This program's research efforts support FAA's timely and safe introduction of advanced technologies that mitigate environmental impacts and climate change. By concentrating on those technologies that are applicable to the aircraft airframe, the engines and their operation, and the aircraft's performance, this program supports noise, emissions, and fuel burn improvements at the source. This has the potential to reduce impacts both in the terminal area, where people in local communities around airports are affected, as well as en-route, where the majority of the impacts to the climate are introduced. The program also provides data to evaluate the safety of alternative jet fuels and ensure they are appropriately integrated within international standards. Additionally, the program explores methodologies to reduce the time and resources necessary to bring new fuels to the point of being ready for final evaluation so that new safe for use products might become available more quickly, which is a key element in achieving the domestic goal of a net-zero aviation sector by 2050.

By reducing the environmental impact of aviation through new technologies and sustainable aviation fuels this program helps to remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation.

**Anticipated Program Activities:**

- CLEEN Phase III
- ASCENT Technology Innovation
- Ensure Novel Jet Fuels are Safe for Use
- Move Beyond the 50% SAF Blend Wall to Enable 100% SAF Use
- Maximize environmental benefits of sustainable aviation fuels
- Support inclusion of Sustainable Aviation Fuels in ICAO CORSIA

**Potential Program Outputs, Value Statement and Impacts:**

Partnering with industry to develop technologies enables manufacturers to accelerate the development of aircraft and engines with lower noise and emissions, and improved fuel efficiency. The program ensures that higher risk technologies are introduced into the fleet much earlier than they would have otherwise and that they will provide their benefit across the fleet for decades. The collaboration with universities on improved methods and data then supports industry in the development of technologies and innovative concepts that will evolve into the next generation of enabling solutions for quiet, clean, and efficient air transportation.

Support of the safety approval process for novel jet fuel pathways within the ASTM International certification process through testing and coordination will expand the opportunities towards environmental sustainability. Additionally, the development of new tools, data, and techniques to more efficiently and cost-effectively evaluate new fuel for aviation is a key step in lowering the entry barrier that time and cost of certification represent for new private ventures. Moreover, developing the robust lifecycle greenhouse gas emissions values and methods for alternative fuel pathways and sustainability criteria for use in ICAO CORSIA promotes the high integrity international standards needed to ensure that sustainable aviation fuels provide CO2 reductions in a sustainable manner.

**Potential Economic or Societal Impacts:**

The development of new innovative tools and technologies, the acceleration of the introduction into the fleet of environmentally conscious airframe and engine technologies, and the support provided to the development and approval of SAF and their integration into the ICAO CORSIA are all key steps towards reducing civil aviation's environmental and climate impacts while ensuring continued sustainable growth of aviation. The technological advances supported by this program not only benefit the environment, but also

promote the continued development of the current aviation industry. The creation of the new and successful SAF industry will provide prosperity for local rural communities while also being the fundamental element needed to achieve the domestic goal of a net-zero aviation sector by 2050.

**Potential Progress Made Toward Achieving Strategic Goals:**

CLEEN aircraft and engine technologies continue appearing in new aircraft with some technologies retrofitted into today's fleet. The GE TAPS II Combustor, for example, entered fleet in 2016 on the LEAP engine installed on Airbus 320neo, Boeing 737 MAX, and COMAC C919 while the GE TAPS III combustion system will be implemented in the GE9X-powered Boeing 777X. All other technologies in the CLEEN program also continue to proceed according to plans, although some delays on testing were experienced due to the impact of the pandemic. Progress on SAF has also continued with seven pathways already certified under the ASTM process and annual domestic procurements having more than doubled just in the last two years. The research efforts under this program have also resulted in significantly reduced fuel volumes being required for new approvals.

**Collaboration Partners:**

All three of the programs, CLEEN, CAAFI and ASCENT, are conducted in partnership with a wide range of aviation stakeholders that leverage resources from the private sector. CLEEN is a public-private partnership where industry contributes cost share that matches or exceeds that provided by the FAA. CAAFI is a coalition among the FAA, airlines, aircraft and engine manufacturers, and industry where each entity contributes staff resources to focus the efforts of commercial aviation to engage the emerging alternative fuels industry. ASCENT, like all FAA COEs, has a 100% cost share requirement from non-federal sources and an Advisory Committee that has robust participation from a wide range of aviation stakeholders, including industry.

The program also incorporates inputs received from stakeholders, such as industry and non-governmental organizations, as well as those from other agencies, including NASA and the Department of Defense. The program gets this expert feedback through the REDAC, the CLEEN Consortium, the ASCENT Center of Excellence, as well as other FAA and industry events.

The CLEEN Program has had eight industry cost-share partners: Aurora Flight Sciences; Boeing; Delta Tech Ops, America's Phenix, MDS Coating Technologies, General Electric (GE) Aviation, Honeywell Aerospace, Pratt & Whitney, Rolls-Royce, and Rohr, Inc./UTC Aerospace Systems. The CLEEN Program is also conducted in a collaborative manner with NASA and the Department of Defense. The industry and government partners benefit from the acceleration of technologies that are made possible by the CLEEN Program. The ASCENT COE also provides an independent review of the technologies that are being matured by the CLEEN Program, at both the aircraft and fleet levels.

As noted previously, the work on sustainable aviation jet fuels is coordinated with industry and academia through CAAFI and ASCENT. We also coordinate across the U.S. Federal Government as well with local authorities and international organizations and nations.

# Human and Aeromedical Factors

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## Flight Deck/Maintenance/Systems Integration Human Factors
**Requested: ($15,292,000)**

**Program Description:**

The Flight Deck/Maintenance/System Integration Human Factors program addresses research, engineering, and development (RE&D) requirements defined by technical sponsors in the Federal Aviation Administration (FAA) Aviation Safety Organization (AVS). These requirements are driven by the human factors needs of Aircraft Certification (AIR) and Flight Standards (AFS) personnel responsible for certification, approval, and continued airworthiness of aircraft, as well as the certification of pilots and mechanics. Program outputs provide the research foundation to update and maintain human factors related regulations, guidance material, procedures, orders, standards, job aids, and other aviation safety documentation. For this purpose, the Flight Deck/Maintenance/System Integration Human Factors program directly aligns and supports the Department of Transportation's (DOT's) strategic goal of Safety.

The revolution in digital avionics has changed flight deck design and operational practices and enabled new advanced vision system technologies, surface moving maps, electronic flight bags, advanced controls, communications, navigation, surveillance systems, and tools for aircraft system management. With these advances come important human performance and human factors implications which must be understood and applied in the appropriate guidance material developed for policy, procedures, operations, and training. This research supports AVS in regulating the development of these products. Human error continues to be a major contributor to aircraft accidents and incidents both in commercial and general aviation. Current research is proactive in identifying error tendencies and thereby enhancing the safe and effective introduction of new technologies and procedures into the NAS.

**Major Program Objectives:**

The Flight deck/Maintenance/System Integration Human Factors program responds to research, engineering and development (RE&D) requirements defined by technical sponsors in the Office of Aviation Safety (AVS). Outputs from this program inform AVS personnel who incorporate evaluation criteria into human factors – related regulations, guidance material, standards, job aids, and other documentation to support safety.

The Flight deck/Maintenance/System Integration Human Factors program supports the DOT's strategic objective "*Safe Systems"* through the *"use* [of] *data…to take proactive actions to address emerging safety risks and support compliance",* including *"improve safety of flight paths…"* The program supports this objective by providing a research foundation for *"…data-driven decision-making…"* and informing, as appropriate, AVS technical sponsors who are responsible for Aviation Safety regulatory policy. The program manages research to address RE&D requirements defined by AVS technical sponsors. This includes the human factors needs of FAA specialists in AIR and AFS who evaluate, approve, accept, and oversee flight deck systems, displays, devices, controls, avionics equipment, novel technologies, procedures, operations, training, qualification, and the certification of pilots and technicians.

**Anticipated Program Activities:**

- Improved Transport Pilot Training, Procedures and Operations – Aircraft Certification, Safety, and Accountability Act (ACSAA) related
- Improved Integration of Human Factors into Aviation Safety Regulatory Policy and Processes for Aircraft Certification and Flight Standards – ACSAA related
- Advances and Innovation in Equipment, Technology, Systems, and Operations – ACSAA related
- Supporting Improvements in Aviation Maintenance – ACSAA related
- Fatigue Mitigation in Flight Operations
- Advanced Vision Systems, Head-Up Displays, and Head Mounted Displays: Operational Standards & Approval Criteria
- Human Factors Considerations and Emerging Trends Associated with Helicopter Air Ambulance Operations
- Human Factors and Pilot Performance Considerations Associated with Flight Deck Operations, Pilot Procedures, and Pilot Performance during Current Arrival, Departure, and Surface Operations

**Potential Program Outputs, Value Statement and Impacts:**

The American flying public depends on the FAA to ensure the safety of flight operations. The Flight Deck/Maintenance/System Integration Human Factors program provides scientific and technical data to those responsible for human factors related regulations, guidance material, and other aviation safety documentation. The program addresses some of the most critical areas of flight safety that are directly relevant to the flying public. This includes multiple sections of HR 133-3 – 116th Congress (2021) Consolidated Appropriations Act, 2021 Division V - Aircraft Certification, Safety, and Accountability Act, which provides recommendations for the FAA to integrate human factors throughout design and certification of aircraft.

**Potential Economic or Societal Impacts:**

The Flight Deck/Maintenance/System Integration Human Factors program will provide research, engineering, and operational data that informs AIR and AFS technical sponsors. The sponsors will clarify and expand Aviation Safety policy, guidance, processes, procedures, and criteria to facilitate the holistic integration human factors in the design, evaluation, and certification of aircraft, innovative technologies, advanced flight deck operations, training, and procedures.

**Potential Progress Made Toward Achieving Strategic Goals:**

The Flight Deck/Maintenance/System Integration Human Factors program supports the DOT's strategic goal of Safety. Recent outputs from this program have been applied by AVS technical sponsors to inform the development of a new advisory circular (AC) on flight path management (FPM). The Administrator acknowledged this AC and its importance November 2021, at a U.S. Senate hearing. The public comment period on draft AC 120-FPM concluded March 2022. It is anticipated that a final Advisory Circular will be published in 2022. Outputs from this program are also being applied by AVS technical sponsors to support FAA contributions to ICAO Personnel Training and Licensing Panel (PTLP) work products and draft updates to AC 91-70 "Oceanic and Remote Continental Airspace Operations."

**Collaboration Partners:**

The Flight Deck/Maintenance/System Integration Human Factors program maintains a diverse research portfolio that capitalizes on robust partnerships with multiple DOT entities, other U.S. government agencies, federally funded research and development centers, government – industry working groups, international

entities, and industry. These partnerships have contributed significantly to the program's success. Example partnerships include:

- Industry: Part 121 and Part 135 operators; Original Equipment Manufacturers (OEMs); Avionics suppliers and service providers
- Labor: Aircraft Owners and Pilots Association (AOPA); Air Line Pilots Association (ALPA) and others
- Federally Funded Research and Development Centers (FFRDCs): MITRE Center for Advanced Aviation System Development (CAASD).
- Academia: Universities; Center of Excellence (COE) for Technical Training and Human Performance (TTHP).
- Government: Department of Transportation (DOT); Volpe National Transportation Systems Center.
- Joint Working Groups: RTCA; Society of Automotive Engineers (SAE) and others
- Intergovernmental Organizations: International Civil Aviation Organization (ICAO)

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## Air Traffic Control/Technical Operations Human Factors
### Requested: ($ 5,911,000)

**Program Description:**

The purpose of the Air Traffic Control/Technical Operations (ATC/TO) Human Factors program is to provide scientific and technical information that our Air Traffic Organization technical sponsors will apply in their work to improve the safety and efficiency of complex ATC systems. The research that we conduct produces information supporting the ATO's needs by measuring and enhancing the performance of individual controllers and specialists. It also improves the integration of National Airspace System (NAS) technologies for controllers and technicians, addressing the human contribution to safety in air traffic control operations, and supporting data-driven decisions related to the workforce, including selection methods, job placement, performance measurement, and training.

The program strives to provide useful human factors R&D results that support the ATO's development and implementation of new technologies and procedures in the NAS, in accordance with FAA Order 9550.8 Human Factors Policy, as the ATO evolves the NAS for the future. The program invests in purpose-driven research and innovation to meet the ATO's human factors challenges of the present by addressing the research topics identified in 49 USC 445. It also addresses the ATO's human factors research needs that are driven by DOT priorities, evolution of the workforce, and advancing technologies and associated procedures that are expected to be implemented in the NAS over the next several years. Thus, the program supports ATO efforts to achieve the air transportation system of the future so that the NAS can serve everyone today and in the decades to come. Research addresses workforce challenges that are especially acute in the large terminal radar air traffic control (TRACONs) facilities and in several of the busy air route traffic control centers (ARTCCs). The FAA must hire, place, and train thousands of new air traffic controllers and technical operations specialists, while continuing to provide safe and efficient air traffic services to NAS users. In addition, the program provides technical guidance that helps FAA acquisition programs to incorporate human factors requirements and methods that will ensure user acceptance and NAS performance with the increasing reliance on automated capabilities, including those that incorporate artificial intelligence and machine learning (AI/ML) technologies. In addition to addressing the human-machine teaming challenges posed by the introduction of these advanced automation tools and capabilities, the research program is also responsible for proactively identifying the potential for human error, and for recommending mitigations.

This program addresses ATO challenges in five human factors R&D focus areas:

1. Human Factors Research for Improved Safety, Reduced Hazards, and Error Mitigation in ATC
2. Human Factors Research on Automation Effects and Controller Performance
3. Human Factors Research for Improved Design and Operation of ATC Systems
4. Human Factors Research for Improved Controller Selection and Training
5. Human Factors Research for Workforce Optimization

**Major Program Objectives:**

The Air Traffic Control/Technical Operations (ATC/TO) Human Factors program responds to research and development (R&D) requirements defined by offices in ATO and other FAA technical sponsors. The program addresses human factors and training challenges through targeted research that yields an understanding of

human performance, and those factors that contribute to facility-specific impacts, especially for high-impact facilities. In the training domain, the program conducts research to evaluate the effectiveness of realistic simulation capabilities that provide a medium for training complex task performance where Air Traffic Control (ATC) system safety depends on job task performance. Effective use of simulation may reduce the time required for controllers to reach certification and will increase their readiness to perform in an increasingly automated task context.

In support of system acquisitions managed within the ATO Program Management Office (PMO), this program focuses on integration of human factors considerations to enhance user-system design. Human performance research aims to enhance overall system performance, reducing errors, and helping reduce life cycle ownership costs. The program, through the FAA's PMO coordination, provides human factors R&D results that support the development and implementation of new technologies and procedures in the NAS. The program ensures that the proper roles and responsibilities are assigned to the ATO workforce so that controller and technician capabilities are compatible with the advanced technology they use in their jobs, enabling air traffic system performance to achieve operational requirements and fulfill safety and efficiency objectives. In terms of research program execution, the program leverages university partnerships to bring new science in the field of artificial intelligence and machine learning (AI/ML) into practice by identifying human factors challenges and guidance for system designers that will help to mitigate them. The program also is strengthening internal federal human factors research laboratory capabilities at the FAA William J Hughes Technical Center (WJHTC) and the Civil Aerospace Medical Institute (CAMI) to address these emerging challenges.

This program continues to provide human factors subject matter expertise to the Joint Resources Council and coordinates with the PMO human factors office in reviewing how acquisitions have complied with human factors design requirements. The program also continues international collaborative research efforts with Eurocontrol and the Single European Sky ATM Research (SESAR) human factors experts.

**Anticipated Program Activities:**

- Address Human Factors Implications of Emerging Transportation Technologies (such as automation with AI/ML capabilities for transportation system operations and ATC infrastructure design)
- Apply Human Factors Research to Support Adoption and Implementation of New ATC Technologies and Innovative Practices
- Compare Training Effectiveness of Various ATC Training Technologies and Methods

**Potential Program Outputs, Value Statement and Impacts:**

The program will generate a human factors handbook for ATC system designers that provides guidance on implementing advanced automation with AI and ML capabilities. This work is essential to provide human factors awareness and strategies to leverage benefits of these capabilities and to mitigate potential challenges to effective human-automation interaction in the ATC domain. This guidance will enable the ATO's program management teams to implement the system design characteristics and functions that yield effective human-system performance in the evolving Infocentric NAS. Improved design for performance will reduce error likelihood and increase efficiency.

In addition, the program will provide a human factors assessment method and recommended approaches for the adoption and implementation of VR/AR technologies to support ATC and Technical Operations personnel training and remote maintenance technical support services. These technologies may significantly reduce training costs and time required to achieve full performance level in these critical aviation occupations.

**Potential Economic or Societal Impacts:**

Economic benefits accrue from increased performance of the evolving Infocentric NAS system through implementation of better user interface designs and procedures, as well as improved training effectiveness at reduced cost compared to traditional instructional methods such as instructor-led classroom training and high fidelity training simulators. Societal impacts include increased safety and more efficient air traffic service through better ATC system design and training that yield superior air traffic controller performance.

**Potential Progress Made Toward Achieving Strategic Goals:**

The research program continues to develop human factors guidance for future programs to improve the ATC system. Recent accomplishments also include guidance to support adoption and implementation of new technologies and innovative practices for controller training. Specific products include:

- Gap Analysis Report with Research Recommendations for Touch User Interfaces
- Draft Recommended Touch User Interface Guidelines for the Human Factors Design Standard
- Recommended updates to the 2016 FAA Human Factors Design Standard (HF-STD-001B): Automation, Workstation Design, and Information Management (draft report)
- Completed research on effectiveness of virtual training methods for the Air Traffic Basics course at the FAA Academy

**Collaboration Partners:**

The Research Engineering and Development Advisory Committee (REDAC), particularly the Human Factors REDAC subcommittee, provides public input to the program. While the work contributes to improve NAS performance, safety, and efficiency and thus ultimately benefits users of the NAS and the public, the sponsors and stakeholders on this research program are not members of industry, but primarily managers and employees of ATO organizations. This is true because the ATC/ATO Human Factors the ATO research sponsors and Deputy Vice Presidents for the ATO's Service Units generate the program's research requirements.

Below is a list of some of the work groups in which NextGen Human Factors Division employees and internal FAA human factors research team members participate. All of these groups involve other FAA organizations, though some include non-FAA government employees. The advantages of these partnerships include the opportunity to interact with individuals who have different expertise than that of our employees and learn about other projects that may be relevant. Interaction may provide opportunities for working together to accomplish similar research or other goals.

- AJI OJTI Safety and Technical Training Workgroup
- AJI Air Traffic Training Summit
- AJI Collegiate Training Institution Training Summit
- DOD/FAA/NASA Aerospace Medicine Research Alignment and Collaboration Working Group (AMRAC)
- FAA Institutional Review Board (IRB)
- REDAC – HF Subcommittee- observer
- ATO Research Roundtable - observer
- Mike Monroney Aeronautical Center NextGen Integration Committee
- Wright State University., University of Oklahoma, and Eurocontrol Coordination Plan 1.7

We also have partnerships with grant recipients, COE participants, and Federally Funded Research and Development Center (FFRDC) employees. We have provided support to COE participants and FFRDC employees by providing them access to our simulation or testing equipment, designing scenarios for them,

helping them gain access to research participants, collecting data for them, providing output files for their use, and in some cases – analyzing their data.

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## Aeromedical Research
### Requested: ($10,000,000)

**Program Description:**

The Aeromedical Research Program focuses on safety sensitive personnel and airline passenger health, safety, and performance in current and forecasted future civilian aerospace operations. The program performs aerospace-relevant applied research in the biomedical, biodynamics and survivability/cabin safety sciences. This research culminates in the transition of knowledge and technology to enable innovation in aerospace operations and mitigation and prevention of aeromedical hazards associated with aerospace mishaps.

**Major Program Objectives:**

This program will support improvements in the safety of passenger cabin environments during routine flight operations by focusing on detection of cabin events from bleed air contamination, transmission of infectious respiratory diseases of potential public health concern, and radiation exposure from extreme space weather events. Additionally, the program will support improvements in the safety of pilots by focusing on development of new approaches to aeromedical risk computation for certification decision-making and biomarker-based methods for detection of fatigue and drug use. Lastly, the program will support improvements in aircraft survivability and innovation in aircraft design by enhancing passenger safety during adverse events and streamlining the certification process for safety equipment and cabin designs.

This program identifies, develops and validates new technologies, policies, training methodologies, personnel selection tools, and procedures to improve the performance of humans in aerospace systems. The program has three lines of effort, which align to aviation safety and create a data-driven, risk-based systemic safety approach. Each line of effort centers on ensuring reliably safe aircraft cabin environments, reliably safe aircrew, and survivable aircraft, with the latter scoped to enhancing passenger safety during adverse events and streamlining the certification process for new safety equipment and cabin designs. The outputs of this research inform updates to standards, guidance, policy, and training materials to improve operational safety and facilitate new entrants into the National Airspace System.

The major program objectives align to the DOT's strategic goal of Safety. Ensuring reliably safe cabin environments protects the traveling public and aircrew from health and safety risks during commercial flights. Ensuring reliability safe aircrew focuses on improving the health, safety, and well-being of pilots working on the flight deck. Ensuring survivable aircraft results in the design and building of aircraft cabins and safety equipment that improve safety outcomes should an aviation mishap occur.

**Anticipated Program Activities:**

- Fatigue Biomarker Panel: Identifying a Metric for Performance Impairment from Sleep Loss
- Precision-based, Data-driven Aeromedical Standards: Next Generation Aeromedical Certification Safety Management System (SMS)
- Develop Safety Standards for Omnidirectional Seats to Support Urban Advanced Air Mobility
- Determine the Influence of Delta-wing Design on Egress Paths and Evacuation Efficiency for Supersonic Transports

**Potential Program Outputs, Value Statement and Impacts:**

Two research activities support the DOT Safety objective of Safe Workers. Research to develop a biomarker based metric for performance impairment from sleep loss will result in a series of technical reports describing identified RNA biomarkers for fatigue state, DNA biomarkers for individual fatigue susceptibility, and associated validation data and biospecimens. These research outputs will facilitate increased postmortem detection of fatigue and improve FAA forensic accident reports provided to the NTSB. Research in pursuit of precision-based, data-driven aeromedical standards will result in technical documentation of the development and validation of tools, techniques, and procedures, particularly in the area of big data and machine learning, to accomplish Evidence Based Risk Assessments. Research outputs will facilitate better use of FAA medical data and enable use of other government and private sector medical data for timely risk based pilot medical certification decision-making.

Two research activities support the DOT Safety objective of Safe Design. Research to develop safety standards for omnidirectional seats to support Advanced Air Mobility will produce technical documentation of the development of injury criteria and test methods to evaluate the crash safety of the range of potential impact scenarios, seat orientations, occupant sizes, and restraint configurations. Research outputs will facilitate the rightsizing of crashworthiness standards, including passenger seat design. Research to determine the influence of delta-wing design on egress paths and evacuation efficiency will result in technical documentation of egress test results and proposed regulatory guidance. The research outputs will equip airworthiness certification with data regarding how many passengers each exit could allow to evacuate safely from an aircraft in an emergency.

**Potential Economic or Societal Impacts:**

The public will benefit from better protection and survival for themselves in the event of an aircraft accident or incident. The aerospace industry will benefit from evidence-based regulations and standards, which are right-sized according to the evidence, but designed to be as inclusive as possible, while ensuring continued operational safety. These benefits will be realized only if the FAA can keep abreast of emerging health and safety issues brought on by technological innovations and changes in the characteristics of the aerospace user population. The research efforts supported by this program will position the FAA to develop the requisite regulations and certification processes to ensure the continued safety, health, and survival of those involved in current and future aerospace operations.

**Potential Progress Made Toward Achieving Strategic Goals:**

This program will enable DOT to make progress toward achieving its strategic goal of Safety. The Office of Aerospace Medicine will use the results of genetic biomarker research activities to mature fatigue assessment methodologies. This will eventually be transitioned into the Civil Aerospace Medical Institute's forensic sciences laboratory for use in accident investigations. The Office of Aerospace Medicine will also use the results of the exploration of computational approaches in aeromedical certification to inform requirements for the post-Aerospace Medicine Safety Information System aeromedical certification system. The Aircraft Certification Service will certify obliquely oriented seats through new injury criteria and test methods. Lastly, the Aircraft Certification Service will use performance data to assist in certification of future supersonic transport aircraft and determine allowable passenger loads.

**Collaboration Partners:**

Aeromedical research maintains a diverse program that capitalizes on robust partnerships with multiple partners:

- Government: National Transportation Safety Board; National Aeronautics and Space Administration; National Oceanic and Atmospheric Administration; Department of Defense; National Highway Traffic Safety Administration; and the Ditching Advisory and Rulemaking Committee
- Academia: Kansas State University, Auburn University, Boise State University, Baylor College of Medicine, and Medical College of Wisconsin
- Industry: MedAir, Inc.; and SAE International
- International: South African National Space Agency

# Aerospace Performance and Planning

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## System Safety Management/ Terminal Area Safety
### Requested: ($10,111,000)

**Program Description:**

The System Safety Management Program focuses on research that will enhance the safe movement of aircraft through the National Airspace System, supporting Air Traffic Control Oversight as well as providing for better tools and techniques for pilots and operators. The research supports the development of analytics tools that aid and support the high safety standard we set for the National Airspace System. To achieve this result, the System Safety Management Terminal Area Safety Program funds research to develop more effective helicopter simulators, vision enhancing and flight monitoring tools to better support helicopter and fixed wing aircraft pilots with higher fidelity training capabilities, safe flight while in reduced vision situations, and cost effective flight data recording tools. This research supports the department's strategic goal of Safety with the ultimate outcome to reduce potential accidents for fixed wing aircraft and helicopters in and around the terminal airspace. This research also supports safety by providing tools and techniques for air traffic oversight, helping to identify potential hazards and issues before changes are made to the National Airspace System.

**Major Program Objectives:**

The System Safety Management (SSM) program, is designed to improve safety through developing safety data collection methods, advanced safety data and risk analysis techniques, and prototypes of risk-based decision-making capabilities to identify and analyze emerging safety issues in a cooperative nature with aviation stakeholders. The program provides an ability to analyze trends across the aviation community that is much more effective than monitoring individual certificated entities, (e.g., air operators and air traffic facilities).

The Terminal Area Safety (TAS) program improves the safety of operations at or near an airport. Research projects in the program focus on developing training solutions and identifying effective technologies to mitigate key causes of fatal accidents such as the loss of control, runway excursions, and runway overruns. These are the leading causes of fatalities in the worldwide commercial jet fleet.

This program evaluates potential solutions to reduce fatal accidents through extending simulator models to allow for better upset training; exploring alternatives to determine runway slipperiness; developing objective motion criteria to minimize inappropriate simulator training; enabling safe helicopter approaches when using advanced vision systems; exploring consistent operational standards for a stable approach to reduce runway excursions; and developing a logical go-around training curriculum that mitigates operational go-around problems. This program also is performing flight tests on representative domestic and international runways that support turbine-powered airplane operations in order to validate the wet-ungrooved and wet-grooved wheel braking coefficient models in 14 CFR Part 25.109(c). These projects address the principal causes of fatalities in the commercial jet, general aviation, and rotorcraft communities but also fill aviation safety research gaps identified in the NTSB's Safety Recommendations such as A-07-003, A-04-62, A-07-64, and A-01-069.

**Anticipated Program Activities:**

- Evaluation of simulated air traffic control (ATC) using artificial intelligence (AI)
- Evaluation of virtual reality goggles for immersive flight simulation
- Develop Helicopter Enhanced Flight Vision Systems (H-EFVS)
- Initiation of data collection and development and application of Artificial Intelligence (AI) and AI/machine learning algorithms to identify and predict risk exposure for Aeronautical Information System (AIS) related risk factors
- Evaluation of data mining techniques applicable to mapping safety reports to Integrated Safety Assessment Model (ISAM)
- Develop data mining techniques to fulfil the analytical needs of Integrated Safety Assessment Model (ISAM)
- Evaluation of Collision Risk Model (CRM) related Artificial Intelligence (AI) and Machine Learning (ML) as well as other advanced analytics techniques
- Identify possible enhancement to current terminal CRM methodologies
- Enhance speech-to-text analytics
- Assess Helicopter Enhanced Flight Vision Systems (H-EFVS) operational concepts to enhance safety in low or reduced visibility conditions
- Pursue development of integrated safety analysis tools, techniques, and metrics using helicopter flight data monitoring (HFDM) data
- Explore enhanced fidelity simulator device models for rotorcraft

**Potential Program Outputs, Value Statement and Impacts:**

The research provides significant value, taking advantage of emerging technologies such as machine learning, artificial intelligence, advanced data analytics and virtual reality to provide better decision making and application of smarter safety tools. When these programs complete, the resulting impact on regulatory and training changes will increase overall safety while enhancing the managing and piloting of aircraft throughout the National Airspace System.

The System Safety Management research supports multiple goals to improve air traffic, and air space management capabilities, accelerate the use of new technologies for aerospace vehicles, and Improve human performance.

**Potential Economic or Societal Impacts:**

The National Airspace System is certainly the safest airspace system in the world. Flight in general is a very safe mode of transportation for passengers and freight alike. However, aviation is rapidly changing such that the Airspace System needs to expand to meet the needs of today's customer and the flying public. Therefore, research conducted to change pilot training, use enhanced vision systems, engage in the use of data science tools for more effective oversight and modeling of the National Airspace System can potentially reduce delays, accidents and bring efficiency to the National Airspace system as it expands, solving problems proactively.

**Potential Progress Made Toward Achieving Strategic Goals:**

System Safety Management and Terminal Area Safety research methods are shifting. As the research moves forward, Machine Learning and Artificial Intelligence tools and techniques will be leveraged more to take advantage of the large amounts of data available. As we move forward with our research, we are becoming more capable of supplementing actual flight tests and similar field exercises with appropriate scenario modeling, using data science and data analytics.

**Collaboration Partners:**

- SAE G10/A4 Committee on Head-Worn/Heads-Up Displays
- EUROCAE Working Group 79 & RTCA SC-213 on Enhanced/Synthetic/Combined Vision Systems
- United States Helicopter Safety Team (USHST)
- Georgia Institute of Technology
- George Mason University
- Rowan University
- Helicopter Association International (HAI)
- Sikorsky, Airbus Helicopters, Leonardo, Bell, Robinson
- Collins, Honeywell, Thales, Elbit Systems/Universal Avionics
- Lifeflight of Maine
- TruthData
- MITRE
- VRM Switzerland

# United States Department of Transportation
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## Commercial Space Transportation Safety
### Requested: ($5,708,000)

**Program Description:**

Commercial space transportation (CST) research focuses on four DOT and National Space Council priorities, including safe integration of commercial space operations into the NAS, spaceport infrastructure, systemic safety initiatives, and regulatory reform. These priorities contribute to the DOT strategic goal of economic growth through increased levels of safe space operations and delivering goods and services in the public and private interest.

**Major Program Objectives:**

Statute directs the FAA Office of Commercial Space Transportation (AST) to regulate commercial space launch and reentry operations only to the extent necessary to ensure compliance with international obligations of the U.S. and to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States. Statute further directs AST to encourage, facilitate, and promote commercial space launches and reentries performed by the private sector. More recently, Congress tasked AST with promoting the continuous improvement of the safety of launch vehicles designed to carry humans.

AST's research activities will find innovative solutions through public-private collaborations and prototype development, to increase safety, efficiency, and U.S. global leadership in CST. AST's RD&T portfolio optimizes AST's mission execution through the development of improved regulations, safety assessment tools, and public safety technologies. Funding supports regulatory research, addresses lessons learned, and enables the FAA to keep pace with the dynamic CST industry. Industry development research benefits all actors within different CST industry segments.

**Anticipated Program Activities:**

- Glass Hazard Risk Testing and Assessment Research
- Upper Stage Reentry Disposal Research
- Random Attitude Failure Modeling Research

**Potential Program Outputs, Value Statement and Impacts:**

This program seeks to provide improved estimation of flight safety phenomena affecting regulatory decisions (e.g., distant field over-pressure, impact of window breakage, hazard area prediction). It also develops new sensors, materials, and technologies to improve safe operations of aerospace vehicles including the physiological responses to hypersonic spaceflight. Finally, this program aims to improve the understanding of policy, law, regulation, and market issues and trends.

**Potential Economic or Societal Impacts:**
Potential economic impacts of this research include increased economic activity of commercial space through an increasing number of successful launches and reentries by private space and spaceport

operators. Potential societal impacts of this research include increased delivery of public-serving goods and services through commercial space operations such as satellite remote sensing and communications in hard-to-reach regions (e.g., experiencing conflict or disaster conditions). Current examples of the societal impact of increased commercial space activity include (1) expedited delivery of "space internet" ground terminals to Ukraine, enabling alternatives to traditional channels of communication disrupted by their adversaries, and (2) imagery from a privately-owned satellite constellation showing "before and after" photographs of distressed regions on Earth created by natural or human sources.

**Potential Progress Made Toward Achieving Strategic Goals:**

To date, specific examples of progress made by the CST research program toward the DOT strategic goal of economic growth is evidenced by the recent creation of a new company (Privateer Space, a direct spin-off of CST-funded research in space situational awareness) and the incorporation of CST research results into human spaceflight standards proposed to the FAA. In general, CST research enables increases in the number of safe operations by commercial space activity, thereby increasing the contribution to economic growth.

**Collaboration Partners:**

The AST Safety Research Program has multiple stakeholders informing the research program content. These include the Commercial Space Transportation Advisory Committee (COMSTAC), the Commercial Spaceflight Federation (CSF), and individual industry members, and universities.

Specific program partners include:

- Contractors (ARCTOS)
- FFRDCs (Aerospace Corp., MITRE/CAASD)
- Trade Organizations (ASTM, COMSTAC, CSF)
- Universities (Florida Tech, New Mexico State University, etc.)

# United States Department of Transportation
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## NextGen – Wake Turbulence
### Requested: ($3,728,000)

**Program Description:**

This program provides aircraft generated wake turbulence research that matures wake mitigation operational concepts to the point that they can be directly implemented by FAA orders and enter the FAA Facilities and Equipment (F&E) development and implementation process to meet National Airspace System (NAS) infrastructure enhancement requirements. This program supports the NextGen objective to accommodate increased demand (flights) during peak demand periods at capacity-constrained airports. The program provides increased access to airport runways and airspace through modifications to Air Traffic Control (ATC) wake separation standards and procedures while maintaining or enhancing the safety of the NAS.

**Major Program Objectives:**

The main goal of the NextGen Wake Turbulence research program is wake mitigation separation. NextGen - Wake Turbulence research analyzes and collects the data to establish the wake mitigation separations that are to be applied by ATC to new series of aircraft entering operational service. The program's analysis capability was used to establish wake turbulence separation requirements for the Airbus A380, Boeing 747-800, Boeing 787, and the Airbus A350 series aircraft prior to these aircraft entering service into the NAS. This project continues to determine wake separations to be applied to manufacturers' newly developed aircraft that will be entering the NAS and continues to address new entrants such as large Unmanned Aircraft Systems (UAS) and Urban Air Mobility vehicles (UAM). Without this work, the FAA will not be able to execute its regulatory role in establishing ATC wake separation standards for new aircraft designs/series that are being integrated into the NAS.

NextGen - Wake Turbulence research also addresses the role that wake separation standards will play in NextGen ATC operations. The project's research has produced validated concepts for applying aircraft performance characteristics and runway crosswind information to reduce the required wake mitigation separations applied to aircraft arriving and departing an airport's runways. The research products have been transitioned into the FAA F&E projects: Wake Re-Categorization, Wake Turbulence Mitigation for Departures, and Wake Turbulence Mitigation for Arrivals. Standards, processes, and decision support tool products from these projects have been demonstrated operationally and some are now being implemented nationally. These products, when implemented, will provide ATC with the tools that allow them to safely increase an airport's runway throughput for both arrival and departure operations when an airport is busiest. Aircraft manufacturers, airport authorities, and air carriers agree that squeezing more operations onto an airport's existing runways results in major reductions of flight delays during and after a bad weather event that occurs at or near an airport.

**Anticipated Program Activities:**

- Assessment of wake separations needed for new aircraft types entering the NAS
- Ground based wake track data collection/analysis
- Wake mitigation solutions & associated infrastructure modification recommendations
- Development of absolute wake hazard metrics for use when relative metrics are not feasible: Metrics development for aircraft flying en route

- Redeploy/repair/upgrade ground-based wake data collection suites and obtain additional en route aircraft wake generation data for recommending ATC en route wake risk mitigations

**Potential Program Outputs, Value Statement and Impacts:**

Wake Turbulence research engineering and development supports the Administration's principles of Safety and provides safety assessments of wake encounter risk, mitigation procedures, and solutions. The program requires keeping its wake turbulence data collection infrastructure technology current and adding improved technology, as it becomes available, to increase the collection of tracks of aircraft generated wake turbulence over a wider range of weather conditions. The program uses the data to develop safety assessments of air traffic control (ATC) wake encounter risk mitigation procedures and solutions in current and future ATC separation operations.

The impact of this program provides wake separation assessments that maintain an acceptable level of safety in the NAS, while allowing for potential air traffic throughput increases. This impact is realized through the wake assessment of new aircraft entering service in the NAS, and the wake assessment of current and proposed procedures planned for implementation.

**Potential Economic or Societal Impacts:**

The Wake Turbulence program provides the necessary data and modeling to advance capacity-efficient ATC wake mitigation solutions that will safely allow more flights during periods of peak demand at our nation's airports. Wake Turbulence program products - when implemented either directly into ATC operations or through follow-on engineering development programs - have and will continue to provide the American flying public:

- Reduced flight delays for passengers and air cargo flights when ATC is using instrument flight rule wake risk mitigation procedures
- Decreased time in the air for passengers due to more ATC flight capacity efficient en route wake risk using enhanced wake risk mitigation procedures

**Potential Progress Made Toward Achieving Strategic Goals:**

The Wake Turbulence program continues to collect and enhance necessary data and accomplishes the modeling to provide ATC with safe, capacity efficient aircraft-to-aircraft wake separation recommendations for its operational use. Additionally, the Wake R,E&D program provides concept development research to advance capacity-efficient ATC wake risk mitigation solutions that will allow more flights during periods of peak demand at our nation's airports and in crowded air corridors.

**Collaboration Partners:**

NextGen capabilities continue to bring positive effects to the aviation industry and the flying public all across the NAS. The FAA and the aviation industry work together through the NextGen Advisory Committee (NAC), which includes carriers such as United Airlines, FedEx, and Delta Airlines, to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term.

This project interacts with numerous third-party stakeholders and aircraft manufacturers. As an example, the current structure of the program allows for a non-biased approach to the application of new aircraft wake separation standards. The wake team conducts the data collection and analysis of a new aircraft type and presents the findings to the safety office without private sector involvement. The Agency is therefore in the position to conduct the research and recommend the appropriate separation standard without bias.

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## Unmanned Aircraft Systems
### Requested: ($14,935,000)

**Program Description:**

The Unmanned Aircraft Systems (UAS) research program supports the FAA's implementation of the Next Generation Air Transportation System (NextGen) by studying the safety implications of new aircraft operational concepts and technology to the NAS, and supporting the development of new and modified regulatory standards. The program's research activities focus on UAS that are fundamentally shifting the aviation landscape and have the potential to provide a wide range of benefits to society. However, there are technical and regulatory challenges that must be overcome as the FAA works to safely integrate these new technologies into the NAS.

Safe, efficient, and timely integration of UAS into the NAS poses substantial technical challenges to the FAA and the aviation industry. UAS often uses new or novel technologies to achieve unique operational capabilities that challenge the expectations of current NAS users. These unique capabilities have demonstrated potential to address commercial applications as well as scientific research needs. Integrating UAS will present a challenge to the entire NAS due to the various sizes of UAS (less than a foot up to the size of a commercial jet), a wide range of maximum take-off weights (less than a pound to the weight of a large jet), large performance disparities compared to existing certificated aircraft, and capabilities of operating in all classes of airspace. UAS weighing less than 100 pounds may be capable of operating in Class A airspace and the integration of a significant volume of UAS air traffic could potentially disrupt normal aircraft traffic flow and induce unknown safety hazards.

**Major Program Objectives:**

Research is the key to solving integration challenges and unlocking the potential of UAS societal benefits. FAA-sponsored research results are being used to shape rulemaking, guide decision-making, and grow the UAS industry. Applied research will continue to be critical to the safe integration of UAS into the NAS and to reaping their potential societal benefits. Activities within the UAS research program are aligned with the FAA's UAS integration strategy. The UAS research program must remain agile and adaptive to keep up with the pace of industry innovation and respond to FAA, DOT, White House executive priorities, and those mandated by Congress.

Research results will continue to drive the FAA's decision-making process, inform rulemaking, enhance operational procedures, air traffic management, and maintain safety. UAS research and analysis yields data and results to inform decision-making processes. Research generates technical information to support the development of rules, policies, guidance materials, advisory circulars, and FAA Safety Management System.

**Anticipated Program Activities:**

- Conduct Science Technology Engineering and Math (STEM) Outreach to Minority K-12 Students Using Unmanned Aircraft Systems (UAS) as a Learning Platform
- Evaluate UAS Disaster Preparedness and Emergency Response Operations
- Explore the Impact of Lost Link (when the pilot in command loses the communications link with the UAS aircraft)

- Assess the Challenges of Retrofitting Technologies for Urban Air Mobility (UAM)

**Potential Program Outputs, Value Statement and Impacts:**

This program will have outputs that will directly inform the advancement of all UAS operational capabilities within the UAS Integration Research Plan. Through the different projects there will be aspects that will increase underrepresented students' interest in the UAS/STEM field, focus on procedures to coordinate with UAS operators from within federal agencies, as well as local and state disaster preparedness and emergency response organizations, to ensure proper coordination. Other research projects will recommend and implement changes to ATO UAS-related ATC policy, procedures, and workstation designs to support UAS integration. Work in this area will inform a variety of UAS standards, FAA policy, and Technical Standard Orders (TSOs). The work effort may also result in future industry standards applicable to Advanced Air Mobility (AAM)/Urban Air Mobility (UAM).

**Potential Economic or Societal Impacts:**

The safe integration of unmanned aircraft into the NAS is a significant challenge. Current UAS research contributes and informs technical and regulatory standards, policy guidance, and operational procedures on which successful UAS integration depends. These research efforts significantly contribute to addressing the challenges of integrating UAS into the NAS by leveraging studies of UAS operations and associated technologies. These research programs will help develop unmanned aircraft systems, training, technology, and procedures that increase the safety of UAS operations and increase the confidence of the American public that UAS flights can be safely and efficiently integrated into the NAS. The research will facilitate approval and use of systems that prevent accidents and help reduce the severity of UAS accidents in the NAS.

**Potential Progress Made Toward Achieving Strategic Goals:**

The FAA's annual five-year UAS Integration Research Plan supports an approach to safe and efficient integration of UAS into the National Airspace System. UAS research is the foundation of FAA/AVS UAS integration activities, and is phased by operational capabilities with underlying key enablers, providing a streamlined pathway to safe UAS integration. These operational capabilities are expanded operations, small UAS package delivery operations, integrated operations, routine/scheduled operations, large carrier cargo operations, and passenger transport operations. The key enablers associated with these capabilities are Detect and Avoid Technology, UAS Traffic Management (UTM), standards, policy and rules. This UAS research informs the development of rules, policies, procedures, standards, decisions, and other outcomes needed to safely integrate UAS into the NAS.

The integration of UAS into the NAS is moving forward and progressing from operations within visual line of sight to missions beyond visual line of sight. These advances are enabling package delivery operations, and operations on airport surfaces, and will someday enable fully integrated operations and the transport of passengers. For FY 2023 the funding levels support UAS Standards Research, Advanced UAS Concepts and Application (including Urban Air Mobility) Research, and UAS Security Research.

**Collaboration Partners:**

The FAA is leveraging a wide spectrum of UAS research being conducted across agencies, within industry, across academia, and internationally. It is collaborating with industry partners, standards bodies, and independent research organizations to inform rulemaking and operational changes that will enable full UAS integration into the NAS. The FAA is leveraging the UAS technical and operational expertise across Federal agencies. The UAS Executive Committee (EXCOM) was established to act as a focal point for resolution of issues on matters of policy and procedures relating to UAS access to the NAS, and to identify solutions to the range of technical, procedural, and policy concerns arising from the integration of DOD UAS into the NAS.

Program partners include:

- Department of Defense (DOD)
- Naval Air Warfare Center Weapons Division (NAWCWD)
- Department of Homeland Security (DHS)
- National Aeronautics and Space Administration (NASA)
- Department of Interior (DOI)
- Department of Justice (DOJ)
- Department of Commerce (DOC)
- Department of Energy (DOE)
- Department of Transportation (DOT)
- National Academies of Science/ Transportation Research Board (TRB) and Aeronautics and Space Engineering Board (ASEB)
- National Science Foundations' Center for UAS
- National Institutes of Standards and Technology (NIST)
- Air Force Research Lab (AFRL)
- UAS Center Of Excellence

# United States Department of Transportation
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## Advanced Technology Development & Prototyping
### Requested: ($25,300,000)

**Program Description:**

The FAA's Advanced Technology Development and Prototyping (ATDP) program develops and validates technology and systems that support air traffic services. These initiatives support the requirements associated with the evolving air traffic system architecture and improvements in airport safety and capacity. A key element of this program is to promote safe and efficient airspace, provide the means to recognize and respond to needs, and evaluate the results. This program lays the foundation for assessment of new innovations and possibilities that could improve safety and capacity measures around our nation's airports.

**Major Program Objectives:**

Individual projects under the ATDP Program develop and maintain mathematical & simulation software models of the NAS. These models evaluate system-wide benefits associated with the implementation of various solutions. These models are particularly useful in evaluating mid-term and long-term benefits associated with NextGen and other enhancements. These models aid organizations throughout FAA with analyses of proposed new investments, trade-off studies, enterprise-wide shortfall analyses, and the operational analyses of new entrants on NAS Performance. Recent examples of this work include the development of the System-Wide Analysis Capability (SWAC) and the Airfield Delay Simulation Model (ADSIM).

Another key component of ATDP is developing and improving FAA systems that meet the regulatory requirement for reporting traffic operations, counts, delays, and safety information. These systems must continue to support the growing demands of the NAS. Working under the ATDP program improves the efficiency and integration of data processing and improves NAS reporting capabilities. This work aids in assessing the performance of airline operations and provides the objective data to support the need for improved traffic flow and efficiency measures within the NAS. The projects under this program will ensure that the essential hardware and software components are in place and operational in order to accurately collect and report operational and safety data associated with air traffic operations. The data collected by these programs will allow for continued assessment of innovation performance in the NAS and ensure that those technologies achieve the transformations as planned.

**Anticipated Program Activities:**

- Complete annual report documenting results of Human in the Loop testing of Human Factors, safety logic, aircraft performance, or any uncertainty or deficiency pertaining to surface based Runway Incursion indications.
- Complete system removal and site restoration of the advanced ground surveillance sensor.
- Develop Technical Transfer Plan for advanced ground surveillance sensor technology.
- Develop initial proof-of-concept that integrates cooperative surveillance and speech recognition technologies with advanced ground surveillance sensor technology.
- Develop a plan for and complete technical transfer to industry for a prototype cockpit-based taxi conformance monitoring system to reduce Runway Incursions at controlled airports.

- Produce the bi-annual assessment of aviation operational performance with Europe as well as the Asia-Pacific region.
- Develop and validate NAS level operational concepts that are key to the FAA NAS modernization efforts.
- Identify, understand, and forward for action proposed changes to FAA enterprise plans.
- Conduct operational assessment and prioritization of emerging efforts to ensure linkage of proposed concepts to validated operational needs.
- Develop concepts of use to describe the operational use of proposed communication, navigation, automation, surveillance and flight deck capabilities.
- Develop operational requirements.
- Support to Radio Technical Commission for Aeronautics (RTCA).
- Ongoing conceptual development of North East Corridor initiatives
- Implementation of North East Corridor initiatives and associated infrastructure
- Major airspace redesign work to support Louisville Standiford Field (SDF) and UPS operations to include infrastructure changes associated with communications outlets and additional positions at SDF TRACON.
- Development of major airspace design changes in Caribbean Airspace on track for implementation in FY23. These changes are to align with FAA investment in spaced based ADS-B services in the region.

**Potential Program Outputs, Outcomes and Impacts:**

Advanced Technology Development and Prototyping develops and validates NAS level operational concepts that are key to the FAA modernization programs and NextGen. Technologies will be identified and assessed that will prevent runway incursions at small to medium airports with historically high rates of runway incursions. Airspace redesign projects will support increased efficiency and enhanced safety by funding physical changes in facilities and result in changes to the number and span of control of operational positions or sectors, including changes to sector, area, or facility boundaries. Deficiencies and gaps in the NAS will continue to be evaluated and proposals will be developed to address those gaps. NAS data outputs will support international performance benchmarking. FAA in coordination with other Air Navigation Service Providers have developed a set of performance indicators that allow for a standardized comparison of performance.

This program will conduct overall analysis and planning for NAS evolution by determining the required annual updates to the NAS Enterprise Architecture products including Operational Improvements, Operational Sustainment, and Operational Requirements. The program executes research, engineering analysis, and evaluation in support of mission analysis and investment analysis. It also conducts shortfall analyses as part of service analysis and ensures the linkage of proposed solutions back to validated operational needs to support budget planning and investment decisions.

**Potential Economic or Societal Impacts:**

This program will promote further development and use of emerging technologies in the aviation business sector. These technologies will replace antiquated systems and software with more efficient and cost effective systems and procedures that enhance the NAS and reduce aviation's carbon footprint.

**Potential Progress Made Toward Achieving Strategic Goals:**

This program is continually assessing emerging technologies for possible inclusion into the NAS to provide further enhancements that result is a safer and more efficient NAS. This program evaluates and documents the concept of operations for those emerging technologies. After test and evaluation of those new advancements, the program documents how those new technologies will improve the NAS and begins formal

investment analysis processes. These efforts ultimately result in ongoing transformation and efficiencies for airlines and FAA air traffic control.

**Collaboration Partners:**

The ATDP program contributes to the FAA's support for the RTCA, a non-profit association that develops standards based on manufacturers, government, and aviation operator inputs. RTCA recommends operational improvements to increase the efficiency of air transportation.

In addition, the program works with the European Union and Civil Aviation Authority of Singapore under memorandums of agreement in an effort to improve traffic flow initiatives in the Asian Pacific region as well as assess performance and develop business cases for International Civil Aviation Organization in the North Atlantic.

# United States Department of Transportation
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## NextGen - Separation Management Portfolio
### Requested: ($18,000,000)

**Program Description:**

The Separation Management Portfolio conducts pre-implementation activities to reduce risk, and implementation activities supporting the safe and efficient separation of aircraft and other vehicles in the NAS. Risk reduction activities may include validation of concepts or technologies; demonstration and integration of operational capabilities; and an understanding of the role of the human through cognitive engineering experiments. This portfolio evaluates and matures concepts and capabilities that focus on the enhancement of separation assurance using both ground based automation and aircraft technology enhancements. This portfolio will develop flight-deck interval management minimum operational performance standards and safety performance requirements, identify improvements to runway access through use of improved aircraft technology, updated standards, safety analysis, and modifications to air traffic monitoring tools and operating procedures that will enable more arrival and departure operations.

**Major Program Objectives:**

The main goal of the NextGen Separation Management Portfolio is to provide recommendations through research and technology development activities to improve the tools, standards, and procedures that air traffic controllers use to separate aircraft. Pre-implementation activities conducted under this program reduce risk, define requirements, and demonstrate operational feasibility to support these recommendations.

As the demand for flights increases, concepts and capabilities that focus on enhancing separation assurance using ground-based automation and aircraft technology enhancements are critical. The Separation Management program supports the FAA's mission to provide the safest, most efficient aerospace system in the world by conducting research that will enhance aircraft separation assurance by safely reducing separation between aircraft, and as a result improve capacity, efficiency and safety in the NAS.

The main goal of the NextGen Separation Management Portfolio is to provide recommendations through research and technology development activities to improve the tools, standards, and procedures that air traffic controllers use to separate aircraft. Pre-implementation activities conducted under this program reduce risk, define requirements, and demonstrate operational feasibility to support these recommendations.

- As the demand for flights increases, concepts and capabilities that focus on enhancing separation assurance using ground-based automation and aircraft technology enhancements are critical. The Separation Management program supports the FAA's mission to develop finalized requirements for adding the RECAT Dynamic Wake risk mitigation solution enhancements to ATC decision support tools
- Develop safety assessments of the finalized requirements for RECAT Dynamic Wake
- Complete next PBN Initiatives Safety Analysis. (e.g., MARS Phase 1).
- Complete concept validation of implementing reductions for integrated arrival departure operations.
- Provide data to support the development of Safety Risk Management Document (SRMD) and procedure authorization standards for reductions in Minimum Radar Separation.

**Anticipated Program Activities:**

- Develop finalized requirements for adding the RECAT Dynamic Wake risk mitigation solution enhancements to ATC decision support tools
- Develop safety assessments of the finalized requirements for RECAT Dynamic Wake
- Provide EoR Pure Duals Concept Validation Report(s)
- Provide concept validation of implementing reductions for integrated arrivals/departures operations

**Potential Program Outputs, Outcomes and Impacts:**

Wake Recategorization supports the Administration's principles of Safety and provides risk mitigating procedures and solutions for NAS operations. The program uses data from the RE&D Wake program to develop safety assessments of air traffic control (ATC) wake encounter risk mitigating procedures and solutions in current and future ATC separation operations.

The Closely Spaced Parallel Operations (CSPO) Program develops safety analyses that support procedural changes for adoption into the Air Traffic Controller Handbook 7110.65. These procedures primarily focus on decreasing separation during IMC conditions. The results of these changes increase airport capacity by increasing the throughput of aircraft on closely spaced parallel runways. The Integrated NAS Design and Procedures Planning (INDP) Program develops concepts that leverage the accuracy of PBN procedures such as EoR and MARS. Procedural changes are adopted into the NAS and updates are made to the controller handbook 7110.65. The results of these changes increase capacity, efficiency, and predictability.

**Potential Economic or Societal Impacts:**

The CSPO Program increases capacity at airports that frequently experience IMC conditions. Through the work the INDP Program is doing, gains are expected to result in benefits such as track mile savings, more optimal flight paths using near idle descent, less fuel burn, less noise and a smaller carbon footprint as compared to ILS approaches. The RECAT program provides the necessary data and modeling to advance capacity-efficient ATC wake mitigation solutions that will safely allow more flights during periods of peak demand at our nation's airports. This program will also result in:

- Reduced flight delays for passengers and air cargo flights when ATC is using instrument flight rule wake risk mitigation procedures
- Decreased time in the air for passengers due to more ATC flight capacity efficient en route wake risk using enhanced wake risk mitigation procedures.

**Potential Progress Made Toward Achieving Strategic Goals:**

The RECAT program continues to refine modeling to develop Dynamic Wake Products for implementation in the NAS. The program is currently developing proof of concept simulations to validate and enhance current automation systems. High Update Rate (HUR) concept was incorporated into the controller handbook. By utilizing the HURs concept this allowed reduced runway centerline spacing requirements for dual and triple independent approaches. EoR is currently in operation at Denver, Houston, and Los Angeles. MARS Safety Human-in-the-Loop simulations and scenarios have begun in Oklahoma City.

**Collaboration Partners:**

NextGen capabilities continue to bring positive effects to the aviation industry and the flying public all across the NAS. The FAA and the aviation industry work together through the NextGen Advisory Committee (NAC), which includes carriers such as United Airlines, FedEx, and Delta Airlines, to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term.

| Program Partners | Benefits |
|---|---|
| Research, Engineering, and Development Advisory Committee (REDAC) (external) | Provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of aviation research program, and reviews and comments on the aviation research programs. |
| NextGen Advisory Committee (NAC) – Federal advisory committee | FAA and industry partnership to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term. The FAA and industry jointly evaluate the effects off NAC commitments on the NAS through the work of a Joint Analysis Team (JAT) to understand the value of implementing this plan. |
| FAA Lines of Business | NextGen collaborates with multiple internal lines of business such as air traffic, program management office, and aviation safety for policy development, concept maturation, and technical acceptance of investment capabilities. |

# United States Department of Transportation
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## NextGen - Traffic Flow Management Portfolio
### Requested: ($21,000,000)

**Program Description:**

The Traffic Flow Management (TFM) portfolio involves NAS operators and FAA traffic managers, along with advanced automation, in managing daily flight and flow decision-making, airspace, and airport capability issues (e.g., special activity airspace, weather, etc.) to improve the overall efficiency of the NAS. Pre-implementation research conducted under this portfolio includes technology development activities for departure scheduling at smaller community airports, improved strategic flow services, and capabilities that will capitalize on future Data Communications (DataComm) capabilities, further integrated traffic flow management and metering operations, advanced trajectory-based operations leveraging the technologies of NASA's Airspace Technology Demonstration 3 (ATD-3), and exploring technologies, infrastructure enhancements, and procedural changes for future traffic management needs.

**Major Program Objectives:**

The main goal of this NextGen – Traffic Flow Management (TFM) Portfolio is to improve both the efficiency of individual flights while optimizing throughput. This work will make travel safer for the traveling public, help reduce passenger delays leading to a better traveling experience, and contribute to less pollution as the result of improved prediction performance for TFM decision support systems and flexible TFM around weather constraints.

The TFM provides greater flexibility to the flight planners, and makes the best use of available airspace and airport capacity to make travel safer for the traveling public, help reduce passenger delays leading to a better traveling experience, and contribute to less pollution as the result of improved prediction performance for TFM decision support systems and flexible TFM around weather constraints.

**Anticipated Program Activities:**

**Surface Tactical Flow**
This program is researching and developing airport surface capabilities to optimize the experience for the flying public, Air Traffic Control and the industry by improving the collaboration and decision-making among NAS users. The program will provide the tools necessary to achieve a virtually collaborative surface environment by participating in collaborative decision-making initiatives where the input of flight operators, airport authorities and air traffic controller's viewpoints are used to provide a shared surface situational awareness and improve predictability. Anticipated program activities include:

- Research mobile/Electronic Flight Bag (EFB)-based solutions that enable participation in integrated departure scheduling and enhanced data exchange with other types of flight operators (regional, cargo, international, etc.).
- Conduct field prototyping and evaluation of Terminal data exchange capabilities. Terminal Data Exchange is the ability to quickly and accurately exchange information digitally within the facility and with other facilities, flight operators, and other NAS users.

**Strategic Flow Management Application**

This program will leverage automation to improve Traffic Flow Management (TFM) operations by addressing system-wide demand and capability imbalances. There is a need to access and share data for the purpose of advancing future traffic flow operations addressed through the research in TFM information flows, and the concepts identified in the Performance Based Flow Management (PBFM) concept of operations. The PBFM environment features shared decision-making responsibilities among relevant stakeholders enabled by improved coordination, communication, and information sharing. Industries across the board are investing in data driven solutions leveraging learning automation and cloud computing. The aviation/aerospace industry is no exception. PBFM will move away from legacy, monolithic automation systems to a new cloud and microservices-based, flexible, and scalable architecture that leverages new learning automation technologies. This includes the following activities:

- TFM capability modeling to include platform development and proof of concept activities. As future TFM concepts are identified, the FAA needs a modeling platform to be able to thoroughly evaluate them and continue their development.
- Concept engineering activities for PBFM Model Development and Tabletop Exercises of PBFM: These activities will help us better understand the role learning automation can play in evolving TFM.
- Concept engineering activities for flow information standard to support traffic flow management planning and execution functions.

**Advanced Methods**: Advanced Methods will explore technologies (e.g. speech recognition, machine learning, and artificial intelligence), infrastructure enhancements, and procedural changes to meet current and future traffic management needs. This program will support improvements to increase airport capacity, sector throughput, and reduce sector delays by providing NAS users and Air Traffic Management with a common understanding of national airspace constraints. The program will develop and test prototype improvements and provide operational concepts and requirements for potential implementation in automation programs and operational organizations. These leading-edge technologies could advance the use of data storage solutions to provide better-organized and accessible data. Additionally, improved coordination data will allow the FAA to drive operational analysis of traffic management. This program will also support improvements needed to adapt the FAA's certification tools, processes, best practices and policies. This includes the following:

- Identify areas where machine learning/deep learning/artificial intelligence algorithms are critical to user performance
- Identify specific methods that will improve the acceptance and certification (as appropriate) of the methods that will be used for operational and safety improvements.

**Potential Program Outputs, Outcomes and Impacts:**

Surface Tactical Flow:
- Complete and deliver a report on cloud-based technologies and services required to exchange data from Electronic Flight Bag applications in a timely and secure manner.
- Conduct field prototyping and evaluation of Terminal data exchange capabilities.
- Mobile Technologies - Demonstration wrap-up, industry engagements, and technology transfer

Strategic Flow Management Application:
- Engineering activities for TFM Capability Modeling to include platform development and proof of concept activities. As future TFM concepts are identified, the FAA needs a modeling platform to be able to thoroughly evaluate them and continue their development.

Advanced Methods:

- Developing a prototype capability for the advanced automation learning/data mining capability that utilizes historical and real-time data.
- Complete Analysis Report on FAA automation systems and stored data for suitability with artificial intelligence technology

**Potential Economic or Societal Impacts:**

The TFM portfolio researches and implements capabilities that are expected to improve both the efficiency of individual flights and optimization of throughput. This work will make travel safer for the traveling public, help reduce passenger delays leading to a better traveling experience, and contribute to less pollution as the result of improved prediction performance for TFM decision support systems. These support systems include flexibility to avoid airspace constraints, better predict capacity demands, and ensure efficient utilization of national airspace capacity.

**Potential Progress Made Toward Achieving Strategic Goals:**

The TFM portfolio supports the average daily airport capacity metric by providing more efficient use of system capacity. This is accomplished by maximizing airspace and airport throughput using time-based management. It also provides improved operational predictability through more accurate and efficient end-to-end strategic planning and scheduling. Enhanced flight efficiency is achieved by delivering more efficient flows into and out of major metropolitan areas through integrated operations. Increased operational flexibility is provided through increased user collaboration regarding preferred trajectories and priorities to support business objectives.

**Collaboration Partners:**

NextGen capabilities continue to bring positive effects to the aviation industry and the flying public all across the NAS. The FAA and the aviation industry work together through the NextGen Advisory Committee (NAC), which includes carriers such as United Airlines, FedEx, and Delta Airlines, to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term.

| Program Partners | Benefits |
|---|---|
| Research, Engineering, and Development Advisory Committee (REDAC) (external) | Provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of aviation research program, and reviews and comments on the aviation research programs. |
| NextGen Advisory Committee (NAC) – Federal advisory committee | The FAA and industry partnership to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term. The FAA and industry jointly evaluate the effects of NAC commitments on the NAS through the work of a Joint Analysis Team to understand the value of implementing this plan. |
| FAA Lines of Business<br>• Program Management Office (PMO)<br>• NATCA | NextGen collaborate with multiple internal lines of business such as air traffic, program management office, and aviation safety for policy development, concept maturation, and technical acceptance of investment capabilities. |

| | |
|---|---|
| NASA | Collaboration to leverage cooperative research in an FAA operational environment |
| DOT Volpe Center | Safety Management System (SMS) support |
| MITRE | Leverage research integration and data exchange and assist with technology transfer |
| Airlines | Cooperative evaluations and development of airline tools |
| Airport Authorities | Support of research activities and access to operational subject matter experts |

## NextGen - On Demand NAS Portfolio
### Requested: ($8,500,000)

**Program Description:**

The On-Demand NAS Information (ODNI) portfolio conducts pre-implementation work to reduce risk in supporting the efficient and secure exchange of information within the FAA and between the FAA and other NAS users. The ODNI portfolio conducts research that examines concepts and matures capabilities through validation activities and demonstrations conducted with stakeholders, to enhance information exchange within the NAS. This portfolio provides flight planners, Air Navigation Service Providers (ANSP) staff, and flight crews with consistent, complete, and easily processed information on changes of conditions in the NAS. It also works toward developing international data standards allowing more users to share flight information and coordinate various activities concerning a flight to support collaborative decision-making. As the FAA evolves towards Info-Centric NAS operations, more structured digital information will be available and technologies such as Internet of Things (IoT) and cloud computing will enable airspace users to make decisions based on current information. The pre-implementation research conducted under this portfolio will leverage this technology evolution and standardize flight deck applications to support flight crew decision making. It will also utilize innovative technologies for creation of structured data which enables the FAA to improve situational awareness and collaboration among various traffic management services through better access to a fully integrated information sharing environment.

**Major Program Objectives:**

The main goal of the NextGen – On-Demand NAS Portfolio is the efficient and secure exchange of information within the FAA and between the FAA and other NAS users for collaborative decision-making. Improvements in developing a standard set of flight information will simplify the flight planning process and provide information that will cross multiple ATC systems and domains with ease, leading to improvements in ongoing traffic management initiatives and decision making. System efficiency, resiliency and flexibility of the NAS is maximized through the reallocation of existing resources to address demand and capacity imbalances and create additional NAS agility in support of contingency operations. The incorporation of aircraft performance, flight intent, and improved flight crew situational awareness will result in increased predictability of future aircraft positions, allowing traffic managers to strategically manage the airspace based on where aircraft will be. Adaptable microservices, architectures, and cloud computing will enhance performance and assure interoperability and scalability. Incorporation of machine learning and artificial intelligence that leverage a network of information will enable enhanced trajectory negotiations while providing optimal traffic management solutions across the NAS.

**Anticipated Program Activities:**

- Develop flight deck trajectory negotiation concept and engineering activities, and conduct proof of concept exercise for flight deck pre and post departure negotiation applications
- Develop flight deck clearance delivery application concept of use and engineering artifacts
- Develop final functional requirements for necessary automation and communication systems in support of dynamic airspace and complete technology transfer of requirements to applicable programs

**Potential Program Outputs, Outcomes and Impacts:**

The Flight Deck Collaborative Decision Making (FD CDM) program under this portfolio is developing standardized flight deck applications that enable enhanced participation by the flight crew. It will augment the ability of both controllers and pilots aiding in the safe and efficient movement on airport surfaces. The adoption of resilient and adaptable microservices architecture will assure service performance, interoperability, and scalability. In addition, machine learning techniques are being studied and applied to provide better information and accommodate seamless integration between voice and digital communication.

The Dynamic airspace (DA) capabilities that are being developed will facilitate the remapping of NAS infrastructure elements to support the flexible and timely temporary transfer of airspace, ensuring maximum throughput in all conditions while maintaining safe operations. Advances in automation will facilitate implementation and the use of dynamic airspace, which will increase the resiliency and flexibility of the NAS as the FAA architecture evolves to a cloud environment.

**Potential Economic or Societal Impacts:**

The Flight Deck Collaborative Decision Making program in this portfolio sets the framework and standards that flight operators will use to implement advanced automation capabilities and improve collaborative decision making. This will enable the creation and implementation of new and visionary applications that support the evolution to a data driven operational environment.

The Dynamic Airspace program within this portfolio will allow traffic managers to optimize airspace configuration across the NAS to decrease congestion in workload-constrained airspace and address unexpected events, such as weather and Special Use Airspace restrictions, thereby supporting the average daily capacity performance metric.

**Potential Progress Made Toward Achieving Strategic Goals:**

As the FAA evolves to Info-Centric NAS operations, more structured digital information will be available and technologies such as Internet of Things will allow airspace users to make decisions based on the most current information. The programs within this portfolio are leveraging this information and adopting technology advancements such as machine learning and cloud computing, while working towards developing and standardizing applications that enable enhanced participation by the flight crew in the collaborative decision-making process. The programs are also working towards the development of capabilities to allow dynamic reconfiguration of NAS infrastructure elements to meet changing demand and capacity needs.

**Collaboration Partners:**

Public stakeholder input is also received through the NextGen Advisory Committee (NAC). The NAC is an industry partnership with the FAA to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term. The FAA and industry jointly evaluate the effects off NAC commitments on the NAS through the work of a Joint Analysis Team (JAT) to understand the value of implementations in this plan.

| Program Partners | Benefits |
|---|---|
| Research, Engineering, and Development Advisory Committee (REDAC) (external) | Provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of aviation research |

| | |
|---|---|
| | programs, and reviews and comments on the aviation research programs |
| NextGen Advisory Committee (NAC) | FAA and industry partnership to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term. The FAA and industry jointly evaluate the effects off NAC commitments on the NAS through the work of a Joint Analysis Team (JAT) to understand the value of implementing this plan. |
| FAA Lines of Business | NextGen collaborates with multiple internal lines of business such as the air traffic, program management, and aviation safety offices for policy development, concept maturation, and technical acceptance of investment capabilities. |
| International Civil Aviation Organization (ICAO) (external) | Partnership with ICAO ensures that the FAA is part of international harmonization of data exchange and management, a key piece of the future of air traffic management and user collaboration. |
| MITRE | Leverage research integration and data exchange and assist with the technology transfer |
| Embry-Riddle Aeronautical University (ERAU) | Leverages University partnership to bring new technologies, concept maturation and strengthen research capabilities. |

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## NextGen - NAS Infrastructure Portfolio
### Requested: ($25,500,000)

**Program Description:**

The NAS Infrastructure portfolio conducts pre-implementation activities to reduce risk for aviation weather-related and cross-cutting engineering issues. This portfolio provides the research, development, and analysis of validation activities, human system engineering, and demonstrations to improve the efficiency and effectiveness of air traffic management. It includes an array of work encompassing emerging issues in communications, weather, information management, trajectory management, collision avoidance, and assessment of requirements for future NAS systems and system enhancements.

**Major Program Objectives:**

The NAS Infrastructure Portfolio contains key transformational and infrastructure sustainment capabilities that are critical to the success of NextGen. This program supports the NextGen goal of expanding capacity by conducting pre-implementation activities geared toward the development of decision support tools that improve the strategic management of operations in the NAS. The main goal of the NextGen – NAS Infrastructure Portfolio is to support the NextGen goals of improved capacity, efficiency, and safety.

**Anticipated Program Activities:**

- Develop weather translation techniques for non-convective weather constraints
- Perform weather advisory and collaborative lab experiments designed to explore ATM Weather Integration (AWI) concepts and capabilities
- Coordinate aviation weather issues with subject matter experts through Community of Interest (COI)
- Identify and conduct high-level assessment for candidate technologies suitable for an enterprise solution for automation systems in the NAS and produce a report
- Develop requirements for hardware application and link performance requirements to support the potential use of internet based data exchange for command and control applications
- Develop initial safety risk management model to assess the use of AI in controller decision support tools
- Develop initial performance requirements for a ubiquitous communications framework

**Potential Program Outputs, Outcomes and Impacts:**

- Concept-level requirements and investment analysis products for NextGen Weather Processor (NWP) and Common Support Services – Weather (CSS-Wx) Future Enhancements
- Identify weather requirements to support ceiling and visibility weather information
- Initial Ubiquitous Communications Framework
- Down-selected set of candidate input device technologies for NAS automation systems
- Initial analysis of requirements for potential use of AI in support of controller functions

**Potential Economic or Societal Impacts:**

In order to be completely successful, efforts are being coordinated within the NextGen Weather Portfolio with interdependencies to other Air Traffic Operations Service Units. The ATM system is globally harmonized through collaborative development and implementation of identified best practices in both standards and procedures. International harmonization also requires advocating for the highest operational standards for aircraft operators and Air Navigation Service Providers (ANSP) to ensure a safe and secure global air transportation system. International Civil Aviation Organization (ICAO) Planning and Implementation Regional Groups (PIRG) or multilateral agreements enable the planning and implementation of NextGen transformations to harmonize the application of technology and procedures. This harmonization allows airspace users to realize the maximum benefits of NextGen transformations. This program will ensure harmonization of U.S. meteorological practices and products with international ICAO protocols. Under the US Meteorological Authority, this program will coordinate with ICAO and EURO CONTROL to maintain alignment of the US with ICAO and SESAR Meteorological (MET) protocols.

The New ATM Requirement program is needed to develop requirements to exchange trajectory information between ATM systems; to communicate data between air and ground systems; to integrate weather data into automated trajectory management systems; to address the need for harmonizing protocols and standards for enterprise information use both internally and with external agency partners; to evaluate cloud architecture to provide common and control services in the future; to conduct engineering studies to define requirements for next generation automation system input devices; to conduct engineering and analysis to support the potential use of internet based data exchange for command and control applications, and to conduct engineering and analysis to support the potential use of artificial intelligence to support controllers in functions including aircraft separation.

**Potential Progress Made Toward Achieving Strategic Goals:**

CSS-Wx & NWP: are currently being developed and matured as implementation projects under the NAS Infrastructure portfolio. These capabilities depend on the Weather Forecast Improvements and New Air Traffic Management (ATM) Requirements projects for the Concept Development, Evaluation and Integration of New Weather Concepts as well as the Investment Analysis of all future enhancements of these two investments.

NWP & CSS-Wx Future Investment Analysis: This work will prepare analysis products in support of future investment decisions for NWP and CSS-Wx. NWP Enhancement 1 will provide the following candidate capabilities: additional enhanced weather algorithms; and advanced aviation specific weather products such as new radar mosaic, predictive products, and weather avoidance fields including precipitation, turbulence, convective weather, ceiling & visibility, icing, and winds. CSS-Wx Enhancement 1 will include additional legacy weather systems such as the weather message switching center replacement, automated weather observing system data acquisition system, automated lightning detection and reporting system, and world area forecast system internet file service. It will also provide the following candidate capabilities: additional web services, filtering, and complex query capabilities; and dissemination of enhanced weather information such as turbulence, convective weather, ceiling and visibility, icing, and wind.

**Collaboration Partners:**

NextGen capabilities continue to bring positive effects to the aviation industry and the flying public all across the NAS. The FAA and the aviation industry work together through the NextGen Advisory Committee (NAC), which includes carriers such as United Airlines, FedEx, and Delta Airlines, to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term.

| Program Partners | Benefits |
|---|---|
| Research, Engineering, and Development Advisory Committee (REDAC) (external) | Provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of the aviation research programs, and reviews and comments on the aviation research programs. |
| International Civil Aviation Organization (ICAO) (external) | Partnership with ICAO ensures FAA's part of international harmonization of data exchange and management, a key piece of the future of air traffic management and user collaboration. |
| Airline Electronic Engineering Committee (AEEC) (external) | Partnership with AEEC support standards development to inform air/ground communications between FAA and airspace users in the future. |
| FAA Lines of Business (internal) | NextGen collaborates with multiple internal lines of business such as air traffic, program management office, and aviation safety for policy development, concept maturation, and technical acceptance of investment capabilities. |
| National Oceanic and Atmospheric Administration (external) | Coordination to identify improvements to aviation weather-observation sensor networks. |
| Department of Defense (external) | Coordination to identify improvements to aviation weather-observation sensor networks. |

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## NextGen - Support Portfolio
**Requested: ($5,000,000)**

**Program Description:**

The NextGen Support Portfolio provides the NAS laboratory environments required to evaluate, mature, and validate the broad framework of NextGen concepts, technologies, operational functions, and systems before they are introduced into the NAS. This program provides the evaluation platforms at the NextGen Integration and Evaluation Capability (NIEC) and Florida NextGen Test Bed (FTB). These labs facilitate the conduct of NextGen concept demonstrations using simulated research NAS environments without affecting actual NAS operations. These demonstrations are often conducted with a variety of stakeholders in attendance to aid in the appropriate propagation of newly learned information. These stakeholders also ensure that the benefits and risk associated with the concepts being demonstrated are considered from several different perspectives.

The NextGen Support Portfolio funding is used to continue laboratory operations in support of on-going NextGen Programs and to enhance existing NIEC and FTB lab capabilities as required to support the development and evaluation of advanced capabilities associated with evolving NextGen operational improvements and implementation plans.

**Major Program Objectives:**

The NextGen Support Portfolio provides targeted research and development within the FAA that will lead to new technology development and deployment in the NAS. Data generated by this program will allow for the assessment of regulatory approaches, foster information sharing, and facilitate coordination and collaboration with industry and other stakeholders. Most importantly, this program facilitates the testing and adoption of new technologies throughout the NAS. To aid in the testing and adoption of new technologies, the portfolio also seeks to incrementally expand the capabilities of the FTB. These capabilities will also align with the NAS modernization demonstration projects and stakeholders' needs and vision.

**Anticipated Program Activities:**

- Provide infrastructure enhancements for NAS modernization research, engineering, development, and validation exercises (e.g. Trajectory Based Operations, UAS Traffic Management and Advanced Air Mobility Beyond Visual Line of Site (AAM BVLOS)
- Provide necessary licenses, maintenance agreements, and equipment of the laboratory
- Complete annual update of the NSIP including analysis of future NAS requirements for integrated enterprise-level planning

**Potential Program Outputs, Outcomes and Impacts:**

This program will further the research of advanced capabilities set to be integrated into the NAS. These capabilities include but are not limited to Multi Regional TBO, Flight Deck Collaborative Decision Making, and Common Support Services – Flight Data. Additionally the program will assess the performance of previously fielded capabilities. These assessments provide leadership with useful information that helps inform their future decisions.

**Potential Economic or Societal Impacts:**

**Potential Progress Made Toward Achieving Strategic Goals:**

This program has made progress toward the strategic goal of Transformation by providing a suitable environment for new and transformative concepts to be developed and validated. Additionally, the program has facilitated the interaction of diverse stakeholders, allowing for the propagation of new ideas. Furthermore, the program has supported and accelerated the research future NAS capabilities.

**Collaboration Partners:**

This program is a pathway to obtaining stakeholder input. Specifically, the NIEC laboratory is used to expose stakeholders in the ATM operational user community to emerging NextGen concepts and capabilities in order to gain their assessment of the potential operational effectiveness and/or suitability of the concept for use in further maturation and development exercises or adoption/implementation.

The Florida NextGen Test Bed is a facility located at the Embry Riddle Aeronautical University in Daytona Beach, Florida. It supports the integration of new and emerging technologies into the NAS through demonstrations and evaluations. One of the main purposes of the Florida NextGen Test Bed is to provide an open-access location for industry, users, and vendors to demonstrate new capabilities and harness NAS architecture solutions. These demonstrations cultivate government, academia, and industry partnerships and facilitate decision making involving key stakeholders.

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## NextGen - Enterprise, Concept Development, Human Factors & Demonstrations Portfolio
### Requested: ($11,000,000)

**Program Description:**

The Enterprise Concept Development, Human Factors, and Demonstrations Portfolio conducts enterprise-level activities, including developing concepts across the NAS, human factors analyses of the NextGen operational environment, and demonstrations of proposed NextGen system improvements to ensure operational feasibility and viability within the NAS.

**Major Program Objectives:**

These concept development efforts lead to improvements that provide air traffic controllers with tools and procedures to separate aircraft with technologically advanced navigation equipment and wake performance capabilities. These concepts enhance system capacity and efficiency while ensuring safe aircraft separation and reducing workload for controllers and flight crews. Concept development identifies early NextGen concepts and maturation activities that will transform the next generation of the NAS. Human factors activities evaluate concepts for human factors implications and inform the maturation of these concepts into successful capabilities. Stakeholder demonstrations provide practical application and analysis of proposed NextGen system improvements to validate and prove concept feasibility and determine which initiatives might be accelerated through fast-track modeling.

**Anticipated Program Activities:**

- Complete human factors assessment of automation enhancement concepts across domains
- Update TBO operational scenarios, incorporating knowledge obtained from related concept development efforts
- Develop operational scenarios for the seamless integration of xTM in the 2030-2035 timeframe
- Develop initial use cases for the evolution of current safety critical systems to a distributed architecture

**Potential Program Outputs, Outcomes and Impacts:**
- Complete human factors assessment of automation enhancement concepts across domains
- Update TBO operational scenarios, incorporating knowledge obtained from related concept development efforts
- Develop operational scenarios for the seamless integration of xTM in the 2030-2035 timeframe
- Develop initial use cases for the evolution of current safety critical systems to a distributed architecture

**Potential Economic or Societal Impacts:**

The Enterprise, Concept Development, Human Factors, and Demonstrations Portfolio provides an operating environment that ensures that all airspace users have right of access to the Air Traffic Management (ATM) resources needed to meet their specific operational requirements and that the shared use of airspace by different users can be achieved safely. It addresses the operational and economic cost-effectiveness of gate-to-gate flight operations from a single-flight perspective, and contributes to the protection of the

environment by considering noise, emissions, and other environmental issues in the implementation and operation of the aviation system.

**Potential Progress Made Toward Achieving Strategic Goals:**

The Enterprise, Concept Development, Human Factors, and Demonstrations Portfolio exploits the inherent capacity to meet airspace user demands at peak times and locations while minimizing restrictions on traffic flow. To respond to future growth, capacity must increase, along with corresponding increases in efficiency, flexibility, and predictability, while ensuring that there are no adverse impacts on safety and giving due consideration to the environment. The ATM system must be resilient to service disruption and the resulting temporary loss of capacity. The portfolio also ensures the ability of all airspace users to modify flight trajectories dynamically and adjust departure and arrival times, thereby permitting them to exploit operational opportunities as they occur.

**Collaboration Partners:**

This program utilizes input from FAA stakeholders, airspace users, and industry. This program works collaboratively with all of these groups to understand the value and feasibility of new FAA concepts and capabilities to determine which concepts should be transitioned for further development.

This program utilizes input from FAA stakeholders and industry partners through the participation in several collaborative communities and workgroups. These partnerships provide advice, recommendations, identify high benefit capabilities and ensure international harmonization.

| Program Partners | Benefits |
|---|---|
| Research, Engineering, and Development Advisory Committee (REDAC) (external) | Provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of aviation research program, and reviews and comments on the aviation research programs |
| Radio Technical Center for Aeronautics (external) | Provides recommendations on technical and operational standards to achieve the necessary improvements in the safety and efficiency of the air transportation system. Input has deepened FAA understanding of technical maturity and resulted in changes to definitions and timing for operational concepts. |
| NextGen Advisory Committee (NAC) – Federal advisory committee (subcommittee of RTCA) | FAA and industry partnership to identify high-benefit, high-readiness NextGen capabilities for implementation in the near term. The FAA and industry jointly evaluate the effects of NAC commitments on the NAS through the work of a Joint Analysis Team (JAT) to understand the value of implementing this plan. |
| International Civil Aviation Organization (ICAO) (external) | Partnership with ICAO ensures FAA's part in international harmonization of data exchange and management, a key piece of the future of air traffic management and user collaboration. |
| FAA Lines of Business (internal) | NextGen collaborates with multiple internal lines of business such as air traffic, program management office, and aviation safety for policy development, concept maturation, and technical acceptance of investment capabilities. |

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## NextGen - Unmanned Airspace Systems
### Requested: ($15,000,000)

**Program Description:**

The Unmanned Airspace System (UAS) Program plays a critical role in enabling UAS operations in the NAS. The activities in this program support research that allows integration of UAS without creating disruptions or delays to manned aircraft, and ensures NAS operations will be as safe as they are today. This program has two core pre-implementations tasks: 1) UAS Concept Validation and Requirements Development (CVRD), and 2) UAS Flight Information Management System (FIMS). The UAS CVRD project will continue identifying, and maturing UAS needs related to air traffic systems and services and refining operational requirements associated with Air Traffic Management (ATM) automation, airspace management, policies, and procedures. The efforts being undertaken by this program will enable future integrated UAS operations. UAS FIMS activities will establish the concepts, use cases, and requirements associated with UAS Traffic Management/FIMS to safely manage UAS operations primarily through operator-operator sharing of flight intent and operator-FAA sharing of flight intent and airspace constraints. This project will build upon the existing FAA information sharing infrastructure to meet the expected increase of UAS operations by enabling the exchange of information among all stakeholders in globally standardized exchange protocols to ensure seamless and interoperable data management.

**Major Program Objectives:**

Air Traffic products, policies, and procedures must be reviewed and refined, or developed through supporting research, to permit UAS operations in the NAS. The UAS research program plays a critical role in enabling UAS operations in the NAS without affecting manned aircraft operations (e.g., creating disruptions or delays) and ensures that NAS operations will be as safe as or safer than they are today.

**Anticipated Program Activities:**

- Updating of Integrated UTM Data Exchange Requirements Version 3.0 (e.g. applications for identification and tracking).
- Developing Advanced Air Mobility (AAM) Beyond Visual Line of Sight (BVLOS) NAS Evaluation (BNE) Concept of Use Development

**Potential Program Outputs, Outcomes and Impacts:**

This program will identify requirements for enabling and managing UAS operations in airspace that are conducted below 400 feet above ground level for predominantly smaller UAS. This will be accomplished through the development of a separate, but complementary traffic management system to coincide along with the FAA s Air Traffic Management System. With FIMS, the FAA will have the ability to provide real-time constraints to UAS operators who will be responsible for managing their own operations safely within these constraints without receiving active Air Traffic Control services from the FAA.

The efforts being undertaken by CVRD will enable future integrated UAS operations. Issues involved with UAS integration include the inability to comply with traditional see and avoid requirements, unique communications needs, lost link procedures, and other challenges that dictate that concept engineering activities address all aspects of how UAS operations fit with other NAS operations.

**Potential Economic or Societal Impacts:**

Demand for access to the NAS is escalating with forecasts for routine access by 2025. It is expected that between now and 2035, the overwhelming majority of UAS operations will be conducted in uncontrolled airspace. As the technical, programmatic, and operational needs associated with UAS integration are addressed, public and civil UAS operations are expected to increase dramatically, and potentially surpass the number of manned aircraft operations by 2035. This new infrastructure will provide FAA with on-demand knowledge of flight intent as well as flight data dissemination, beyond what currently exists and what is assumed to exist in the future (e.g., Instrument Flight Rules (IFR) flight plans, Notices to Airmen), to support the increased numbers of UAS operations in both uncontrolled and controlled airspace. Additionally, more robust mechanisms and procedures for disseminating known and potential hazards to airspace users will be developed to provide timelier, efficient, and accessible information as the NAS evolves. The program provides the means to address the surge in demand for UAS operations in the NAS and support development of procedures, standards, safety, risk mitigation, and governance as appropriate to help foster economic growth and societal advancement.

**Potential Progress Made Toward Achieving Strategic Goals:**

TBD

**Collaboration Partners:**

Additional public stakeholder input is obtained through the Radio Technical Commission for Aeronautics (RTCA) and Drone Advisory Committee (DAC). RTCA provides recommendations on technical and operational standards to achieve the necessary improvements in the safety and efficiency of the air transportation system. Input has deepened the FAA's understanding of technical maturity and resulted in changes to definitions and timing for operational concepts. DAC is comprised of the FAA and key decision-makers supporting the safe introduction of UAS into the NAS. The Committee seeks to identify and propose actions for the FAA on how best to facilitate the resolution of issues affecting the efficiency and safety of integrating UAS into the NAS.

| Program Partners | Benefits |
|---|---|
| • FAA Lines of Business<br>• Program Management Organization (AJM) | NextGen collaborates with multiple internal lines of business such as air traffic, program management office, and aviation safety for policy development, concept maturation, and technical acceptance of investment capabilities. |
| FAA/NASA UTM Research Transition Team (RTT) Stakeholder Group | Oversees the RTT activities, including efforts by all working groups to develop the necessary requirements, concepts, and infrastructure for low-altitude operations for UAS. UTM RTT Stakeholder support will ensure proper recording and coordination of RTT progress and actions. |

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## Emerging Technology Accelerator
**Requested: ($10,000,000)**

**Program Description:**

The Emerging Technology Accelerator (ETA) Program was established to foster emerging science, engineering, and technology advancements and align innovation with known and forecasted challenges and opportunities in the aviation industry.

**Major Program Objectives:**

The program aims to address air transportation safety and efficiency needs in the near and far term. It also addresses statutory requirements to invest in long-term research that better positions the agency to shape the air transportation system of the future. The ETA will advance the Department's mission by fueling inclusive and sustainable economic growth.

Additionally, the Program will modernize the aviation sector by seeking partnerships with industry, academia, and government such that jobs are created and innovation encouraged in underserved communities. The ETA will engage innovators across the nation in the application of emerging science and technology. It will additionally provide an avenue for relatively rapid maturation and commercialization of promising technologies.

**Anticipated Program Activities:**

- Evaluation of initial Innovation Proposals
- Develop Aviation Challenge Statement
- Issue Innovation Solicitation
- Annual Report

**Potential Program Outputs, Value Statement and Impacts:**

The ETA Program will enhance the FAA's ability to leverage emerging science and technology to rapidly respond to operational challenges. It is the program's goal to assist industry in maturing a product, CRADA, patent, license, or proven technology within 24 months.

**Potential Economic or Societal Impacts:**

The ETA Program may produce commercially viable products by enabling: (1) an entirely new industry area, (2) technologies that the FAA may observe in an effort to determine future regulatory guidance for commercialization, (3) a logical stepping-stone in growing the US autonomy industry (for example), and lastly, (4) protection and security of the American people.

**Potential Progress Made Toward Achieving Strategic Goals:**

Not applicable. Funding for this program still to be approved.

**Collaboration Partners:**

Not Applicable

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## Aviation Workforce Development - Section 625
**Requested: ($6,169,000)**

**Program Description:**

The Aviation Workforce Development grant program will provide support to administer grants for eligible projects that educate, develop, and recruit aircraft pilots and an aviation maintenance technical workforce, as directed by Congress in Section 625 of the FAA Reauthorization Act of 2018.

**Major Program Objectives:**

Consistent with section 625, program eligibility and outreach will be aimed at communities underrepresented in the industry as well as economically disadvantaged geographic areas and thus support equity in transportation federal policy objectives.

**Anticipated Program Activities:**

- Provide grants to support education, recruitment, and development of aircraft pilots and aviation maintenance technicians

**Potential Program Outputs, Value Statement and Impacts:**

FAA Aviation Workforce Development will support projects creating pathways into the aviation workforce in order to maintain a safe and efficient national airspace system in the world.

Program outputs will consist of recruitment and outreach, program completion and certification.

The program outputs of the project will assist FAA in determining program impact for universities, public and private schools in diverse areas. If outputs are not achieved, then impact cannot be measured. Monitoring accomplishments and quality of the activity outputs is essential to ensure that the project produces its proposed outcomes.

**Potential Economic or Societal Impacts:**

The Aviation Workforce Development grant program will benefit the next generation of aircraft pilots and maintenance technicians by cultivating a workforce pipeline that may experience economic impacts.

**Potential Progress Made Toward Achieving Strategic Goals:**

In January 2022, awards were issued to 31 grant recipients with a period of performance for 18 months. We are in the early stages of assessing the progress of the program performance.

**Collaboration Partners:**

Not Applicable

# United States Department of Transportation
# FY 2023 Annual Modal Research Plans

## System Planning and Resource Management
### Requested: ($4,141,000)

**Program Description:**

The System Planning and Resource Management (SPRM) program lead the planning, coordination, development, presentation, and review of the FAA's research and development (R&D) portfolio. Its key programmatic outputs include the National Aviation Research Plan (NARP), the Annual Review – both of which are annual statutory deliverables to Congress. SPRM conducts the administration of the congressionally mandated (P.L. 100-591 Section 6 Advisory Committee) Research, Engineering and Development Advisory Committee (REDAC) and resultant reports. SPRM also provides program advocacy and outreach and maintains alignment with departmental R&D program planning and performance reporting guidance. SPRM leads the portfolio planning, formulation, presentation, and review activities to ensure the FAA meets the President's criteria for R&D, increases program efficiency, sustains and maintains management of the program within operating cost targets, and enables effective program review by the REDAC and the OST Office of Research and Technology.

SPRM also develops program guidance and conducts compliance reviews to ensure that departmental R&D program planning and performance reporting requirements specified in the Fixing America's Surface Transportation (FAST) Act are satisfied. It also coordinates the establishment and administration of the Air Transportation Centers of Excellence (COE) Program and ensures compliance with related financial assistance and grants management departmental policy guidance.

The SPRM program advances the Department's mission by providing an inclusive and innovative culture to effectively serve communities and responsibly steward the public's applied research dollars. SPRM ensures the American public's resources are invested in such a manner as to deliver substantive research that provides safety and efficiencies while delivering results to the flying public.

**Major Program Objectives:**

The main goal of the SPRM program is planning and program management support for the FAA to formulate its annual RE&D portfolio and submit the mandatory R&D planning documents to Congress each year. Through the management of the FAA REDAC, this program facilitates an independent, expert review of the FAA's R&D portfolio that provides meaningful recommendations for the FAA to refine and improve its portfolio. This results in a more effective research program that will benefit the public by making aviation safer and smarter and enhance U.S. global leadership in aviation.

**Anticipated Program Activities:**

- Completion of annual Congressional deliverables (NARP, Annual Review)
- Coordination and completion of REDAC reports, guidance and transmittals
- Development and dissemination of R&D Program Performance Reports
- Development and submission of R&D investment portfolio
- Development and coordination of OST R&D management deliverables (including the Annual Modal Research Plan)

- Facilitate government and private sector partnerships to help develop and commercialize aviation ideas, concepts, and products

**Potential Program Outputs, Value Statement and Impacts:**

Ensure legislatively required R&D program planning and performance reporting requirements are satisfied.

**Potential Economic or Societal Impacts:**

The SPRM program helps prevent duplication of R&D work and ensures that the FAST Act reporting requirements are met by one organization. These reports and committees provide senior management with the information needed to make informed decisions on future R&D programs. The SPRM program also offers an opportunity for the public to get involved in the future of aviation.

**Potential Progress Made Toward Achieving Strategic Goals:**

By providing support for the FAA to formulate its annual RE&D portfolio and submit the yearly Congressional planning documents, the SPRM program provides complete transparency on the R&D work that is performed. Its efforts help prevent duplicative work by collaborating with other federal agencies, academia, and private industry to better serve the aviation industry. By highlighting the excellent work performed and collaboration, the SPRM program presents DOT with opportunities to be an employer of choice.

**Collaboration Partners:**

The development and submission of all SPRM products (Annual Review, National Aviation Research Plan, Annual Modal Research Plan, President's Budget Request Budget Narrative, Technology Transfer (Congressional Report) and associated services (REDAC and Research Executive Board (REB) conduct) involve the same stakeholders. FAA Research Planning and Reporting Stakeholders include:

- Office of the William J. Hughes Technical Center Director – Manages the entire FAA Research portfolio, oversees research funding allocations and disbursements, research management and accountability, and serves as the Chair of the Research Executive Board (REB);
- Office of the Assistant Administrator for NextGen – Provides Executive oversight of NextGen research;
- Office of the Associate Administrator for Aviation Safety – Manages portfolio of Aviation Safety Research Programs, Voting Member of both the REDAC and the REB;
- Office of the Associate Administrator for Airports – Manages portfolio of Airport Technology and Cooperative Research Programs, Voting Member of both the REDAC and the REB
- Office of the Associate Administrator for Commercial Space Transportation – Manages portfolio of Commercial Space Research Programs, Voting Member of both the REDAC and the REB
- Office of the Assistant Administrator for Policy, International Affairs and Environment - Voting Member of both the REDAC and the REB;
- Office of the Assistant Administrator for Finance and Management – Provides all financials associated with the planning and reporting products, serves as financial POC to OST, serves as Advisory Member of the REB; and
- Air Traffic Organization – Advisory Member of the REB.

# United States Department of Transportation
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## William J. Hughes Technical Center Laboratory Facilities
### Requested: ($5,481,000)

**Program Description:**

This program sustains research facilities located at the William J. Hughes Technical Center Laboratory (WJHTC) to support Research and Development (R&D) program goals. These programs require specialized facilities to emulate and evaluate field conditions. The R&D laboratories are comprised of the Cockpit Simulation Facility (CSF), Target Generation Facility (TGF), Research Development and Human Factors Laboratory (RDHFL), and The NextGen Prototyping Network (NPN). R&D programs require specialized facilities which provide flexible, high-fidelity environments to conduct research and perform Human-in-the-Loop (HITL) simulations that evaluate advanced air traffic concepts. Researchers measure baseline human performance using existing air traffic controller configurations and determine changes in performance when new systems or procedures are introduced to identify and evaluate human factors (HF) issues. These laboratories include integrated cockpits, air traffic controller workstation capabilities (simulated and real), and specialized biometric data collection systems to evaluate the system and human components that can only be addressed in a full mission end-to-end simulation environment. The R&D laboratories are fully integrated with other WJHTC capabilities allowing for an extremely high fidelity environment supporting R&D research. This research encompasses capabilities of the current day systems, NextGen, and the transition between these systems (e.g., mixed equipage, adjacent site deployment, etc.). The funding provides for existing infrastructure support, project support, engineering support, R&D facility modifications and improvements, equipment and software/hardware licenses, and support tools.

**Major Program Objectives:**

The main goal of the William J. Hughes Technical Center Laboratory Facility is the provision of a laboratory environment that is fully integrated, extremely high fidelity, and that encompasses capabilities of current day systems, the NextGen system, and the transition between the two. The goals of these simulation facilities include developing capabilities to enable the research of complex problems due to weather, UAS, and commercial space flight in a controlled laboratory environment. The fully integrated facilities will enable research from the ground and airborne elements for a complete simulation capability. Concepts and systems integration RDHFL goals include doing proactive HF research on proposed changes to the NAS that identify human performance issues early in the concept development phase. Network Infrastructure – NPN goals are to maximize shared resources, relieve the need to establish separate connections, and minimize duplication of efforts and the resources to manage these extra connections and efforts. The NPN provides a common network approach that affords distributed access to NextGen and R&D laboratories, and a distributed set of capabilities.

The LNOC provides an environment to maintain, monitor status and cyber events and operate the NPN and customer networks. The Laboratory Facility provides researchers with the specialized laboratories and infrastructure required to achieve R&D program goals and objectives. Having an efficient and flexible platform to evaluate current and future air transportation system concepts and technologies enhances the safety and efficiency of air travel for the American public. Performing research in simulation rather than with live aircraft generates cost savings, is intrinsically safer, and allows the study of the extremes that would not be possible in live flight conditions. The implementation of new technologies, such as the intelligent agent-based capability, allow for a reduction in the number of test subject participants needed for a given study; again, maximizing cost savings and efficiencies. Modernization of the FAA R&D network

infrastructure and further extensibility into the Mike Monroney Aeronautical Center (MMAC) laboratories will directly support exploration of Info Centric National Airspace System (NAS) capabilities. Finally, human factors-related issues resolved prior to implementation result in cost savings and ensure that the FAA's safety standards for air traffic control operations are met.

**Anticipated Program Activities:**

- Enhance the ATC simulation infrastructure with capabilities to support evaluation of human factors issues associated with new ATC console hardware and advanced information display concepts.
- Continue to support cybersecurity exercises and Whole of Nation Exercise with DoD.
- Continue to integrate FAA and partner networks and facilities into the NPN baseline to expand the collaborative capabilities and position the FAA to best support NextGen research within the FAA, other government agencies, industry and academia partners.
- Support CyTF Secure Laboratory partner activities investigating cyber threats to the NAS. This is expected to include joint FAA/DoD/DHS activities.
- Implement intelligent agent-based capability for both En Route & Terminal environments into TGF for CONUS simulations in Tech Center R&D and field support laboratories as well as remotely located simulation facilities.
- Develop prototypes within the ATC simulation software that support research into coordinating conflict probe and trial planning with Time Based Operations.
- Up-level simulation software with any new capabilities supporting Time Based Operations.
- Support cybersecurity exercises and Whole of Nation Exercise with DoD.
- Integrate FAA and partner networks and facilities into the NPN baseline to expand the collaborative capabilities and position the FAA to best support NextGen research within the FAA, other government agencies, industry and academia partners

**Potential Program Outputs, Value Statement and Impacts:**

Research and Development laboratories will facilitate enhancements to safety as well as minimizing operational costs. Early Research and Development activities help enhance safety to the National Airspace System by reducing operational errors in the systems and enhancing human performance as new technologies are adopted.

**Potential Economic or Societal Impacts:**

Use of laboratory facilities provides an opportunity for early detection of issues during the concept development lifecycle. This will reduce costs down the road as the new systems are developed and operationalized.

**Potential Progress Made Toward Achieving Strategic Goals:**

Use of WJHTC laboratories enables new and innovative technology research, development, and testing for the R&D portfolio.

**Collaboration Partners:**

This program has the following partners:

- **Academia:** Arizona State University, Drexel University, George Mason University, Georgia Tech, Embry Riddle Aeronautical University, Ohio State University, Rowan University, National Aviation Research & Technology Park
- **FFRDCs:** MITRE, MIT Lincoln Laboratories

- **Government:** Department of Defense, NASA, Volpe
- **Industry**: AvMet, ComSAT, Concepts Beyond, DocuSign, General Dynamics, Harris, Liberty IT Solutions, Saab Sensis, SAIC, Boeing
- **Other Government**: EUROControl

These partnerships are beneficial because they enable the achievement of efficient solutions by eliminating duplicative efforts, filling capability gaps, and sharing technical knowledge.

# United States Department of Transportation
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## William J. Hughes Technical Center Laboratory Sustainment
**Requested: ($16,900,000)**

**Program Description:**

This program sustains the William J. Hughes Technical Center laboratories. This centralized set of laboratories supports the Acquisition Management System (AMS) lifecycle from concepts and requirement definition to In-Service decision. These laboratories are the only location where it is possible to realistically simulate the NAS and it is necessary to maintain the laboratory systems with capabilities that match field sites that currently exist or are planned for the future. These test beds can be altered to replicate desired field configurations and traffic scenarios providing stakeholders with an understanding of how upgraded systems will perform prior to operational deployment. These labs also provide a flexible high-fidelity environment to conduct research and perform Human-In-The-Loop (HITL) simulations that evaluate advanced air traffic concepts and are fully integrated with the other WJHTC capabilities.

**Major Program Objectives:**

The goal of this program is to modernize the equipment and infrastructure necessary for the FAA's centralized NAS laboratory facilities so that F&E programs can deliver products that result in a safe, reliable, and efficient NAS. The WJHTC centralized labs eliminate the need for each acquisition program to establish and sustain separate laboratory facilities to support their individual programs and fielded systems. The capabilities developed in these laboratories reduce overall cost of NAS and NextGen development while increasing traveler safety and decreasing travel times by reducing airspace congestion. This program is necessary to sustain the WJHTC laboratory test facility, which provides direct field support for operational NAS systems. Problems identified at various field locations are quickly transmitted to the appropriate laboratory where solutions are developed and tested. The test beds are used by acquisition programs and partner agencies for development, test, evaluation, integration, transition testing, and first and second level support to the field. This program is further necessary to maintain these laboratory systems in configurations and capabilities that match field sites that currently exist or are planned for the future.

**Potential Program Outputs, Value Statement and Impacts:**

Research and Development laboratories will facilitate enhancements to safety as well as minimizing operational costs. Early Research and Development activities help enhance safety to the National Airspace System by reducing operational errors in the systems and enhancing human performance as new technologies are adopted.

**Potential Economic or Societal Impacts:**

Use of laboratory facilities provides an opportunity for early detection of issues during the concept development lifecycle. This will reduce costs down the road as the new systems are developed and operationalized.

**Potential Progress Made Toward Achieving Strategic Goals:**

Use of WJHTC laboratories enables new and innovative technology research, development, and testing for the R&D portfolio.

**Collaboration Partners:**

Not Applicable

# William J. Hughes Technical Center Infrastructure Sustainment
## Requested: ($15,000,000)

**Program Description:**

Infrastructure sustainment at the WJHTC reduces expenses associated with ongoing operation and maintenance activities as well as reducing the frequency of expenses associated with system replacement. System updates reduce energy consumption, and cost, on a per-square-foot basis, thus supporting current Federal Energy Management requirements for sustainability and energy consumption.

**Major Program Objectives:**

This program sustains the William J Hughes Technical Center (WJHTC) facilities, site utilities, and infrastructure. This represents approximately 1.6 million square feet of test and evaluation, research and development, and administrative facilities, plus numerous project test sites on 5,000+ acres of land.

**Potential Program Outputs, Value Statement and Impacts:**

Research and Development laboratories will facilitate enhancements to safety as well as minimizing operational costs. Early Research and Development activities help enhance safety to the National Airspace System by reducing operational errors in the systems and enhancing human performance as new technologies are adopted.

**Potential Economic or Societal Impacts:**

Use of laboratory facilities provides an opportunity for early detection of issues during the concept development lifecycle. This will reduce costs down the road as the new systems are developed and operationalized.

**Potential Progress Made Toward Achieving Strategic Goals:**

Use of WJHTC laboratories enables new and innovative technology research, development, and testing for the R&D portfolio.

**Collaboration Partners:**

Not Applicable

# Chapter 2 – FY 2024 Program Descriptions

**The AMRP FY 2024 outlook year chapter in the annual plan is not developed in alignment with the President's budget request of the same year due to the AMRP development schedule per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning.**

# Airport Infrastructure and Technologies

# FY 2024 Program Descriptions
## Airports Cooperative Research Program

**Program Description:**

The Airport Cooperative Research Program (ACRP) is designed to address needs that are not being addressed by other Federal research programs, and that cannot be undertaken cost-effectively by individual airports.

The ACRP is an industry-driven research program managed by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine. It was authorized by section 712 of Vision 100 – Century of Aviation Reauthorization Act. The Secretary of Transportation maintains a memorandum of agreement among DOT, FAA, and the National Academy of Sciences to implement the ACRP. The Secretary also appoints the 13 members of the ACRP Oversight Committee (AOC).

The ACRP is a national resource for the airport industry, providing valuable information, guidance and practical tools to airport owners and operators (as well as consultants and contractors) by performing industry-driven research identified as critical by airport operators, industry, and users.

ACRP advances safety, economic strength and competitiveness, equity, climate and sustainability, and transformation by providing applied research products to the airport industry that address these issues. Research continues in the use of sustainable airport operations and construction, carbon reduction/carbon capture, diversity/equity/inclusion in both airport staff and airport contracts, improved governance and transparency, and ensuring data privacy and cyber security of airport operations.

**Major Program Objectives:**

The ACRP's mission is to develop near-term, practical solutions to problems faced by airport operators. The ACRP uses contractors selected in a competitive process to conduct the research, which is overseen by industry experts and designated FAA subject matter experts (SMEs). The results of the research are published in the form of handbooks and best practices. To date, the vast library of publications includes areas of safety, airport management, airport financing, airport environmental quality, airport compliance, and airport planning. These publications are available to the public on the ACRP website and for purchase in hard copy.

The ACRP's main goal is to provide resources to support applied research on a wide variety of issues faced by airport practitioners, including all levels of professional staff within the airport community, from CEOs, airport managers, executive directors, to mid-level managers, nonsupervisory technical and professional staff, trainees, students, and interns. These professionals represent airports, suppliers, public safety agencies, airlines, airport tenants, local and regional government authorities, industry associations, and many other stakeholders in the airport community. Each of these practitioners has different interests and responsibilities, and each is an integral part of this cooperative research effort. Although the exact projects selected for research are chosen by an industry-led oversight committee, the committee endeavors to address topics that advance the policy objectives of the Department of Transportation. In addition, the National Academies of Science ensure that research conducted is done in a way that addresses the Department's goals and ensures that research is conducted in a transparent, objective, and academically sound manner.

**Anticipated Program Activities:**

- The ACRP Oversight Committee will meet in summer of 2023 to determine FY24 research funding, projects, and priorities.

# FY 2024 Program Descriptions
## Airports Technology Research Program

**Program Description:**

The Airport Technology Research (ATR) Program supports the safe and efficient integration of new technologies into the airport environment through the development and updates of the FAA's Advisory Circulars (ACs).

The ATR program has a number of research program areas that directly support the DOT's strategic goals, namely Safety, Climate and Sustainability, Transformation, Equity and Economic Strength and Global Competitiveness. For instance, the ATR Program supports the integration of UAS at airports, the development of new infrastructure design standards for Advanced Air Mobility (AAM), the search for newer more-environmentally-friendly firefighting agents, the testing and use of new emerging recycled/carbon neutral pavement materials for use at airports, as well as, the sustainability of extending airport pavement life past the current 20 year design life. It also funds research to quantify and mitigate aircraft noise near airports.

**Major Program Objectives:**

The ATR program directly supports the development and updates of the FAA's Airports ACs in airport safety and airport infrastructure. Research results and objectives from the ATR program are ultimately reflected in these AC's, which form the technical guidance used by airports across the nation.

On the infrastructure side, key objectives, in FY 2023, are the search, testing and applicability of various recycled and more environmentally-friendly pavement materials that may be integrated into the design of airport pavements and extending the life of the airport pavements so the use of new raw material will be reduced and made more sustainable. Since the construction and rehabilitation of airport pavements represent a very large annual capital investment at airports (over $ 2.5 Billion), the use of these non-traditional pavement materials will help lead to a more sustainable airport infrastructure.

On the airport safety side, in FY 2023, the ATR program will remain engaged in the performance testing of solar lighting, continued in-house testing of environmentally-friendly firefighting agents, improving airport noise, reducing the risk of wildlife strikes by aircraft, researching infrastructure needs of rapidly emerging Advanced Air Mobility vehicles, and integrating UAS operations at airports.

Of note, the program also provides an environment where companies of all sizes can test new ideas and products to meet FAA standards. This encourages companies to be innovative in their product development and competitive at the global level.

**Anticipated Program Activities:**

- Research recycled pavement materials and other pavement materials that are more carbon neutral
- Research performance studies to determine pavement surface treatment application and locations at the airfield.
- Research and develop asphalt surface and base courses (FAA Specifications P401, P403 and P404) minimum material, and construction and acceptance recommendations.
- Research the field performance of solar powered lighting systems in various regions of the United States.

- Update the annual FAA Runway Incursion Mitigation report to include an airfield geometry assessment of all towered airports that may have airport design features that are considered at risk for incursions.
- Continue research the impact and needs of Advanced Air Mobility (AAM), including electric Vertical Take-Off (eVTOL) vehicles on existing and future airport infrastructures.
- Continue to evaluate of new PFAS-free Aircraft Firefighting agents for airports
- Continue field testing for the use of UAS applications at airports.
- Research ways to reduce community noise impacts.
- Continue Resilience Study of Vulnerable NPIAS Airports for Climate Change and Severe Weather
- Research autonomous vehicles for various airport applications.

# Aircraft Safety Assurance

# FY 2024 Program Descriptions
## Fire Research and Safety

**Program Description:**

The purpose of this program is to conduct research to prevent accidents caused by in-flight fire and to improve survivability during a post-crash fire. The program supports the FAA's Associate Administrator for Aviation Safety, which is responsible for issuing regulations, standards, and guidance material to ensure the highest level of safety in commercial aviation. Research efforts specific to hazardous material transports are completed in coordination with DOT's Pipelines and Hazardous Materials Safety Administration (PHMSA) and the FAA Office of Hazardous Materials (AXH-1).

The program benefits the aviation industry by developing, validating, and transferring cost-effective aircraft fire safety technology. This program is necessary because of the catastrophic consequences of an uncontrollable aircraft fire, including loss of life and the destruction of the aircraft. An example of this program's efforts is demonstrated through the participation in the Society of Automotive Engineering's (SAE) G-27 committee. This is an international committee focused on efforts to develop a packaging standard for the safe shipment of lithium batteries on aircraft. The International Civil Aviation Organization (ICAO) requested this standard after the ban on the carriage of lithium batteries as cargo on passenger aircraft. Following this ban, the Fire Safety and Research program proposed a test standard and conducted extensive tests to understand the details and develop pass/fail criteria. The PHMSA is also participating in the standard development and, if adopted, would have the responsibility to change the hazardous materials shipping regulations to mandate its use.

**Major Program Objectives:**

The primary goal of this research is the prevention of catastrophic aircraft accidents caused by in-flight fires and increased survivability during a post-crash fire. Other benefits derived from this program include: 1) the introduction of enabling technologies to prevent accidents caused by a fire in freighter aircraft and hidden in-flight fires in passenger-carrying airplanes, and 2) the development, validation, and transfer of cost-effective aircraft fire safety technology to the aviation industry.

The Fire Safety Branch at the FAA WJHTC has unique aircraft fire testing capabilities that do not exist anywhere else in the world. The Commercial Aviation Safety Team (CAST) Safety Enhancement (SE) SE127 team recognized this fact, which recommended that the FAA Fire Safety Branch conduct the research. The FAA Associate Administrator for Aviation Safety relies on objective research results to make decisions on required changes to certification methods as aircraft manufacturing incorporates new materials and processes that may have unforeseen consequences with respect to aircraft fire safety. Global aircraft manufacturers have no incentive to conduct research that might limit the safe use of these new materials and processes.

Major Fire Research and Safety program objectives are consistent with the Department of Transportation's strategic research and policy objective to implement measures that mitigate or eliminate incidents among aviation operations and the traveling public. These efforts include testing and evaluation of new and emerging fire/smoke detection technologies; testing of new fire-resistant cargo container materials and their efficacy in containing cargo fires, including the hazards associated with the carriage of hazardous materials; and supporting the development of a safe packaging standard for lithium batteries on passenger aircraft.

**Anticipated Program Activities:**

- Aircraft and Passenger Survivability
- Cargo Safety
- Propulsion, Fuels, and the Environment

# FY 2024 Program Descriptions
## Advanced Materials/Structural Safety

**Program Description:**

Throughout most civil aviation history, aircraft have evolved slowly with little change to the basic aluminum materials or design concepts. A vast body of knowledge about such aircraft has been gained, often at the expense of fatal crashes. As this knowledge has grown, the safety record of civil aviation has steadily improved to the near-perfect record of the past few years. Over the decades, the pace of evolution of civil aircraft has increased dramatically. One of the most significant changes has been the widespread adoption of advanced composites in aviation products. This represents the first significant change in aircraft materials, design concepts, and fabrication techniques since the introduction of the first modern airliners in the 1930s.

This program conducts research to support FAA safety and regulatory activities in the technical areas of composites and other advanced materials and processes, and their impact on flight safety. The overall goal of this research is to support development of standardized certification protocols and safe maintenance practices for advanced materials and structural applications. While traditional composites have been used in aircraft structure for some time, non-traditional composites such as those with discontinuous fibers or thermoplastics, as well as other advanced materials and processes such as additive manufacturing, are increasingly being used in aviation products. All of these materials are expanding into new aircraft applications, with composites expanding to new critical shell and highly loaded beam structures to replace traditional metal construction, without commensurate standards and the existing service experience. By comparison, metal and composite additive manufacturing applications are just getting started in different areas that involve the challenges of numerous unique parts with complex geometry and loadings. As a result, the FAA must keep abreast with industry advances in all of these applications to support standards that ensure safe and efficient practices for the future.

This program supports the Department's strategic goal of safety. It coordinates its efforts with industry to provide data to support the FAA's oversight role of ensuring new technologies are adopted safely, as well as its mandate not to place an undue burden on industry. The program focuses on potential issues with material and structural performance, manufacturing quality control and assurance, and operational support/maintenance needs. The Advanced Materials and Structural Safety Program seeks to fill gaps in our knowledge related to these issues before they can cause catastrophic loss of aircraft and lives. This research program is a proactive approach to preventing accidents rather than the reactive approach to preventing the recurrence of accidents pursued in the past.

**Major Program Objectives:**

Advanced Materials and Structural Safety program objectives are driven by industry advancements in the construction of airframes and related components presented for certification. The FAA must ensure that the changes maintain an equivalent or improved level of safety for traveling public compared to that achieved with current operational aircraft. Requests from the aircraft certification offices and the aircraft manufacturers seeking "type certification" approval are major influences shaping research requirements. Additional requirements are developed from assessments of existing techniques, protocols, and service histories. These are examined to determine if modifications to certification compliance methods are required for novel materials, processes, and forms. The National Transportation Safety Board review of accidents involving these structures provides additional impetus for research required to understand these emerging technologies. Sample reports can be viewed at:

- http://www.ntsb.gov/investigations/AccidentReports/Pages/AAR0404.aspx

- https://www.atsb.gov.au/publications/investigation_reports/2007/aair/aair200701625.aspx

In this context, major program objectives include:

- Development of guidelines for characterizing and controlling new material forms and assessing manufacturing maturity. Traditional composite materials may be considered those that are continuous fiber, and typically involve epoxy resin systems. Existing FAA guidance and industry standards for design, certification, manufacturing and maintenance tends to focus on behaviors associated with this class of materials. As new materials are introduced, the FAA, and industry as a whole, needs to characterize and control these materials in a way that produces a consistently sound structure to protect public from safety risks. This objective aligns with the DOT strategic research and policy objective of designing transportation systems to maintain and improve safety outcomes.

- Evaluation of fatigue, damage tolerance, and other aging behaviors of existing and new advanced materials. Many advances with manufacturing methods are inducing part-specific characteristics that require careful consideration for fatigue, aging, or other long-term effects. This supports the FAA strategic focus areas of continued passenger transport operations and to set standards for emerging materials. Additionally, it supports the DOT strategic research and policy objective of protecting travelers from safety risks and designing transportation systems to improve safety outcomes.

- Evaluation and characterization of dynamic or crashworthiness behavior of advanced structures to drive certification standards and guidelines. Current industry standards and test methods for dynamic applications such as seating systems and bird strike evaluations were developed assuming metallic structure in the load path. Composites are now being used in these applications; therefore current guidance material needs to be expanded to describe how certification test methodologies can be adapted. Another aspect of this research is investigating new applications, such as electric vertical takeoff and landing (eVTOL) aircraft that may be used for passenger carrying operations such as urban air mobility. These may require unique dynamic evaluation of advanced materials and structures, compared to existing vehicles, as they will have different design and impact requirements. This research aligns with the DOT strategic research and policy objective of protecting travelers from safety risks and designing transportation systems to improve safety outcomes.

- Development of efficient methods for characterizing composite and additively manufactured structural details and elements to tie to best practice design and certification principles. Advanced materials and structures are typically certified using a "building block approach" defined in FAA Advisory Circular AC 20-107B. The process involves a complex mix of test and analysis with test articles of varying complexity in order to predict and model full scale structural behavior. The building block is somewhat standardized at the lowest level of material coupon testing. The top of the building block "pyramid" is full scale testing required by regulations and is by necessity unique for each applicant. All configurations in the middle of the building block are currently also uniquely evaluated. The goal of this research is to standardize test methods for common mid-level building block details and elements for both composite and additive parts. This supports the FAA strategic focus areas of continued passenger transport operations and to set standards for emerging materials.

- Support development of industry handbooks and other standardization activities, and promote knowledge sharing for advanced materials and structures, including evaluation of emerging supporting technologies with the public as well as internally within the FAA. This objective helps strengthen the use of informed data-driven decision-making and use of comprehensive approaches such as safety management systems, one of the DOT strategic policy objectives.

**Anticipated Program Activities:**

- Evaluate long-term aging behavior of advanced materials and associated maintenance practices
- Evaluate fatigue and damage tolerance behavior of bonded structure and associated maintenance practices
- Evaluate and characterize dynamic behavior of advanced structures to drive new test and certification standards and guidelines Crashworthiness performance of composite aircraft seats.
- Develop guidelines for characterizing new material forms and assessing manufacturing maturity.

# FY 2024 Program Descriptions
## Continued Airworthiness

**Program Description:**

The Continued Airworthiness Program promotes the development of technologies, procedures, technical data, and performance models to prevent accidents and mitigate accident severity related to civil aircraft failures as a function of their continued operation and usage. The program focuses on longer-term maintenance of the structural integrity of fixed-wing aircraft and rotorcraft, continued safety of aircraft engines, development of inspection technologies, and the safety of electrical wiring interconnect systems and mechanical systems.

The quest for improved fuel, operational efficiency, and lower environmental impact is driving the evolution of aircraft at an unprecedented rate. Advances are being made in every aspect of aircraft design such as: additive manufacturing, composites and other new materials; structural technologies such as structural bonding and welding; propulsion systems such as battery, hydrogen, and hybrid powered electrical propulsion; and avionics. The FAA must ensure that these new technologies are safe, not only as they enter the airspace, but also throughout the life of the aircraft. This requires a deep understanding of the effects of aging, environmental exposure, and in-service damage to ensure that they are adequately addressed by the applicant during the certification process.

The Continued Airworthiness Program works with industry to perform the research required to develop such a body of knowledge. The data developed and insights gained are used to create and update guidance and policy, inform airworthiness directives, and create industry standards. The program focuses on longer-term maintenance of the structural integrity of fixed-wing aircraft and rotorcraft, continued safety of aircraft engines, development of inspection technologies, and the safety of electrical wiring interconnect systems and mechanical systems.

**Major Program Objectives:**

The Continued Airworthiness Program supports the FAA aviation safety oversight responsibility to ensure that aircraft maintain operational safety as they age. The FAA accomplishes this in two ways: first, by anticipating aging issues during the certification process and ensuring that they are adequately covered in the operations of the application; and second, by monitoring the in-service data as it is accumulating, finding issues at the earliest possible point, and ensuring that they are managed through advisories, directives, regulation, or other guidance.

Since its establishment, the program has led extensive studies on the in-service behavior of airframe structures and aircraft systems. The knowledge and information produced directly supported a wide range of FAA safety rulemaking, including the Aging Aircraft Safety Rule (AASR) 2005; the Widespread Fatigue Damage Rule (WFD) 2010, the Damage Tolerance Data for Repairs and Alterations rule under 14 CFR Part 26, 2007; Order 8110.104, Responsibilities and Requirements for Implementing Part 26 Safety Initiatives, 2007, as well as related guidance materials and advisory circulars.

**Anticipated Program Activities:**

- Develop a Method of Compliance to Support Certification of Advanced Flight Controls in General Aviation and Hybrid Vehicles
- Metallic Materials Development and Standardization (MMPDS)
- Examine the effects that different platform materials have on the results of rotorcraft fuel system drop testing

- Large electric energy storage systems research
- Evaluate fatigue and damage tolerance behavior of emerging structural materials
- Effect of turbulence on aircraft structural loading
- Probabilistic damage tolerance based fleet management for small airplanes
- Development of Control Surface and Stabilizer Freeplay Limits

# FY 2024 Program Descriptions
## Propulsion and Fuel Systems

**Program Description:**

The FAA establishes rules for the certification and operation of aircraft engines, fuels, and fuel management systems that enhance the airworthiness, reliability, and performance of aircraft propulsion and fuel systems. The Propulsion and Fuel Systems Program conducts research that provide the Office of Aviation Safety (AVS) with the basis for new or revised engine certification and continued airworthiness standards. This research also supports FAA actions in response to National Transportation Safety Board (NTSB) safety recommendations. It supports the preparation of Advisory Circulars (ACs) that provide the industry with technical information on acceptable means of compliance with regulations. Benefits accrue in the form of a reduced risk of engine failures and fewer accidents, leading to fewer injuries and fatalities. Finally, research in this program supports the U.S. DOT strategic goal of "Climate and Sustainability" by researching and performing experiments with electric propulsion systems. This supports the Strategic Objective of "Economy-wide Net-Zero Emissions by 2050."

**Major Program Objectives:**

To prevent uncontained engine failures, the FAA and the AIA formed the Rotor Integrity Steering Committee (RISC) to augment the traditional safe-life design approach with one that employs a probabilistic design methodology to account for extremely rare material and service induced anomalies. This revolutionary change resulted in the FAA issuing rule 33.70, which describes the certification of critical life-limited engine parts. In order for the FAA to ensure that the industry is able to comply with the new safety rule, a series of FAA advisory circulars and a publicly available probabilistic software code will be developed.

The objective of this research is to develop the damage tolerance framework and supporting data to provide a basis for the necessary advisory materials and a design software code called Design Assessment of Reliability With Inspection (DARWIN) in support of rule 33.70. A further objective of this research is to develop improved nondestructive evaluation (NDE) methods to characterize engine component material conditions that can compromise integrity. This need was highlighted by the NTSB in recommendations A-18-03 and A-18-04 resulting from the 2016 AA Flight 383 uncontained turbine failure event. Additionally, this research develops data and analysis methods for blade fragment impact and containment in support of rule 33.94 as well as uncontained debris vulnerability assessment tools necessary to minimize catastrophic risk in support of rule 25.901 and 25.903. To accomplish these objectives, research will be pursued through government and industry collaboration to ensure that a consistent level of safety is widely adopted by the engine industry.

Finally, as outlined in the U.S. DOT strategic plan, the research into electric propulsion will assist in the reduction of air pollution and greenhouse gas emissions from transportation and advance a sustainable transportation system while improving the resilience of at-risk infrastructure. Electric propulsion can accomplish this by utilizing renewable resources to supply onboard aircraft storage systems.

**Anticipated Program Activities:**

- Improved Nondestructive Evaluation to Prevent Uncontained Engine Failures
- Advanced Analysis Methods for Impact of Aircraft Materials from Rotor Burst and Blade Release
- Engine Safety Event Prevention thru Engine Health Monitoring (EHM)
- Electric Motor Research for the Safe Implementation of Electric Propulsion

# Digital Systems and Technologies

# FY 2024 Program Descriptions
## Digital System Safety

**Program Description:**

Airborne systems' designs have become increasingly dependent on highly integrated software and hardware architectures that share power, computing, networking, input/output, and other resources to support the needs of multiple aircraft functions. The main goal in Digital Safety Research is to analyze airworthiness and certification assurance aspects of highly integrated, complex digital aircraft systems, including systems development processes, requirements validation, and integration; use of Commercial Off The Shelf (COTS) devices; new and novel electronic hardware and software implementation techniques (such as Artificial Intelligence [AI] and/Machine Learning [ML]), tools, methods, and processes; streamlining approaches to development assurance and aircraft certification. Additionally, this research develops, validates, streamlines, and improves certification methods to reduce time and cost to both FAA and industry in certifying aircraft employing advanced digital airborne systems. Finally, research in this program supports the U.S. DOT strategic goal of safety to ensure that automation brings significant safety benefits; and pursue performance-based rather than prescriptive regulations.

**Major Program Objectives:**

The research conducted within this program differs from industry research. The program's main focus is considering new technology, materials, and procedures while maintaining or increasing current safety levels. The program's main sponsor is the regulatory community, which can be hindered by proprietary and intellectual property rights. The programs under this BLI provide the aviation community with publicly available data and insight for consistent aircraft certification safety.

The research requirement will provide additional insights into safety vulnerabilities of complex digital systems that are developed, integrated, or verified using unproven processes, techniques, and methodologies that could introduce a safety risk for undetected errors with failure manifested at the aircraft level. The Complex Digital Systems research will develop policy, guidance and training for new technologies and techniques to promote their safe use in aircraft systems; develop processes and training material used to streamline the certification of complex digital systems. Also, seeks to understand, address, and provide an annual measurement indicator of Safety Data Sheets (SDS)-related continued operational safety issues.

**Anticipated Program Activities:**

- Complex Digital Systems- Assurance Criteria for Emerging Technologies
- Complex Digital Systems- Assurance Approaches
- Aircraft Performance, Navigation, and Timing Cyber Safety-Assessment and Prototyping

# FY 2024 Program Descriptions
## Information/Cyber Security

**Program Description:**

This program researches cyber data science methodologies using Machine Learning (ML) and Artificial Intelligence (AI), addressing cyber security parameters such as data volume, data velocity, data variety, data veracity, behavioral data, and various other parameters. This helps to prevent disruptive cyber incidents that may affect NextGen air traffic operational data, which includes the NAS, R&D, and mission support domains. The research consists of Air Traffic Management Operations, Net-Centric Operations, and NAS Infrastructure. The big data research will include various communications such as Internet Protocol (IP) traffic, big data in the cloud (public, private, community, and hybrid), and various application data within FAA systems and external aviation partners' systems communicating with FAA systems. The long-term goal is to help prevent disruptive cyber incidents within NextGen future traffic that will include digital and flexible communication in future Air Traffic Control (ATC) missions and improve big data cyber security within Air Traffic Management Operations, Net-Centric Operations, and NAS Infrastructure (communication, and information management) resilience through:

- Big Data Cyber Analytics – to effectively compile and correlate data volume, data velocity, data variety, data veracity, behavioral data, large volumes of data, new technologies, and algorithms
- Visualization tools – related to big data to develop visualization techniques: creative visual presentations of data that quickly differentiate warning signs from normal operating behaviors
- Exploratory research topics – Self-Adaptive Networks and Systems and Design Assurance Methods for Mixed Trust Environments

The past decade has seen an exponential increase in cyberattacks that threaten several components of the aviation ecosystem. To address these needs, the FAA NextGen Organization (ANG) has established the Cybersecurity Data Science (CSDS) research program with emphasis on discovery, assessment, adaptation, demonstration and transfer of cyber technology in the form of concepts and guidance - to enhance information cybersecurity for elements of the aviation ecosystem. Specifically, this research program will focus on identifying breakthrough discoveries in core research areas, and applying the resulting information to help create a more resilient and sustainable aviation ecosystem. Emphasis on Artificial Intelligence and Machine Learning (AI/ML), data science, and collaboration across industry segments will address these aviation ecosystem cybersecurity threats.

This includes working closely with the industry to refine and mature a CSDS Aviation Architecture Framework (AAF) and developing use cases that express specific interests of designated industry collaborators that will reduce the cybersecurity safety threats to the flying public.. This includes technology exploration studies, market surveys, Proof-of-Concept experimental software prototyping, and Advanced Technology Demonstrations. The applied research is targeted toward use case development, technology concept exploration, Proof-of- Concept demonstrations, and development of documented guidance materials, through close work with industry stakeholders.

Core research will be performed to enable breakthrough discoveries and new knowledge in research areas that include:

- Vulnerability and Risk Assessment (V&RA)
- Lateral Movement Defense (LMD)
- Predictive Analytics (PA)

- Context Aware AI

Applied research will lead to technology transfer through the development of Relative Research Environments to evaluate the concepts of the core research in conjunction with industry applications. The transfer of the technology will be accomplished through the development of industry documentation and guidance.

**Major Program Objectives:**

The NextGen Information Security R&D objective is to prevent and predictively determine the potential of cyber events such as unauthorized access, destruction, disclosure, modification of information or data, and/or denial of service. In addition to increases in traditional air traffic, the aviation ecosystem will undergo significant changes to mission requirements over time. Examples of significant potential changes to the aviation ecosystem include, emerging technologies, open architectures, cloud computing, and shared aviation information. Other changes that may happen at the run time include potential increases in communications traffic due to malicious activity, and network and resource availability changes. As the aviation ecosystem grows in mission and complexity, the cost of making changes requiring human interaction becomes prohibitively expensive. In addition, in the case of run-time changing conditions, humans cannot keep up with the pace of system operational changes.

The main goal of the NextGen Information Security program is the prevention and deterrence of disruptive cyber incidents that affect various components of the aviation ecosystem. The program directly supports the FAA Cyber Security Strategic Plan to research advanced tools, techniques, and processes adapted for use in the transfer of new cybersecurity technologies. It will also enable critical research and development leading to enhanced industry capabilities for a more resilient, safe, and secure aviation ecosystem.

Furthermore, this program is designed to address the following guidance:

- OMB Memorandum M-20-29 (14 Aug 2020), prioritizes AI/ML. Additionally, two "priority crosscutting actions" that "underpin the five R&D priorities" include #3 "facilitate multisector partnerships and technology transfer" and #4 "leverage the power of data."
- The National Strategy for Aviation Security (Dec 2018), broadens the scope of potential threats to, or disruption of, the aviation ecosystem with emphasis on cybersecurity to include emerging threats such as malicious cyber actors. The national strategy directs a holistic and adaptive approach to securing the aviation ecosystem.

EO 13800 (11 May 2017) directs the strengthening of cybersecurity for the nation's critical infrastructure. It emphasizes identification of capabilities that agencies could employ to support the cybersecurity efforts of critical infrastructure entities at greatest risk of attacks that could reasonably result in catastrophic regional or national effects on public health or safety, economic security, or national security.

**Anticipated Program Activities:**

- Context Aware Behavioral AI Algorithm Adaptation and Initial Software Prototype Development
- Predictive analytics prototype development and demonstration
- Explainable AI (XAI)
- Mature Aviation Architecture Framework (AAF)
- Develop CSDS Systemic Analysis Process (CSDS-SAP)
- Evaluate industry specific use case scenarios in collaboration with Aircraft, Airlines and Airport partners

# Environmental and Weather Impact Mitigation

# FY 2024 Program Descriptions
## Aircraft Icing

**Program Description:**

The FAA establishes rules for the certification and operation of aircraft in icing conditions. The agency uses research results to generate Advisory Circulars (ACs) and other forms of technical information to guide certification and airworthiness specialists and inspectors on acceptable means for meeting requirements. This research and the guidance materials generated from this research help to reduce aircraft accidents and incidents caused by aircraft icing, which meets the Department's strategic goal of safety.

**Major Program Objectives:**

The Aircraft Icing program will improve existing capabilities and develop new engineering tools to support improved means of compliance and new guidance material for engine and airframe certification and operations in super cooled small and large drops, mixed-phase, and ice crystal icing conditions. The outputs will support improved safety through the issuance of new guidance materials for ACs.

The main goal in Aircraft Icing research is to improve aviation safety related to aircraft icing. This includes developing a better understanding of the effects of environmental icing, the development of data in support of new regulations and guidance materials, the support for improvements to engineering tools for certification and operations, and improving icing weather information for decision-making in terminal areas and in-flight avoidance of high ice water content ice crystal conditions.

The Aircraft Icing Program focuses primarily on providing the information needed by the FAA to ensure that the industry complies with certification and operational requirements. Much of this information is also useful to the industry in its efforts to ensure safety. The Aircraft Icing Program seeks and receives valuable input and insights from the industry through meeting with industry working groups and committees and participation in national and international conferences.

**Anticipated Program Activities:**

- Ice protection of vertical stabilizer prior to takeoff
- Deicing and anti-icing fluid protection time for mixed phase ground icing conditions

# FY 2024 Program Descriptions
## Weather Program

**Program Description:**

The Weather Program performs applied research to enhance safety and operational efficiency in adverse weather conditions in the National Airspace System (NAS) as well as in oceanic and remote regions.

The Weather Program facilitates the transition of legacy capabilities to meet NextGen requirements, often through collaborative and complementary initiatives with National Weather Service (NWS); as well as focused initiatives to help mitigate safety and/or efficiency issues associated with well-documented weather problems. The program leverages advances in meteorological science to enhance observation methods, improve weather prediction models, and produce increasingly accurate forecasts of convective weather, turbulence, icing, and low ceiling and visibility conditions. The National Oceanic and Atmospheric Administration (NOAA)/NWS platforms and forecasters use algorithms developed by the AWRP to provide regulatory forecast products and NAS decision aids. The timely dissemination and presentation of such information provides decision support input to enable traffic flow managers, controllers, pilots, and airline operations personnel to implement tactical and strategic traffic management initiatives to avoid encounters with severe weather, reduce delays, and mitigate safety risks.

The Weather Program research projects are conducted to develop, verify, and validate recommendations for incorporation into Minimum Weather Service (MinWxSvc) standards and guidance documents to enhance the safety and efficiency of commercial, business, and general aviation operations. For the WTIC program, a MinWxSvc is defined as:

- Minimum cockpit meteorological (MET) information
- Minimum performance standards (e.g., accuracy) of the MET information
- Minimum rendering standards
- Enhanced weather training
- Minimum cockpit technology capability recommendations

**Major Program Objectives:**

The FAA's Weather Program develops capabilities to improve observations, diagnoses, and forecasts of weather information to support operational planning and decision making by users including air traffic managers, flight dispatchers, and pilots. It also addresses needs for enhanced cockpit weather technology, information, and human factors principals to improve operational efficiency and safety, and reduce flight delays and gaseous emissions in adverse weather.

The main goals of the AWRP are to mitigate the impact of weather on the NAS; mitigate weather related NAS safety and/or traffic flow efficiency issues; support the evolution of legacy weather capabilities into the capabilities developed and deployed as NextGen decision-support weather processes; improve the accuracy and relevancy of legacy weather products and services mandated by FAA regulatory guidance and/or international agreements; and support the achievement of the NextGen weather vision.

The main goals of the WTIC Program are to enhance aviation safety by resolving gaps in cockpit weather information and technology that are causal factors in prior accidents/incidents or have the potential to be a causal factor in future accidents/incidents. The numerous gaps being resolved by the WTIC Program have been identified by WTIC gap analyses, NTSB accident investigations, stakeholder inputs, and research

experiments. The program also seeks to enhance pilot weather knowledge and experience in flight under adverse weather conditions to enhance their safety and the safety of passengers. The WTIC Program is developing weather training using augmented, virtual, and mixed reality that can be presented on personal computers with minimal additional technology. This program aims to increase the quality of cockpit weather automation and information by developing techniques for enabling pilots to easily monitor automation performance and the quality of weather data inputs. It also seeks to enhance the weather infrastructure for aviation by using non-traditional sources to gather the information that provides utility to pilots in making adverse weather avoidance decisions. Though the quality of these sources has historically been too uncertain for aviation, the WTIC Program is using crowd sourcing algorithms, artificial intelligence, machine learning, and big data to recognize outlier data and to converge on accurate observation data. Finally, the WTIC Program reduces gaseous emissions by enabling more effective reroute decisions relative to adverse weather avoidance. Adverse weather is a primary causal factor in excess emissions due to the difficulty in optimizing hazardous weather avoidance. WTIC is researching using artificial intelligence and machine learning to assist pilot situational awareness of adverse weather to enable strategic planning to enhance reroute efficiency.

Market Surveys conducted by the Weather Program have shown that industry has little experience, expertise, and incentive to perform applied aviation weather research without government funding. The investment (computer processing equipment, data retrieval, specialized personnel, etc.) required upfront, and the fact that airlines and other users have limited budgets to spend on weather information leads to a low return of investment (ROI) that is not enough to initiate or sustain an industry effort. In cases where the industry does develop new products, data, or techniques, the resulting output is usually proprietary, which limits use by the government. Without oversight and the ability to test the output for accuracy and conformity to standards and safety regulations, it is generally not suitable for use by NextGen or NWS. Therefore, the only viable option is for the Weather Program to conduct and manage weather research to meet FAA requirements.

**Anticipated Program Activities:**

- Improve Convective Weather Forecasts for Aviation and resolve convective weather information gaps in cockpits
- Improve Frequency of Ceiling and Visibility (C&V) Forecast Guidance and enhance observation data in cockpits
- Turbulence Forecast and Observations Enhancements
- Inflight Icing Forecast Enhancements
- Improving Turbulence Avoidance Phase 4 - ADS-B Turbulence
- Resolving Cockpit Weather Information Gaps - ADS-B and Hands-Free Pilot Report (PIREP) Submittals
- Cockpit Decision Support Tools - Most Representative Weather Information Sources in Remote Areas

# FY 2024 Program Descriptions
## Alternative Fuels for General Aviation

**Program Description:**

Due to various environmental, regulatory, and market forces in the U.S. and worldwide, leaded avgas will be eliminated at a future point in time. The Alternative Fuels for General Aviation research program operates as part of the Piston Aviation Fuel Initiative (PAFI). PAFI was established at the request of a broad cross-section of the aviation and petroleum industries and consumer representatives to develop a path forward for identifying, evaluating, and deploying the most promising unleaded replacements for 100 low lead aviation gasoline. Unfortunately, in concert with existing government regulations and policies, the aviation and petroleum marketplace does not support a safe, orderly, and economically viable fleet-wide transition to a new fuel or fuels, hence the need for the joint government and industry collaborative initiative known as PAFI. The Alternative Fuels program collaborates with 40 different entities in this program, as further detailed below.

This program supports the DOT's strategic goal of Climate and Sustainability and also Executive Order 14008 "Tackling the Climate Crisis at Home and Abroad" by conducting research to mitigate climate pollution using multiple cleaner alternatives to current general aviation gasoline. More specifically, as part of the FAA EAGLE (Eliminate Aviation Gasoline Lead Emissions) initiative, this research supports addressing current and historical environmental injustices from aviation, particularly lead emissions. The EAGLE stated program timeline is to eliminate lead emissions from general aviation by 2030.

There is no known safe exposure level of lead, and multiple studies have documented the health impacts to urban and other disadvantaged communities of lead exposure. Current leaded aviation gasoline (avgas) is the only remaining transportation fuel in the U.S. that contains lead additives. These additives protect piston engines against damaging detonation, or engine 'knock'. The Environmental Protection Agency (EPA) reports that GA aircraft contribute approximately 70 percent of total airborne lead emissions and is currently evaluating lead emissions from piston aircraft and their impact. The EPA plans to issue a proposal on lead in aviation gasoline for public review and comment in 2022 and take final action in 2023. In addition, the European Chemicals Agency (ECHA) has also proposed restrictions on the form of lead used in aviation gasoline. Market forces, along with national/international regulatory actions will eliminate the availability of leaded avgas in the near future. Safe alternatives must be in place before the end of leaded gasoline availability.

**Major Program Objectives:**

The Alternative Fuels program will support the EAGLE Initiative as it leverages and builds upon a continuing collaboration with industry through the PAFI. The program objectives are to enhance and accelerate research in the areas of unleaded, sustainable, and other fuel alternatives for use in piston-engine aircraft; aircraft and engine modifications to allow safe operation on reduced octane unleaded fuels; and innovative aircraft technologies that safely reduce emissions. Additionally, the program will support the accelerated development of fuel efficient, low-emissions aircraft technologies, including electric, and electric hybrid propulsion, and support collaborative research on other leading edge and next generation technologies that will also reduce harmful emissions. These all will address the broader goals of reducing air pollution, and addressing the historical, negative impacts on disadvantaged communities from aviation, particularly due to lead emissions.

For more information on the EAGLE Program, please see https://www.faa.gov/about/initiatives/avgas.

For more information on FAA/EPA collaboration, please see https://www.epa.gov/regulations-emissions-vehicles-and-engines/regulations-lead-emissions-aircraft. For more information on FAA sustainability initiatives, please see https://www.faa.gov/sustainability.

# FY 2024 Program Descriptions
## Environment and Energy

**Program Description:**

The FAA's long-term vision is to remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation. This program supports this vision by advancing our understanding of civil aviation noise and emissions at their source, how noise and emissions propagate and are modified in the atmosphere, and their ultimate health and welfare impacts. A central part of the program is the continued development of an integrated aviation environmental tools suite that can be used to evaluate a wide range of environmental mitigation solutions. The suite is built upon a sound scientific understanding of aviation noise and emissions as well as their environmental, health, and welfare impacts. The tools analyze and inform decision-making on technology development, operational procedures, regulatory compliance, and international and domestic standards and policies relating to civil aviation's energy use and environmental impacts. The FAA's long-term vision is to remove environmental constraints on aviation growth by achieving quiet and fuel-efficient operations. Understanding of the root causes and the interactions of these pollutants with the environment is the fundamental step in developing the technologies and strategies necessary to reduce their impacts on people, their environment, and climate.

**Major Program Objectives:**

Aviation noise and emissions are a considerable challenge to the continued growth of aviation. Despite the technological advancements achieved during the last four decades, and the resultant 95 percent reduction in the population exposure to significant noise, the impact of aircraft noise demands considerable Federal resources and is a constraint on aviation growth. Since 1982, the FAA has provided over $11 billion for sound insulation of houses and schools around U.S. airports through the Part 150 Program. Environmental impacts, especially aircraft noise, are often the number one cause of opposition to airport capacity expansion and airspace redesign (http://www.gao.gov/assets/310/309622.pdf). Concerns about the impacts of aircraft emissions on climate change could limit the growth of international aviation. The implementation of precision navigation over the last few years has contributed to increased airport community concerns regarding noise. This challenge is anticipated to grow with new entrants such as unmanned aerial systems, urban air mobility, and civil supersonic aircraft. The ability to manage this growth will partly depend on the extent to which we address the effects of noise and emissions. Technologies that reduce noise and emissions are regulated at the vehicle level as a part of airworthiness certification.

These environmental standards are harmonized internationally through the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP). A significant portion of this Program is devoted to informing decision making at ICAO CAEP. Further, this program supports domestic policy and regulatory considerations in the absence of timely consensus on international policies and standards. This research supports the Administration's vision as outlined in Executive Order 14008 to put the United States on a path to achieve net-zero carbon dioxide emissions, economy-wide, by no later than 2050. The research in this budget line item also addresses local environmental concerns that are a result of aviation noise and emissions that impact local communities in the vicinity of airports. This includes the need for environmental justice in line with Executive Order 12898. This program's research efforts support the development of technological innovations for the current fleet of aircraft that will mitigate climate change and address local environmental concerns. Furthermore, the program will coordinate efforts with federal partners to ensure that knowledge is shared broadly thus increasing the benefits provided by the supported efforts.

**Anticipated Program Activities:**

- Advance Scientific Understanding of Environmental Impacts of Noise and Emissions
- Aviation Environmental Design Tool (AEDT) Development
- Decision Making on Standard Setting, Certification, and Policy

# FY 2024 Program Descriptions
## NextGen – Environmental Research: Aircraft Technologies and Fuels

**Program Description:**

The NextGen Environmental Research – Aircraft Technologies and Fuels Program supports efforts to develop new aircraft and engine technologies, and advance sustainable aviation fuels in line with the Administration's commitments on climate change and the environment. Technologies developed by this program will result in a fleet of aircraft that have lower noise, use less fuel, and produce fewer emissions. This program also provides test data, analyses, and methodologies to support the development and deployment of sustainable aviation fuels. Funds from this program ensure novel jet fuels are drop-in compatible with today's fleet of aircraft and are certified as being safe for use. They also ensure that Sustainable Aviation Fuels (SAF), produced from renewable and waste feedstocks, and lower carbon aviation fuels, produced from fossil feedstocks, are appropriately credited under the International Civil Aviation Organization (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA).

Through the Continuous Lower Energy Emissions and Noise (CLEEN) program,[4] which is supported by this project, the FAA and industry are working together to develop technologies that will enable manufacturers to create aircraft and engines with lower noise and emissions, as well as improved fuel efficiency. Technologies accelerated by the CLEEN program have relatively large technological risk. Government resources help mitigate this risk and incentivize aviation manufacturers to invest in developing these technologies. By cost sharing the development with the FAA, industry is willing to accept the greater risk. Once entered into service, the CLEEN technologies will produce noise, fuel burn, and emissions benefits throughout the fleet for years to come.

Funding from this program also supports efforts by ASCENT — the FAA's Center of Excellence (COE) for Alternative Jet Fuels and Environment — to develop innovative technological solutions to reduce noise, emissions, and fuel burn from subsonic and supersonic aircraft. Aircraft technology development projects under ASCENT complement the CLEEN Program's industry partnership approach by providing a venue for University-led research to expand knowledge broadly across the industry and develop technologies at all levels of maturity that will reduce noise, emissions, and fuel burn. The program also provides funding for alternative jet fuel testing and analysis efforts by ASCENT, which aim to accelerate the development and approval of SAF. This cooperative aviation research organization is co-led by Washington State University and Massachusetts Institute of Technology.[5]

This program also supports the Commercial Aviation Alternative Fuels Initiative (CAAFI) in its efforts to engage with commercial aviation and emerging alternative fuels industries.[6]

**Major Program Objectives:**

The main goal of the NextGen Environmental Research – Aircraft Technologies and Fuels program is the development of aircraft and engine technologies and sustainable aviation fuels that collectively will reduce noise, fuel burn, and emissions. Technologies developed by this program result in a fleet of aircraft that have lower noise, use less fuel and produce fewer emissions, thus supporting the overarching environmental performance goal for NextGen to achieve environmental protection that allows sustainable aviation growth.

[4] For more information on the CLEEN Program, please see http://faa.gov/go/cleen
[5] For more on the ASCENT COE, please see http://ascent.aero
[6] For more on the Commercial Aviation Alternative Fuels Initiative (CAAFI), please see http://caafi.org

This program's research efforts support FAA's timely and safe introduction of advanced technologies that mitigate environmental impacts and climate change. By concentrating on those technologies that are applicable to the aircraft airframe, the engines and their operation, and the aircraft performance this program supports noise, emissions, and fuel burn improvements at the source thus with the potential to reduce impacts both in the terminal area, where people in local communities around airports are affected, as well as en-route, where the majority of the impacts to the climate are introduced.

The program also provides data to evaluate the safety of alternative jet fuels and ensure they are appropriately integrated within international standards. Additionally, the program explores methodologies to reduce the time and resources necessary to bring new fuels to the point of being ready for final evaluation so that new safe for use products might become available more quickly, which is a key element in achieving the domestic goal of a net-zero aviation sector by 2050.

By reducing the environmental impact of aviation through new technologies and sustainable aviation fuels this program helps to remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation.

**Anticipated Program Activities:**

- CLEEN Phase III
- ASCENT Technology Innovation
- Ensure Novel Jet Fuels are Safe for Use
- Move Beyond the 50% SAF Blend Wall to Enable 100% SAF Use
- Maximize environmental benefits of sustainable aviation fuels
- Support inclusion of Sustainable Aviation Fuels in ICAO CORSIA

# Human and Aeromedical Factors

# FY 2024 Program Descriptions
## Flight Deck/Maintenance/System Integration Human Factors

**Program Description:**

The Flight Deck/Maintenance/System Integration Human Factors program addresses research, engineering, and development (RE&D) requirements defined by technical sponsors in the Federal Aviation Administration (FAA) Aviation Safety Organization (AVS). These requirements are driven by the human factors needs of Aircraft Certification (AIR) and Flight Standards (AFS) personnel responsible for certification, approval, and continued airworthiness of aircraft, as well as the certification of pilots and mechanics. Program outputs provide the research foundation to update and maintain human factors related regulations, guidance material, procedures, orders, standards, job aids, and other aviation safety documentation. For this purpose, the Flight Deck/Maintenance/System Integration Human Factors program directly aligns and supports the Department of Transportation's (DOT's) strategic goal of Safety.

The revolution in digital avionics has changed flight deck design and operational practices and enabled new advanced vision system technologies, surface moving maps, electronic flight bags, advanced controls, communications, navigation, surveillance systems, and tools for aircraft system management. With these advances come important human performance and human factors implications which must be understood and applied in the appropriate guidance material developed for policy, procedures, operations, and training. This research supports AVS in regulating the development of these products. Human error continues to be a major contributor to aircraft accidents and incidents both in commercial and general aviation. Current research is proactive in identifying error tendencies and thereby enhancing the safe and effective introduction of new technologies and procedures into the NAS.

**Major Program Objectives:**

The Flight deck/Maintenance/System Integration Human Factors program responds to research, engineering and development (RE&D) requirements defined by technical sponsors in the Office of Aviation Safety (AVS). Outputs from this program inform AVS personnel who incorporate evaluation criteria into human factors – related regulations, guidance material, standards, job aids, and other documentation to support safety.

The Flight deck/Maintenance/System Integration Human Factors program supports the DOT's strategic objective "*Safe Systems"* through the *"use* [of] *data…to take proactive actions to address emerging safety risks and support compliance",* including *"improve safety of flight paths…"* The program supports this objective by providing a research foundation for *"…data-driven decision-making…"* and informing, as appropriate, AVS technical sponsors who are responsible for Aviation Safety regulatory policy. The program manages research to address RE&D requirements defined by AVS technical sponsors. This includes the human factors needs of FAA specialists in AIR and AFS who evaluate, approve, accept, and oversee flight deck systems, displays, devices, controls, avionics equipment, novel technologies, procedures, operations, training, qualification, and the certification of pilots and technicians.

**Anticipated Program Activities:**

- Human Factors Design Standards for New and Advanced Flight Deck Alerting Systems – ACSAA related
- Advances and Innovation in Equipment, Technology, Systems, and Operations – ACSAA related
- Integration of Human Factors into Operational Evaluations (OE) and Flight Standardization Board (FSB) Process

# FY 2024 Program Descriptions
## Air Traffic Control/Technical Operations Human Factors

**Program Description:**

The purpose of the Air Traffic Control/Technical Operations (ATC/TO) Human Factors program is to provide scientific and technical information that our Air Traffic Organization technical sponsors will apply in their work to improve the safety and efficiency of complex ATC systems. The research that we conduct produces information supporting the ATO's needs by measuring and enhancing the performance of individual controllers and specialists. It also improves the integration of National Airspace System (NAS) technologies for controllers and technicians, addressing the human contribution to safety in air traffic control operations, and supporting data-driven decisions related to the workforce, including selection methods, job placement, performance measurement, and training.

The program strives to provide useful human factors R&D results that support the ATO's development and implementation of new technologies and procedures in the NAS, in accordance with FAA Order 9550.8 Human Factors Policy, as the ATO evolves the NAS for the future. The program invests in purpose-driven research and innovation to meet the ATO's human factors challenges of the present by addressing the research topics identified in 49 USC 445. It also addresses the ATO's human factors research needs that are driven by DOT priorities, evolution of the workforce, and advancing technologies and associated procedures that are expected to be implemented in the NAS over the next several years. Thus, the program supports ATO efforts to achieve the air transportation system of the future so that the NAS can serve everyone today and in the decades to come. Research addresses workforce challenges that are especially acute in the large terminal radar air traffic control (TRACONs) facilities and in several of the busy air route traffic control centers (ARTCCs). The FAA must hire, place, and train thousands of new air traffic controllers and technical operations specialists, while continuing to provide safe and efficient air traffic services to NAS users. In addition, the program provides technical guidance that helps FAA acquisition programs to incorporate human factors requirements and methods that will ensure user acceptance and NAS performance with the increasing reliance on automated capabilities, including those that incorporate artificial intelligence and machine learning (AI/ML) technologies. In addition to addressing the human-machine teaming challenges posed by the introduction of these advanced automation tools and capabilities, the research program is also responsible for proactively identifying the potential for human error, and for recommending mitigations.

This program addresses ATO challenges in five human factors R&D focus areas:

1. Human Factors Research for Improved Safety, Reduced Hazards, and Error Mitigation in ATC
2. Human Factors Research on Automation Effects and Controller Performance
3. Human Factors Research for Improved Design and Operation of ATC Systems
4. Human Factors Research for Improved Controller Selection and Training
5. Human Factors Research for Workforce Optimization

**Major Program Objectives:**

The Air Traffic Control/Technical Operations (ATC/TO) Human Factors program responds to research and development (R&D) requirements defined by offices in ATO and other FAA technical sponsors. The program addresses human factors and training challenges through targeted research that yields an understanding of human performance, and those factors that contribute to facility-specific impacts, especially for high-impact facilities. In the training domain, the program conducts research to evaluate the effectiveness of realistic simulation capabilities that provide a medium for training complex task performance where Air Traffic Control (ATC) system safety depends on job task performance. Effective use of simulation may reduce the

time required for controllers to reach certification and will increase their readiness to perform in an increasingly automated task context.

In support of system acquisitions managed within the ATO Program Management Office (PMO), this program focuses on integration of human factors considerations to enhance user-system design. Human performance research aims to enhance overall system performance, reducing errors, and helping reduce life cycle ownership costs. The program, through the FAA's PMO coordination, provides human factors R&D results that support the development and implementation of new technologies and procedures in the NAS. The program ensures that the proper roles and responsibilities are assigned to the ATO workforce so that controller and technician capabilities are compatible with the advanced technology they use in their jobs, enabling air traffic system performance to achieve operational requirements and fulfill safety and efficiency objectives. In terms of research program execution, the program leverages university partnerships to bring new science in the field of artificial intelligence and machine learning (AI/ML) into practice by identifying human factors challenges and guidance for system designers that will help to mitigate them. The program also is strengthening internal federal human factors research laboratory capabilities at the FAA William J Hughes Technical Center (WJHTC) and the Civil Aerospace Medical Institute (CAMI) to address these emerging challenges.

This program continues to provide human factors subject matter expertise to the Joint Resources Council and coordinates with the PMO human factors office in reviewing how acquisitions have complied with human factors design requirements. The program also continues international collaborative research efforts with Eurocontrol and the Single European Sky ATM Research (SESAR) human factors experts.

**Anticipated Program Activities:**

- Address Human Factors Implications of Emerging Transportation Technologies
- Apply Human Factors Research to Support Adoption and Implementation of New ATC Technologies and Innovative Practices
- Compare Training Effectiveness of Various ATC Training Technologies and Methods

# FY 2024 Program Descriptions
## Aeromedical Research

**Program Description:**

The Aeromedical Research Program focuses on safety sensitive personnel and airline passenger health, safety, and performance in current and forecasted future civilian aerospace operations. The program performs aerospace-relevant applied research in the biomedical, biodynamics and survivability/cabin safety sciences. This research culminates in the transition of knowledge and technology to enable innovation in aerospace operations and mitigation and prevention of aeromedical hazards associated with aerospace mishaps.

**Major Program Objectives:**

This program will support improvements in the safety of passenger cabin environments during routine flight operations by focusing on detection of cabin events from bleed air contamination, transmission of infectious respiratory diseases of potential public health concern, and radiation exposure from extreme space weather events. Additionally, the program will support improvements in the safety of pilots by focusing on development of new approaches to aeromedical risk computation for certification decision-making and biomarker-based methods for detection of fatigue and drug use. Lastly, the program will support improvements in aircraft survivability and innovation in aircraft design by enhancing passenger safety during adverse events and streamlining the certification process for safety equipment and cabin designs.

This program identifies, develops and validates new technologies, policies, training methodologies, personnel selection tools, and procedures to improve the performance of humans in aerospace systems. The program has three lines of effort, which align to aviation safety and create a data-driven, risk-based systemic safety approach. Each line of effort centers on ensuring reliably safe aircraft cabin environments, reliably safe aircrew, and survivable aircraft, with the latter scoped to enhancing passenger safety during adverse events and streamlining the certification process for new safety equipment and cabin designs. The outputs of this research inform updates to standards, guidance, policy, and training materials to improve operational safety and facilitate new entrants into the National Airspace System.

The major program objectives align to the DOT's strategic goal of Safety. Ensuring reliably safe cabin environments protects the traveling public and aircrew from health and safety risks during commercial flights. Ensuring reliability safe aircrew focuses on improving the health, safety, and well-being of pilots working on the flight deck. Ensuring survivable aircraft results in the design and building of aircraft cabins and safety equipment that improve safety outcomes should an aviation mishap occur.

**Anticipated Program Activities:**

- Fatigue Biomarker Panel: Identifying a Metric for Performance Impairment from Sleep Loss
- Precision-based, Data-driven Aeromedical Standards: Next Generation Aeromedical Certification Safety Management System (SMS)
- Develop Safety Standards for Omnidirectional Seats to Support Advanced Air Mobility
- Determine the Influence of Delta-wing Design on Egress Paths and Evacuation Efficiency for Supersonic Transports

# Aerospace Performance and Planning

# FY 2024 Program Descriptions
## System Safety Management/Terminal Area Safety

**Program Description:**

The System Safety Management Program focuses on research that will enhance the safe movement of aircraft through the National Airspace System, supporting Air Traffic Control Oversight as well as providing for better tools and techniques for pilots and operators. The research supports the development of analytics tools that aid and support the high safety standard we set for the National Airspace System. To achieve this result, the System Safety Management Terminal Area Safety Program funds research to develop more effective helicopter simulators, vision enhancing and flight monitoring tools to better support helicopter and fixed wing aircraft pilots with higher fidelity training capabilities, safe flight while in reduced vision situations, and cost effective flight data recording tools. This research supports the department's strategic goal of Safety with the ultimate outcome to reduce potential accidents for fixed wing aircraft and helicopters in and around the terminal airspace. This research also supports safety by providing tools and techniques for air traffic oversight, helping to identify potential hazards and issues before changes are made to the National Airspace System.

**Major Program Objectives:**

The System Safety Management (SSM) program, is designed to improve safety through developing safety data collection methods, advanced safety data and risk analysis techniques, and prototypes of risk-based decision-making capabilities to identify and analyze emerging safety issues in a cooperative nature with aviation stakeholders. The program provides an ability to analyze trends across the aviation community that is much more effective than monitoring individual certificated entities, (e.g., air operators and air traffic facilities).

The Terminal Area Safety (TAS) program improves the safety of operations at or near an airport. Research projects in the program focus on developing training solutions and identifying effective technologies to mitigate key causes of fatal accidents such as the loss of control, runway excursions, and runway overruns. These are the leading causes of fatalities in the worldwide commercial jet fleet.

This program evaluates potential solutions to reduce fatal accidents through extending simulator models to allow for better upset training; exploring alternatives to determine runway slipperiness; developing objective motion criteria to minimize inappropriate simulator training; enabling safe helicopter approaches when using advanced vision systems; exploring consistent operational standards for a stable approach to reduce runway excursions; and developing a logical go-around training curriculum that mitigates operational go-around problems. This program also is performing flight tests on representative domestic and international runways that support turbine-powered airplane operations in order to validate the wet-ungrooved and wet-grooved wheel braking coefficient models in 14 CFR Part 25.109(c). These projects address the principal causes of fatalities in the commercial jet, general aviation, and rotorcraft communities but also fill aviation safety research gaps identified in the NTSB's Safety Recommendations such as A-07-003, A-04-62, A-07-64, and A-01-069.

**Anticipated Program Activities:**

- Evaluation of simulated air traffic control (ATC) using artificial intelligence (AI)
- Evaluation of virtual reality goggles for immersive flight simulation
- Develop strategies for training pilots on psychological biases that can effect safety
- Develop Runway Safety Monitoring and Surveillance Tool and Sector Risk Profile for Airport Surface Safety

- Develop Aeronautical Information Service (AIS) Sector Risk Profile and Safety Surveillance Tool.
- Implement and Improve Integrated Safety Assessment Model (ISAM) Capability
- Enhance Speech-to-Text Analytics
- Enhance Safety Event Detection
- Enhance CRM Techniques and Methodologies
- Assess Helicopter Enhanced Flight Vision Systems (H-EFVS)
- Analyze Helicopter Flight Data Monitoring (HFDM) Data
- Improve Helicopter Simulation Models
- Develop Predictive Analytics

# FY 2024 Program Descriptions
## Commercial Space Transportation Safety

**Program Description:**

Commercial space transportation (CST) research focuses on four DOT and National Space Council priorities, including safe integration of commercial space operations into the NAS, spaceport infrastructure, systemic safety initiatives, and regulatory reform. These priorities contribute to the DOT strategic goal of economic growth through increased levels of safe space operations and delivering goods and services in the public and private interest.

**Major Program Objectives:**

Statute directs the FAA Office of Commercial Space Transportation (AST) to regulate commercial space launch and reentry operations only to the extent necessary to ensure compliance with international obligations of the U.S. and to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States. Statute further directs AST to encourage, facilitate, and promote commercial space launches and reentries performed by the private sector. More recently, Congress tasked AST with promoting the continuous improvement of the safety of launch vehicles designed to carry humans.

AST's research activities will find innovative solutions through public-private collaborations and prototype development, to increase safety, efficiency, and U.S. global leadership in CST. AST's RD&T portfolio optimizes AST's mission execution through the development of improved regulations, safety assessment tools, and public safety technologies. Funding supports regulatory research, addresses lessons learned, and enables the FAA to keep pace with the dynamic CST industry. Industry development research benefits all actors within different CST industry segments.

**Anticipated Program Activities:**

- Explosive Yield Research Project
- Human Spaceflight Participant Research

# FY 2024 Program Descriptions
## NextGen – Wake Turbulence

**Program Description:**

This program provides aircraft generated wake turbulence research that matures wake mitigation operational concepts to the point that they can be directly implemented by FAA orders and enter the FAA Facilities and Equipment (F&E) development and implementation process to meet National Airspace System (NAS) infrastructure enhancement requirements. This program supports the NextGen objective to accommodate increased demand (flights) during peak demand periods at capacity-constrained airports. The program provides increased access to airport runways and airspace through modifications to Air Traffic Control (ATC) wake separation standards and procedures while maintaining or enhancing the safety of the NAS.

**Major Program Objectives:**

The main goal of the NextGen Wake Turbulence research program is wake mitigation separation. NextGen - Wake Turbulence research analyzes and collects the data to establish the wake mitigation separations that are to be applied by ATC to new series of aircraft entering operational service. The program's analysis capability was used to establish wake turbulence separation requirements for the Airbus A380, Boeing 747-800, Boeing 787, and the Airbus A350 series aircraft prior to these aircraft entering service into the NAS. This project continues to determine wake separations to be applied to manufacturers' newly developed aircraft that will be entering the NAS and continues to address new entrants such as large Unmanned Aircraft Systems (UAS) and Urban Air Mobility vehicles (UAM). Without this work, the FAA will not be able to execute its regulatory role in establishing ATC wake separation standards for new aircraft designs/series that are being integrated into the NAS.

NextGen - Wake Turbulence research also addresses the role that wake separation standards will play in NextGen ATC operations. The project's research has produced validated concepts for applying aircraft performance characteristics and runway crosswind information to reduce the required wake mitigation separations applied to aircraft arriving and departing an airport's runways. The research products have been transitioned into the FAA F&E projects: Wake Re-Categorization, Wake Turbulence Mitigation for Departures, and Wake Turbulence Mitigation for Arrivals. Standards, processes, and decision support tool products from these projects have been demonstrated operationally and some are now being implemented nationally. These products, when implemented, will provide ATC with the tools that allow them to safely increase an airport's runway throughput for both arrival and departure operations when an airport is busiest. Aircraft manufacturers, airport authorities, and air carriers agree that squeezing more operations onto an airport's existing runways results in major reductions of flight delays during and after a bad weather event that occurs at or near an airport.

**Anticipated Program Activities:**

- Assessment of wake separations needed for new aircraft types entering the NAS
- Wake Mitigation Solutions and Associated Infrastructure Modification Recommendations
- Ground-based wake track data collection and analysis

# FY 2024 Program Descriptions
## Unmanned Aircraft Systems

**Program Description:**

The Unmanned Aircraft Systems (UAS) research program supports the FAA's implementation of the Next Generation Air Transportation System (NextGen) by studying the safety implications of new aircraft operational concepts and technology to the NAS, and supporting the development of new and modified regulatory standards. The program's research activities focus on UAS that are fundamentally shifting the aviation landscape and have the potential to provide a wide range of benefits to society. However, there are technical and regulatory challenges that must be overcome as the FAA works to safely integrate these new technologies into the NAS.

Safe, efficient, and timely integration of UAS into the NAS poses substantial technical challenges to the FAA and the aviation industry. UAS often uses new or novel technologies to achieve unique operational capabilities that challenge the expectations of current NAS users. These unique capabilities have demonstrated potential to address commercial applications as well as scientific research needs. Integrating UAS will present a challenge to the entire NAS due to the various sizes of UAS (less than a foot up to the size of a commercial jet), a wide range of maximum take-off weights (less than a pound to the weight of a large jet), large performance disparities compared to existing certificated aircraft, and capabilities of operating in all classes of airspace. UAS weighing less than 100 pounds may be capable of operating in Class A airspace and the integration of a significant volume of UAS air traffic could potentially disrupt normal aircraft traffic flow and induce unknown safety hazards.

**Major Program Objectives:**

Research is the key to solving integration challenges and unlocking the potential of UAS societal benefits. FAA-sponsored research results are being used to shape rulemaking, guide decision-making, and grow the UAS industry. Applied research will continue to be critical to the safe integration of UAS into the NAS and to reaping their potential societal benefits. Activities within the UAS research program are aligned with the FAA's UAS integration strategy. The UAS research program must remain agile and adaptive to keep up with the pace of industry innovation and respond to FAA, DOT, White House executive priorities, and those mandated by Congress.

Research results will continue to drive the FAA's decision-making process, inform rulemaking, enhance operational procedures, air traffic management, and maintain safety. UAS research and analysis yields data and results to inform decision-making processes. Research generates technical information to support the development of rules, policies, guidance materials, advisory circulars, and FAA Safety Management System.

**Anticipated Program Activities:**

- Conduct Science Technology Engineering and Math (STEM) Outreach to Minority K-12 Students Using Unmanned Aircraft Systems (UAS) as a Learning Platform
- Evaluate UAS Disaster Preparedness and Emergency Response Operations
- Demonstrate and Assess Technologies for Detecting and Mitigating Unauthorized UAS Near Airports
- Assess the Challenges of Retrofitting Technologies for Urban Air Mobility (UAM)
- Assess the Risk of Collision between Unmanned Air Mobility (UAM) vehicles and Unmanned Aircraft

# FY 2024 Program Descriptions
## Advanced Technology Development & Prototyping

**Program Description:**

The FAA's Advanced Technology Development and Prototyping (ATDP) program develops and validates technology and systems that support air traffic services. These initiatives support the requirements associated with the evolving air traffic system architecture and improvements in airport safety and capacity. A key element of this program is to promote safe and efficient airspace, provide the means to recognize and respond to needs, and evaluate the results. This program lays the foundation for assessment of new innovations and possibilities that could improve safety and capacity measures around our nation's airports.

**Major Program Objectives:**

Individual projects under the ATDP Program develop and maintain mathematical & simulation software models of the NAS. These models evaluate system-wide benefits associated with the implementation of various solutions. These models are particularly useful in evaluating mid-term and long-term benefits associated with NextGen and other enhancements. These models aid organizations throughout FAA with analyses of proposed new investments, trade-off studies, enterprise-wide shortfall analyses, and the operational analyses of new entrants on NAS Performance. Recent examples of this work include the development of the System-Wide Analysis Capability (SWAC) and the Airfield Delay Simulation Model (ADSIM).

Another key component of ATDP is developing and improving FAA systems that meet the regulatory requirement for reporting traffic operations, counts, delays, and safety information. These systems must continue to support the growing demands of the NAS. Working under the ATDP program improves the efficiency and integration of data processing and improves NAS reporting capabilities. This work aids in assessing the performance of airline operations and provides the objective data to support the need for improved traffic flow and efficiency measures within the NAS. The projects under this program will ensure that the essential hardware and software components are in place and operational in order to accurately collect and report operational and safety data associated with air traffic operations. The data collected by these programs will allow for continued assessment of innovation performance in the NAS and ensure that those technologies achieve the transformations as planned.

**Anticipated Program Activities:**

- Complete annual report documenting results of Human in the Loop testing of Human Factors, safety logic, aircraft performance, or any uncertainty or deficiency pertaining to surface based Runway Indications.
- Complete annual technical and operational test and evaluation report of an advanced ground surveillance sensor to drive the activation of direct to pilot annunciator.
- Develop Concept of Operations for preventing Wrong Surface Operations using prototype taxi conformance monitoring technologies.
- Develop data processing pipelines and analytical methodologies to support the production of the Joint Performance Benchmark Report with EUROCONTROL/the European Commission.
- Produce joint performance benchmarking reports with Asia-Pacific partners, including the Civil Aviation Authority of Singapore (CAAS).
- Facilitate integration of improved surface time metrics developed under NEXTOR into enterprise data systems.
- Develop methodologies and analytical capabilities to assess the operational impact of Trajectory Based Operations.

- Provide updates to automated assessment capabilities for ATO advanced planning through the integration of advanced analytics and machine learning techniques.
- Verify methodologies developed to identify convective weather impacts on NAS performance and to assess the use of traffic management initiatives to respond to those impacts.
- Develop and validate NAS level operational concepts that are key to the FAA NAS modernization efforts.
- Identify, understand, and forward for action proposed changes to FAA enterprise plans.
- Conduct operational assessment and prioritization of emerging efforts to ensure linkage of proposed concepts to validated operational needs.
- Develop concepts of use to describe the operational use of proposed communication, navigation, automation, surveillance and flight deck capabilities.
- Support to Radio Technical Commission for Aeronautics (RTCA).
- Conceptual development of North East Corridor initiatives.
- Implementation of North East Corridor initiatives and associated infrastructure Major airspace redesign work to support Louisville Standiford Field (SDF) and UPS operations to include infrastructure changes associated with communications outlets and additional positions at SDF TRACON.
- Development of major airspace design changes supporting the new Airspace Modernization Roadmap initiative.

# FY 2024 Program Descriptions
## NextGen - Separation Management Portfolio

**Program Description:**

The Separation Management Portfolio conducts pre-implementation activities to reduce risk, and implementation activities supporting the safe and efficient separation of aircraft and other vehicles in the NAS. Risk reduction activities may include validation of concepts or technologies; demonstration and integration of operational capabilities; and an understanding of the role of the human through cognitive engineering experiments. This portfolio evaluates and matures concepts and capabilities that focus on the enhancement of separation assurance using both ground based automation and aircraft technology enhancements. This portfolio will develop flight-deck interval management minimum operational performance standards and safety performance requirements, identify improvements to runway access through use of improved aircraft technology, updated standards, safety analysis, and modifications to air traffic monitoring tools and operating procedures that will enable more arrival and departure operations.

**Major Program Objectives:**

The main goal of the NextGen Separation Management Portfolio is to provide recommendations through research and technology development activities to improve the tools, standards, and procedures that air traffic controllers use to separate aircraft. Pre-implementation activities conducted under this program reduce risk, define requirements, and demonstrate operational feasibility to support these recommendations.

As the demand for flights increases, concepts and capabilities that focus on enhancing separation assurance using ground-based automation and aircraft technology enhancements are critical. The Separation Management program supports the FAA's mission to provide the safest, most efficient aerospace system in the world by conducting research that will enhance aircraft separation assurance by safely reducing separation between aircraft, and as a result improve capacity, efficiency and safety in the NAS.

The main goal of the NextGen Separation Management Portfolio is to provide recommendations through research and technology development activities to improve the tools, standards, and procedures that air traffic controllers use to separate aircraft. Pre-implementation activities conducted under this program reduce risk, define requirements, and demonstrate operational feasibility to support these recommendations.

As the demand for flights increases, concepts and capabilities that focus on enhancing separation assurance using ground-based automation and aircraft technology enhancements are critical. The Separation Management program supports the FAA's mission to develop finalized requirements for adding the RECAT Dynamic Wake risk mitigation solution enhancements to ATC decision support tools

**Anticipated Program Activities:**

- Develop safety assessments of the finalized requirements for RECAT Dynamic Wake
- Complete next PBN Initiatives Safety Analysis. (e.g., MARS Phase 1).
- Complete concept validation of implementing reductions for integrated arrival departure operations.
- Provide data to support the development of Safety Risk Management Document (SRMD) and procedure authorization standards for reductions in Minimum Radar Separation.

# FY 2024 Program Descriptions
## NextGen - Traffic Flow Management Portfolio

**Program Description:**

The Traffic Flow Management (TFM) portfolio involves NAS operators and FAA traffic managers, along with advanced automation, in managing daily flight and flow decision-making, airspace, and airport capability issues (e.g., special activity airspace, weather, etc.) to improve the overall efficiency of the NAS. Pre-implementation research conducted under this portfolio includes technology development activities for departure scheduling at smaller community airports, improved strategic flow services, and capabilities that will capitalize on future Data Communications (DataComm) capabilities, further integrated traffic flow management and metering operations, advanced trajectory-based operations leveraging the technologies of NASA's Airspace Technology Demonstration 3 (ATD-3), and exploring technologies, infrastructure enhancements, and procedural changes for future traffic management needs.

**Major Program Objectives:**

The main goal of this NextGen – Traffic Flow Management (TFM) Portfolio is to improve both the efficiency of individual flights while optimizing throughput. This work will make travel safer for the traveling public, help reduce passenger delays leading to a better traveling experience, and contribute to less pollution as the result of improved prediction performance for TFM decision support systems and flexible TFM around weather constraints.

The TFM provides greater flexibility to the flight planners, and makes the best use of available airspace and airport capacity to make travel safer for the traveling public, help reduce passenger delays leading to a better traveling experience, and contribute to less pollution as the result of improved prediction performance for TFM decision support systems and flexible TFM around weather constraints.

**Anticipated Program Activities:**

**Surface Tactical Flow:**

- Modeling and Simulation for mobile information exchange w/ future FAA services
- Complete and deliver technical interchange of strategic demand capabilities through mobile applications
- Improvement of departure demand predictions through collection of strategic departure intent information and machine learning methods
- Non-TFDM CFR Time Coordination Field Evaluation
- Modeling and Simulation of On-Demand Surface Management

**Strategic Flow Management Applications:**

- Initial model development for additional TFM capabilities
- Conduct validation activities for the integration of flow management activities such as xTM in ATM

**Advanced Methods**

- Identify which capabilities can be used to predict demand and develop solutions including those for machine learning and incorporating earlier findings.
- Develop prototype capabilities for the advanced automation learning/data mining capability.

# FY 2024 Program Descriptions
## NextGen - On Demand NAS Portfolio

**Program Description:**

The On-Demand NAS Information (ODNI) portfolio conducts pre-implementation work to reduce risk in supporting the efficient and secure exchange of information within the FAA and between the FAA and other NAS users. The ODNI portfolio conducts research that examines concepts and matures capabilities through validation activities and demonstrations conducted with stakeholders, to enhance information exchange within the NAS. This portfolio provides flight planners, Air Navigation Service Providers (ANSP) staff, and flight crews with consistent, complete, and easily processed information on changes of conditions in the NAS. It also works toward developing international data standards allowing more users to share flight information and coordinate various activities concerning a flight to support collaborative decision-making. As the FAA evolves towards Info-Centric NAS operations, more structured digital information will be available and technologies such as Internet of Things (IoT) and cloud computing will enable airspace users to make decisions based on current information. The pre-implementation research conducted under this portfolio will leverage this technology evolution and standardize flight deck applications to support flight crew decision making. It will also utilize innovative technologies for creation of structured data which enables the FAA to improve situational awareness and collaboration among various traffic management services through better access to a fully integrated information sharing environment.

**Major Program Objectives:**

The main goal of the NextGen – On-Demand NAS Portfolio is the efficient and secure exchange of information within the FAA and between the FAA and other NAS users for collaborative decision-making. Improvements in developing a standard set of flight information will simplify the flight planning process and provide information that will cross multiple ATC systems and domains with ease, leading to improvements in ongoing traffic management initiatives and decision making. System efficiency, resiliency and flexibility of the NAS is maximized through the reallocation of existing resources to address demand and capacity imbalances and create additional NAS agility in support of contingency operations. The incorporation of aircraft performance, flight intent, and improved flight crew situational awareness will result in increased predictability of future aircraft positions, allowing traffic managers to strategically manage the airspace based on where aircraft will be. Adaptable microservices, architectures, and cloud computing will enhance performance and assure interoperability and scalability. Incorporation of machine learning and artificial intelligence that leverage a network of information will enable enhanced trajectory negotiations while providing optimal traffic management solutions across the NAS.

**Anticipated Program Activities:**

- Complete flight deck clearance application development and testing.
- Develop flight deck aircraft parameter exchange application concept and engineering artifacts.
- Conduct engineering analysis on information architecture to support information exchange to meet the performance, security requirements.
- Develop flight deck aircraft parameter exchange application prototype.
- Develop an implementation strategy plan for flight deck applications.
- Concept development for a resilient infrastructure beyond legacy systems.
- Develop concept of operations for a resilient infrastructure in support of Info-Centric NAS Vision.
- Initiate planning for laboratory evaluation for resilient network technologies.

# FY 2024 Program Descriptions
## NextGen - NAS Infrastructure Portfolio

**Program Description:**

The NAS Infrastructure portfolio conducts pre-implementation activities to reduce risk for aviation weather-related and cross-cutting engineering issues. This portfolio provides the research, development, and analysis of validation activities, human system engineering, and demonstrations to improve the efficiency and effectiveness of air traffic management. It includes an array of work encompassing emerging issues in communications, weather, information management, trajectory management, collision avoidance, and assessment of requirements for future NAS systems and system enhancements.

**Major Program Objectives:**

The NAS Infrastructure Portfolio contains key transformational and infrastructure sustainment capabilities that are critical to the success of NextGen. This program supports the NextGen goal of expanding capacity by conducting pre-implementation activities geared toward the development of decision support tools that improve the strategic management of operations in the NAS. The main goal of the NextGen – NAS Infrastructure Portfolio is to support the NextGen goals of improved capacity, efficiency, and safety.

**Anticipated Program Activities:**

- Develop weather translation techniques for non-convective weather constraints, and weather advisory and collaborative lab experiments designed to explore ATM Weather Integration (AWI) concepts and capabilities
- Coordinate aviation weather issues with subject matter experts through Community of Interest (COI).
- Develop framework to advance the innovative concepts that leverage the connected aircraft for various application and establish an integrated roadmap for the development of future air traffic management services and policies that take advantage of the emerging air/ground connectivity.
- Analyses of command and control performance and security requirements to support the potential use of internet based data exchange for command and control applications and document results.
- Conduct initial assessment of NAS-wide operations using ubiquitous communications
- Develop feasibility assessment of the potential use of Artificial Intelligence (AI)/Machine Learning (ML) to support controller operations and decision making
- Develop initial safety risk management model to assess the use of AI in controller decision support tools.
- Identify and conduct high-level assessment for candidate technologies suitable for an enterprise solution for automation systems in the NAS automation systems and produce report
- Develop requirements for hardware application and link performance requirements to support the potential use of internet based data exchange for command and control applications

# FY 2024 Program Descriptions
## NextGen Support Portfolio

**Program Description:**

The NextGen Support Portfolio provides the NAS laboratory environments required to evaluate, mature, and validate the broad framework of NextGen concepts, technologies, operational functions, and systems before they are introduced into the NAS. This program provides the evaluation platforms at the NextGen Integration and Evaluation Capability (NIEC) and Florida NextGen Test Bed (FTB). These labs facilitate the conduct of NextGen concept demonstrations using simulated research NAS environments without affecting actual NAS operations. These demonstrations are often conducted with a variety of stakeholders in attendance to aid in the appropriate propagation of newly learned information. These stakeholders also ensure that the benefits and risk associated with the concepts being demonstrated are considered from several different perspectives.

The NextGen Support Portfolio funding is used to continue laboratory operations in support of on-going NextGen Programs and to enhance existing NIEC and FTB lab capabilities as required to support the development and evaluation of advanced capabilities associated with evolving NextGen operational improvements and implementation plans.

**Major Program Objectives:**

The NextGen Support Portfolio provides targeted research and development within the FAA that will lead to new technology development and deployment in the NAS. Data generated by this program will allow for the assessment of regulatory approaches, foster information sharing, and facilitate coordination and collaboration with industry and other stakeholders. Most importantly, this program facilitates the testing and adoption of new technologies throughout the NAS. To aid in the testing and adoption of new technologies, the portfolio also seeks to incrementally expand the capabilities of the FTB. These capabilities will also align with the NAS modernization demonstration projects and stakeholders' needs and vision.

**Anticipated Program Activities:**

- Support Advanced Methods initiative by supporting testing of prototype capability for advanced automation learning and data mining to align with 2035 Vision plan.
- Support Strategic Flow Management Application (SFMA) to leverage automation capabilities to improve Traffic Flow Management (TFM) operations.
- Support engineering and validation of activities related to Trajectory Based Operations (TBO) for commercial space, UAS, and supersonic aircraft.
- Support future DataComm services to deliver messages and communications via Internet Protocol (IP).
- Provide air and ground systems components necessary to conduct demonstrations related to flight trials.
- Provide necessary hardware and software for DataComm services to deliver messages via Internet Protocol.
- Maintain security infrastructure, authorization, and technology as it relates to various projects. Support additional security related projects and requirements.
- Support concept development and validation activities, research, engineering, analysis, demonstrations and evaluations exploring concepts related to trajectory based operations.

# FY 2024 Program Descriptions

## NextGen– Enterprise, Concept Development, Human Factors & Demonstrations Portfolio

**Program Description:**

The Enterprise Concept Development, Human Factors, and Demonstrations Portfolio conducts enterprise-level activities, including developing concepts across the NAS, human factors analyses of the NextGen operational environment, and demonstrations of proposed NextGen system improvements to ensure operational feasibility and viability within the NAS.

**Major Program Objectives:**

These concept development efforts lead to improvements that provide air traffic controllers with tools and procedures to separate aircraft with technologically advanced navigation equipment and wake performance capabilities. These concepts enhance system capacity and efficiency while ensuring safe aircraft separation and reducing workload for controllers and flight crews. Concept development identifies early NextGen concepts and maturation activities that will transform the next generation of the NAS. Human factors activities evaluate concepts for human factors implications and inform the maturation of these concepts into successful capabilities. Stakeholder demonstrations provide practical application and analysis of proposed NextGen system improvements to validate and prove concept feasibility and determine which initiatives might be accelerated through fast-track modeling.

**Anticipated Program Activities:**

- Begin execution of research into future vision (Charting Aviation's Future) automation enhancement concepts. Follow-on identification of innovations with possible human factors effects and research plans for addressing them.
- Finalize functional analysis for AI in the NAS
- Complete AI in the NAS Concept of Operations
- Develop an update to the NAS Vision 2035 2.0 CONOPs

# FY 2024 Program Descriptions
## NextGen - Unmanned Airspace Systems

**Program Description:**

The Unmanned Airspace System (UAS) Program plays a critical role in enabling UAS operations in the NAS. The activities in this program support research that allows integration of UAS without creating disruptions or delays to manned aircraft, and ensures NAS operations will be as safe as they are today. This program has two core pre-implementations tasks: 1) UAS Concept Validation and Requirements Development (CVRD), and 2) UAS Flight Information Management System (FIMS). The UAS CVRD project will continue identifying, and maturing UAS needs related to air traffic systems and services and refining operational requirements associated with Air Traffic Management (ATM) automation, airspace management, policies, and procedures. The efforts being undertaken by this program will enable future integrated UAS operations. UAS FIMS activities will establish the concepts, use cases, and requirements associated with UAS Traffic Management/FIMS to safely manage UAS operations primarily through operator-operator sharing of flight intent and operator-FAA sharing of flight intent and airspace constraints. This project will build upon the existing FAA information sharing infrastructure to meet the expected increase of UAS operations by enabling the exchange of information among all stakeholders in globally standardized exchange protocols to ensure seamless and interoperable data management.

**Major Program Objectives:**

Air Traffic products, policies, and procedures must be reviewed and refined, or developed through supporting research, to permit UAS operations in the NAS. The UAS research program plays a critical role in enabling UAS operations in the NAS without affecting manned aircraft operations (e.g., creating disruptions or delays) and ensures that NAS operations will be as safe as or safer than they are today.

**Anticipated Program Activities:**

- Complete UTM Data Exchange Requirements for Integrated UTM Operations Version 4.0 (e.g. BVLOS)
- Identify terrestrial communications technology needed to support large UAS BVLOS operations
-

# FY 2024 Program Descriptions
## Emerging Technology Accelerator

**Program Description:**

The Emerging Technology Accelerator (ETA) Program was established to foster emerging science, engineering, and technology advancements and align innovation with known and forecasted challenges and opportunities in the aviation industry.

**Major Program Objectives:**

The program aims to address air transportation safety and efficiency needs in the near and far term. It also addresses statutory requirements to invest in long-term research that better positions the agency to shape the air transportation system of the future. The ETA will advance the Department's mission by fueling inclusive and sustainable economic growth.

Additionally, the Program will modernize the aviation sector by seeking partnerships with industry, academia, and government such that jobs are created and innovation encouraged in underserved communities. The ETA will engage innovators across the nation in the application of emerging science and technology. It will additionally provide an avenue for relatively rapid maturation and commercialization of promising technologies.

**Anticipated Program Activities:**

- Evaluation of initial Innovation Proposals
- Develop Aviation Challenge Statement
- Issue Innovation Solicitation
- Annual Report

# FY 2024 Program Descriptions
## Aviation Grant Management

**Program Description:**

This program supports the Administration's principles of Rebalancing Investments to Meet Racial Equity and Economic Inclusion Goals and also Executive Order 13985 "Advancing Racial Equity and Support for Underserved Communities Through the Federal Government" by pursuing a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality.

The aviation grant management program provides support for the administration and management of pre-award, post-award, closeout, records management, program management and information technology support.

The aviation grant management process is always evolving and includes various lifecycle tasks through the unique award phases. The program priorities meet FAA's strategic goals by ensuring a comprehensive approach to achieving the award of grants to equip the next generation of aviation professionals.

**Major Program Objectives:**

The aviation grant management program aims to provide support for the administration and management of pre-award, post-award, closeout, records management, and program management and information technology. Through the aviation grant management program, this program will aide in the development of building an infrastructure that encompasses the entire lifecycle of grant management.

**Anticipated Program Activities:**

- Aviation Research and Workforce Grants

# FY 2024 Program Descriptions
## System Planning and Resource Management

**Program Description:**

The System Planning and Resource Management (SPRM) program lead the planning, coordination, development, presentation, and review of the FAA's research and development (R&D) portfolio. Its key programmatic outputs include the National Aviation Research Plan (NARP), the Annual Review – both of which are annual statutory deliverables to Congress. SPRM conducts the administration of the congressionally mandated (P.L. 100-591 Section 6 Advisory Committee) Research, Engineering and Development Advisory Committee (REDAC) and resultant reports. SPRM also provides program advocacy and outreach and maintains alignment with departmental R&D program planning and performance reporting guidance. SPRM leads the portfolio planning, formulation, presentation, and review activities to ensure the FAA meets the President's criteria for R&D, increases program efficiency, sustains and maintains management of the program within operating cost targets, and enables effective program review by the REDAC and the OST Office of Research and Technology.

SPRM also develops program guidance and conducts compliance reviews to ensure that departmental R&D program planning and performance reporting requirements specified in the Fixing America's Surface Transportation (FAST) Act are satisfied. It also coordinates the establishment and administration of the Air Transportation Centers of Excellence (COE) Program and ensures compliance with related financial assistance and grants management departmental policy guidance.

The SPRM program advances the Department's mission by providing an inclusive and innovative culture to effectively serve communities and responsibly steward the public's applied research dollars. SPRM ensures the American public's resources are invested in such a manner as to deliver substantive research that provides safety and efficiencies while delivering results to the flying public.

**Major Program Objectives:**

The main goal of the SPRM program is planning and program management support for the FAA to formulate its annual RE&D portfolio and submit the mandatory R&D planning documents to Congress each year. Through the management of the FAA REDAC, this program facilitates an independent, expert review of the FAA's R&D portfolio that provides meaningful recommendations for the FAA to refine and improve its portfolio. This results in a more effective research program that will benefit the public by making aviation safer and smarter and enhance U.S. global leadership in aviation.

**Anticipated Program Activities:**

- Annual statutory deliverables to Congress
- Departmental (OST) R&D program planning and performance reporting requirements
- Development and submission of the FAA's R&D investment portfolio

# FY 2024 Program Descriptions
## William J. Hughes Technical Center Laboratory Facilities

**Program Description:**

This program sustains research facilities located at the William J. Hughes Technical Center Laboratory (WJHTC) to support Research and Development (R&D) program goals. These programs require specialized facilities to emulate and evaluate field conditions. The R&D laboratories are comprised of the Cockpit Simulation Facility (CSF), Target Generation Facility (TGF), Research Development and Human Factors Laboratory (RDHFL), and The NextGen Prototyping Network (NPN). R&D programs require specialized facilities which provide flexible, high-fidelity environments to conduct research and perform Human-in-the-Loop (HITL) simulations that evaluate advanced air traffic concepts. Researchers measure baseline human performance using existing air traffic controller configurations and determine changes in performance when new systems or procedures are introduced to identify and evaluate human factors (HF) issues. These laboratories include integrated cockpits, air traffic controller workstation capabilities (simulated and real), and specialized biometric data collection systems to evaluate the system and human components that can only be addressed in a full mission end-to-end simulation environment. The R&D laboratories are fully integrated with other WJHTC capabilities allowing for an extremely high fidelity environment supporting R&D research. This research encompasses capabilities of the current day systems, NextGen, and the transition between these systems (e.g., mixed equipage, adjacent site deployment, etc.). The funding provides for existing infrastructure support, project support, engineering support, R&D facility modifications and improvements, equipment and software/hardware licenses, and support tools.

**Major Program Objectives:**

The main goal of the William J. Hughes Technical Center Laboratory Facility is the provision of a laboratory environment that is fully integrated, extremely high fidelity, and that encompasses capabilities of current day systems, the NextGen system, and the transition between the two. The goals of these simulation facilities include developing capabilities to enable the research of complex problems due to weather, UAS, and commercial space flight in a controlled laboratory environment. The fully integrated facilities will enable research from the ground and airborne elements for a complete simulation capability. Concepts and systems integration RDHFL goals include doing proactive HF research on proposed changes to the NAS that identify human performance issues early in the concept development phase. Network Infrastructure – NPN goals are to maximize shared resources, relieve the need to establish separate connections, and minimize duplication of efforts and the resources to manage these extra connections and efforts. The NPN provides a common network approach that affords distributed access to NextGen and R&D laboratories, and a distributed set of capabilities.

The LNOC provides an environment to maintain, monitor status and cyber events and operate the NPN and customer networks. The Laboratory Facility provides researchers with the specialized laboratories and infrastructure required to achieve R&D program goals and objectives. Having an efficient and flexible platform to evaluate current and future air transportation system concepts and technologies enhances the safety and efficiency of air travel for the American public. Performing research in simulation rather than with live aircraft generates cost savings, is intrinsically safer, and allows the study of the extremes that would not be possible in live flight conditions. The implementation of new technologies, such as the intelligent agent-based capability, allow for a reduction in the number of test subject participants needed for a given study; again, maximizing cost savings and efficiencies. Modernization of the FAA R&D network infrastructure and further extensibility into the Mike Monroney Aeronautical Center (MMAC) laboratories will directly support exploration of Info Centric National Airspace System (NAS) capabilities. Finally, human

factors-related issues resolved prior to implementation result in cost savings and ensure that the FAA's safety standards for air traffic control operations are met.

**Anticipated Program Activities:**

- Research Development and Human Factors Laboratory enhancements
- Network Infrastructure
- Cockpit Simulation Facility & Target Generation Facility enhancements

# FY 2024 Program Descriptions
## William J. Hughes Technical Center Laboratory Sustainment

**Program Description:**

This program sustains the William J. Hughes Technical Center laboratories. This centralized set of laboratories supports the Acquisition Management System (AMS) lifecycle from concepts and requirement definition to In-Service decision. These laboratories are the only location where it is possible to realistically simulate the NAS and it is necessary to maintain the laboratory systems with capabilities that match field sites that currently exist or are planned for the future. These test beds can be altered to replicate desired field configurations and traffic scenarios providing stakeholders with an understanding of how upgraded systems will perform prior to operational deployment. These labs also provide a flexible high-fidelity environment to conduct research and perform Human-In-The-Loop (HITL) simulations that evaluate advanced air traffic concepts and are fully integrated with the other WJHTC capabilities.

**Major Program Objectives:**

The goal of this program is to modernize the equipment and infrastructure necessary for the FAA's centralized NAS laboratory facilities so that F&E programs can deliver products that result in a safe, reliable, and efficient NAS. The WJHTC centralized labs eliminate the need for each acquisition program to establish and sustain separate laboratory facilities to support their individual programs and fielded systems. The capabilities developed in these laboratories reduce overall cost of NAS and NextGen development while increasing traveler safety and decreasing travel times by reducing airspace congestion. This program is necessary to sustain the WJHTC laboratory test facility, which provides direct field support for operational NAS systems. Problems identified at various field locations are quickly transmitted to the appropriate laboratory where solutions are developed and tested. The test beds are used by acquisition programs and partner agencies for development, test, evaluation, integration, transition testing, and first and second level support to the field. This program is further necessary to maintain these laboratory systems in configurations and capabilities that match field sites that currently exist or are planned for the future.

**Anticipated Program Activities:**

Not Applicable

# FY 2024 Program Descriptions
## William J. Hughes Technical Center Infrastructure Sustainment

**Program Description:**

Infrastructure sustainment at the WJHTC reduces expenses associated with ongoing operation and maintenance activities as well as reducing the frequency of expenses associated with system replacement. System updates reduce energy consumption, and cost, on a per-square-foot basis, thus supporting current Federal Energy Management requirements for sustainability and energy consumption.

**Major Program Objectives:**

This program sustains the William J Hughes Technical Center (WJHTC) facilities, site utilities, and infrastructure. This represents approximately 1.6 million square feet of test and evaluation, research and development, and administrative facilities, plus numerous project test sites on 5,000+ acres of land.

**Anticipated Program Activities:**

Not Applicable

# Acronyms

| ACRONYM | DEFINITION |
|---|---|
| **A** | |
| A4A | Airlines for America |
| AAAE | American Association of Airport Executives |
| AAM | Office of Aerospace Medicine |
| AASR | Aging Aircraft Safety Rule |
| ABST | Airframe Beam Structure Test |
| AC | Advisory Circular |
| ACAS-Xr | Aircraft Collision Avoidance System for NextGen (rotorcraft) |
| ACI | Aircraft Cyber Initiative |
| ACI-NA | Airports Council International–North America |
| ACRP | Airport Cooperative Research Program |
| ADG | Airplane Design Groups |
| ADS-B | Automatic Dependent Surveillance-Broadcast |
| ADSIM | Airfield Delay Simulation Model |
| AEEC | Airline Electronic Engineering Committee |
| AEDT | Aviation Environmental Design Tool |
| AEH | Airborne Electronic Hardware |
| AFA | Association of Flight Attendants |
| AFFF | Aqueous Film-Forming Foams |
| AFRL | Air Force Research Lab |
| AFS | Active Flutter Suppression |
| AGC | Office of the Chief Council |
| AI | Artificial Intelligence |
| AIA | Aerospace Industries Association |
| AID | Aircraft Interface Devices |
| AIMM | Aeronautical Information Management Modernization |
| AIR | Aircraft Certification Service |
| AJI | Safety and Technical Training Organization |
| AJM | Program Management Organization |
| AJV | Aeronautical Information Services Organization |
| AL | Abstraction Layer |
| ALPA | Air Line Pilots Association |
| ALSF | Approach Lighting System with Sequence Flashing |
| AMRAC | Aerospace Medicine Research Alignment and Collaboration |
| AMRP | Annual Modal Research Plan |
| AM | Additive Manufacturing |
| AMS | Acquisition Management System |

| ACRONYM | DEFINITION |
|---|---|
| ANG | Office of NextGen |
| ANSP | Air Navigation Service Provider |
| AOPA | Aircraft Operators and Pilots Association |
| AOC | ACRP Oversight Committee |
| AOV | Air Traffic Safety Oversight Office |
| APT | Advanced Persistent Threats |
| APU | Auxiliary Power Units |
| AR | Annual Review |
| ARC | Evacuation Aviation Rulemaking Committee |
| ARAC | Aviation Rulemaking Advisory Committee |
| ARRF | Aircraft Rescue Firefighting |
| ARTCCs | Air Route Traffic Control Centers |
| ASCENT | Aviation Sustainability Center of Excellence |
| ASEB | Aeronautics and Space Engineering Board |
| ASOS | Automated Surface Observing System |
| ASRS | Aviation Safety and Reporting System |
| AST | Office of Commercial Space Transportation |
| ASTM | American Society for Testing Materials |
| ASU | Arizona State University |
| ATA | Air Transport Association |
| ATC | Air Traffic Control |
| ATC/ATO | Air Traffic Control/Technical Operations |
| ATD-3 | Airspace Technology Demonstration 3 |
| ATDP | Advanced Technology Development and Prototyping |
| ATM | Air Traffic Management |
| ATN | Aeronautical Telecommunications Network |
| ATO | Air Traffic Organization |
| ATNB2 | Aeronautical Telecommunications Network Baseline 2 |
| ATR/ATRP | Airport Technology Research Program |
| ATSM | American Society for Testing and Materials |
| AVP | Accident Investigation and Prevention |
| AVS | Office of Aviation Safety |
| AVSI | Aerospace Vehicle Systems Institute |
| AHX-1 | FAA Office of Hazardous Materials |
| AXIM | Aeronautical Information Exchange Model |
| **B** | |
| BLI | Budget Line Item |
| BOM | Bureau of Meteorology |
| **C** | |

| ACRONYM | DEFINITION |
|---|---|
| CAA | Civil Aviation Authority |
| CAAFI | Commercial Aviation Alternative Fuels Initiative |
| CAASD | Center for Advanced Aviation System Development |
| CAEP | Committee on Aviation Environmental Protection |
| CAMI | Civil Aerospace Medical Institute |
| CAST | Commercial Aviation Safety Team |
| CAT | Category |
| CCSU | Central Connecticut State University |
| CDM | Collaborative Decision Making |
| CDTI | Cockpit Display of Traffic Information |
| CFR | Code of Federal Regulations |
| CHM | Composite Materials Handbook |
| CLEEN | Continuous Lower Energy, Emissions and Noise |
| CNS | Communication, Navigation, and Surveillance |
| COE | Centers of Excellence |
| COMSTAC | Commercial Space Transportation Advisory Committee |
| ConOps | Concept of Operations |
| CONUS | Continental United States |
| CORSIA | Carbon Offsetting and Reduction Scheme for International Aviation |
| COTS | Commercial off-the-shelf |
| CP | Coordination Plan |
| CRADA | Cooperative Research and Development Agreements |
| CRM | Crew Resource Management |
| CSC | Cyber Steering Committee |
| CSF | Cockpit Simulation Facility |
| CSS-FD | Common Support Services-Flight Data |
| CST | Commercial Space Transportation |
| CTOP | Collaborative Trajectory Options Program |
| CVRD | UAS Concept Validation and Requirements Development |
| CVS | Combined Vision System |
| CWAM | Convective Weather Avoidance Model |
| **D** | |
| DAL | Development Assurance Levels |
| DARWIN® | Design Assessment Of Reliability With Inspection |
| DAC | Drone Advisory Committee |
| DataComm | Data Communications |
| DGAC | Direction Generale de l'Aviation Civil |
| DHS | Department of Homeland Security |
| DO | Domain |
| DOC | Department of Commerce |

| ACRONYM | DEFINITION |
|---|---|
| DOD | U.S. Department of Defense |
| DOE | Department of Energy |
| DOI | Department of Interior |
| DOJ | Department of Justice |
| DOT | U.S. Department of Transportation |
| DSTs | Decision Support Tools |
| **E** | |
| E&E | Environment and Energy |
| EAA | Experimental Aircraft Association |
| EASA | European Aviation Safety Agency |
| ECCC | Environment and Climate Change Canada |
| EDR | Eddy Dissipation Rate |
| EDRC | U.S. Army Engineer Research and Development Center |
| EFB | Electronic Flight Bags |
| EVS | Enhanced Vision System |
| EFVS | Enhanced Flight Vision System |
| EMAS | Engineered Material Arresting System |
| EMST | Emerging Metallic Structures Technologies |
| EO | Executive Order |
| EoR | Established on RNP (Required Navigation Performance) |
| EPA | Environmental Protection Agency |
| EPOCH | Prediction of Oceanic Convective Hazards |
| ERAU | Embry Riddle Aeronautical University |
| ERDC | U.S. Army Engineer Research and Development Center |
| ERIF | Engine Related Impact and Failure |
| ETM | Engineering Test Model |
| EUROCAE | European Organization for Civil Aviation Equipment |
| EXCOM | Executive Committee |
| **F** | |
| 4DT | Four Dimensional Trajectory |
| F&E | Facilities and Equipment Appropriation |
| F&Rs | Findings and Recommendations |
| FAA | Federal Aviation Administration |
| FACA | Federal Advisory Committee Act |
| FAST | Fixing America's Surface Transportation |
| FASTER | Full-Scale Aircraft Structural Test Evaluation and Research |
| FD-DER | Flight Deck Date Exchange Requirements |
| FF-ICE | Flight and Flow – Information Collaborative Environment |
| FFRDC | Federally Funded Research and Development Center |
| FICAN | Federal Interagency Committee on Aviation Noise |

| ACRONYM | DEFINITION |
|---|---|
| FIMS | UAS Flight Information Management System |
| FIXM | Flight Information Exchange Model |
| FMC | Flight Management Computer |
| FMS | Flight Management Systems |
| FPM | Flightpath Management |
| FTB | Florida NextGen Test Bed |
| FTU | Flight Test Unit |
| FY | Fiscal Year |
| **G** | |
| GA | General Aviation |
| GAJSC | General Operations Joint Steering Committee |
| GAMA | General Aviation Manufacturers Association |
| GE | General Electric |
| GAO | Government Accountability Office |
| GMU | George Mason University |
| **H** | |
| HEMS | Helicopter Emergency Medical Services |
| HF | Human Factors |
| HITL | Human In The Loop |
| HMD | Head Mounted Display |
| HUD | Heads-Up Display (also, Department of Housing and Urban Development |
| **I** | |
| IAM | Identity and Access Management |
| IARD | Investment Analysis Readiness Decision |
| IATA | International Air Transport Association |
| ICAO | International Civil Aviation Organization |
| IFR | Instrument Flight Rules |
| IID | Initial Investment Decision |
| IOT | Internet of Things |
| IP | Intellectual Property (also, Internet Protocol) |
| IRB | FAA Institutional Review Board |
| ISO | International Organization for Standardization |
| **J** | |

| ACRONYM | DEFINITION |
|---|---|
| JAMS | Joint COE for the Advanced Materials and Structures |
| JAT | Joint Analysis Team |
| JCAB FATS | Japan Civil. Aviation Bureau Future Air Transportation System |
| JENQC | Jet Engine Nickel Quality Committee |
| JETQC | Jet Engine Titanium Quality Committee |
| JPL | Jet-Propulsion Labs |
| **K** | |
| KSA | Knowledge, Skills, and Abilities |
| **L** | |
| LED | Light Emitting Diode |
| LL | Lincoln Laboratory |
| LOC | Loss of Control |
| LPV | Localizer Performance with Vertical guidance |
| LS-DYNA | An advanced general-purpose multiphysics simulation software package developed by the Livermore Software Technology Corporation |
| LST | Livermore Software Technology |
| **M** | |
| MALSR | Medium Intensity Approach Lighting System With Runway Alignment Indicator Lights |
| Massport | Massachusetts Port Authority |
| MARS | Multiple Airport Route Separation |
| MET | Minimum Cockpit Meteorological |
| MI | University of Michigan |
| MinWxSvc | Minimum Weather Service |
| MIT | Massachusetts Institute of Technology |
| ML | Machine Learning |
| MMPDS | Metallic Materials Properties Development and Standardization |
| MOU | Memorandum of Understanding |
| MRMS | Multi-Radar Multi-Sensor |
| **N** | |
| NAC | NextGen Advisory Committee |
| NAFI | National Association of Flight Instructors |
| NARP | National Aviation Research Plan |
| NAS | National Airspace System |
| NASA | National Aeronautics and Space Administration |
| NASAO | National Association of State Aviation Officials |
| NATA | National Air Transportation Association |
| NATCA | National Air Traffic Controllers Association |
| NATO | North Atlantic Treaty Organization |
| NDE | Nondestructive Evaluation |
| NESG | NAS Enterprise Security Gateway |

| ACRONYM | DEFINITION |
|---|---|
| NextGen | Next Generation Air Transportation System |
| NGIP | NextGen Implementation Plan |
| NHTSA | National Highway Traffic Safety Administration |
| NI | NAS Infrastructure |
| NIA | National Institute of Aerospace |
| NIAR | National Institute for Aviation Research |
| NIEC | NextGen Integration and Evaluation Capability |
| NIH | National Institute of Health |
| NIST | National Institutes of Standards and Technology |
| NOAA | National Oceanographic and Atmospheric Administration |
| NPN | NextGen Prototyping Network |
| NPPD | National Protection and Programs Directorate |
| NRC | National Research Council |
| NSIP | NextGen Segment Implementation Plan |
| NSTC | National Science and Technology Council |
| NTSB | National Transportation Safety Board |
| NWS | National Weather Service |
| **O** | |
| ODNI | On Demand National Airspace System (NAS) Information |
| OEM | Original Equipment Manufacturers |
| OP | Overarching Properties |
| OPC | Offshore Precipitation Capability |
| ORA | Operational Risk Assessment |
| ORTA | Office of Research and Technology Applications |
| OST | Office of the Secretary |
| OSU | Ohio State University |
| OTA | Other Transaction Agreements |
| OTJI | On The Job Training Instructor |
| **P** | |
| PAFI | Piston Aviation Fuels Initiative |
| PAFI TAC | PAFI Technical Advisory Committee |
| PAMA | Professional Aviation Maintenance Association |
| PEGASAS | Partnership to Enhance General Aviation Safety, Accountability and Sustainability |
| PBN | Performance Based Navigation |
| PCPSI | Pilot/Controller Procedures and Systems Integration |
| PFAS | Perfluoroalkyl and Polyfluoroakyl Substances |
| PHMSA | Pipeline and Hazardous Materials Safety Administration |
| PIREPs | Pilot Reports |
| PMA | Parts Manufacturer Approval |

| ACRONYM | DEFINITION |
|---|---|
| PMO | Program Management Organization |
| PPD | Presidential Policy Directive |
| PSG | PAFI Steering Group |
| PV | Photovoltaic |
| **Q** | |
| **R** | |
| R&D | Research and Development |
| RDHFL | Research Development and Human Factors Laboratory |
| RD&T | Research, Development, and Technology |
| REB | Research Executive Board |
| R,E&D | Research, Engineering and Development Appropriation |
| REDAC | Research, Engineering, and Development Advisory Committee |
| RECAT TW | Re-Categorization Total Wind |
| RISC | Rotor Integrity Steering Committee |
| RNP | Required Navigation Performance |
| RoMan | Rotor Manufacturing |
| RTCA | Radio Technical Commission for Aeronautics |
| RTT | Research Transition Team |
| RVR | Runway Visual Range |
| **S** | |
| SA CAT | Special Authorization Category |
| SAE | Society of Automotive Engineers International |
| SBS | Surveillance Broadcast Services |
| SDO | Standards Development Organizations |
| SE | Safety Enhancement |
| SME | Subject Matter Expert |
| SPRM | System Planning and Resource Management |
| SSM | System Safety Management |
| SVS | Synthetic Vision Systems |
| SVGS | Synthetic Vision Guidance Systems |
| SWAC | System Wide Analysis Capability |
| SWIM | System Wide Information Management |
| **T** | |
| TAC | Technical Advisory Committee |
| TAS | Terminal Area Safety |
| TCRG | Technical Community Representative Group |
| TBO | Trajectory Based Operations |
| TF/RF | Track to Fix/Radius to Fix |
| TFM | Traffic Flow Management |
| TGF | Target Generation Facility |

| ACRONYM | DEFINITION |
|---|---|
| TRACON | Terminal Radar Air Traffic Control |
| TRB | Transportation Research Board |
| TSO | Technical Standards Order |
| TWU | Transport Workers Union |
| **U** | |
| UAM | Urban Air Mobility |
| UAS | Unmanned Aircraft System |
| UCF | University of Central Florida |
| UEDDAM | Uncontained Engine Debris Damage Assessment Model |
| U.S. | United States |
| USAF | United States Air force |
| USDA | United States Department of Agriculture |
| USHST | United States Helicopter Safety Team |
| USN | United States Navy |
| UTAS | United Technologies Aerospace Systems |
| UTM | UAS Traffic Management |
| **V** | |
| VDN | Virtual Dispersive Networking |
| VFR | Visual Flight Rules |
| VNR | VFR Not Recommended |
| **W** | |
| WFD | Widespread Fatigue Damage Rule |
| WJHTC | William J. Hughes Technical Center |
| WTIC | Weather Technology in the Cockpit |
| **Z** | |
| ZASA | Zodiac Arresting Systems America |