United States Department of Transportation
Annual Modal Research Plans FY 2024
Program Outlook FY 2025

Cover Page

Federal Aviation Administration

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Submitted by:
Shelley Yak
William J. Hughes Technical Center Director
FAA Research Portfolio Manager

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Executive Summary

The Annual Modal Research Plan (AMRP) outlines planned research for fiscal year 2024 (FY 2024) and the outlook for fiscal year 2025 (FY 2025). 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 mandated in 49 U.S.C. Chapter 65 (Research Planning) (Sec. 6501(a)(1)).

The FAA invests in research and development (R&D) to support policymaking and planning, regulation, certification, standards development, and national airspace system (NAS) modernization. Annually, over 54 million flights are managed within the NAS, approaching a billion passengers. The FAA R&D portfolio supports day-to-day NAS operations and balances near-term, mid-term, and far-term aviation research needs to provide the safest and most efficient aerospace system in the world. Additionally, FAA R&D cultivates the innovation needed to evolve the NAS; to prepare the aviation system for the next generation, making it more adaptable, sustainable, resilient, equitable, and safer for all; and to advance aviation in an environmentally responsible and energy-efficient manner.

The FAA's R&D portfolio priorities, objectives, and strategies correspond to the DOT's Research, Development, and Technology (RD&T) Strategic Plan to meet its goals of Safety, Economic Strength and Global Competitiveness, Equity, Climate and Sustainability, Transformation, and Organizational Excellence. Examples of program research under the FAA's R&D portfolio include System Safety Management/Terminal Area Safety, which is assessing new operational concepts for the use of vision systems in all-weather conditions and varied mission environments during critical phases of flight; Commercial Space Transportation Safety, which is improving safety analyses and other tools to facilitate the safe and efficient integration of space vehicle traffic through the NAS; and The William J. Hughes Technical Center (WJHTC) Laboratory Facilities, an FAA federal laboratory that is developing aviation innovations and capabilities, and transferring them to industry and/or academia for public benefit. 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 invests in high-priority research and development activities that are critical to reinforcing its role as the world's premier aerospace body and supports the RD&T Strategic Plan FY2022-2026 strategic goals and research priorities. This section highlights critical research within the R&D portfolio, including program alignment to the RD&T Strategic Plan's goals and research priorities. The highlighted research includes only a sample of specific activities and is not intended to represent or characterize the full breadth of the FAA's research portfolio.

Aviation Accessibility Research
(*Equity, Mobility Innovation*)

Travelers who use wheelchairs experience burdens that can make air travel inconvenient, uncomfortable, and potentially unsafe. Examples include mishandled or lost wheelchairs and scooters and issues with transfers to and from aircraft seats.

In support of the Department of Transportation (DOT)'s *Bill of Rights for Airline Passengers with Disabilities* and in accordance with the Air Carrier Access Act, the FAA is evaluating the occupant safety and crashworthiness aspects of installing wheelchairs on commercial aircraft.

Using existing data and research furnished by the Federal Railroad Administration and the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), the agency is evaluating whether

existing crashworthiness standards for wheelchairs can be used as a means of satisfying FAA regulations for emergency landing conditions. In addition, the agency is working with the Civil Aerospace Medical Institute (CAMI) and Wichita State University (WSU) through the National Institute of Aviation Safety (NIAR) to study requirements necessary to ensure safe integration of wheelchair restraint systems onto aircraft. Research will be used to determine whether it is feasible to add wheelchair securement systems on passenger aircraft. Studies are ongoing with planned completion in 2024-2025.

After research is completed, the FAA can begin its implementation plan through the development of guidance and policy to demonstrate compliance to the occupant safety regulations.

Aeromedical Research Program
(Safety, Human Factors)

The Aeromedical Research Program seeks to develop biologically based diagnostic tools using biomarkers to identify performance impairment from inadequate sleep. Researchers will apply these tools to provide a reliable means of identifying fatigue in aviation accident investigations, improving FAA forensic analysis for the National Transportation Safety Board.

Tools developed under this program may also provide improved diagnostics to allow objective real-time measurement of operator fatigue for accident prevention. Following stakeholder coordination and adoption by the aviation industry, these tools could be helpful for fatigue risk management strategies and improving current regulations, such as 14 CFR 117 — the federal guidelines governing flight, duty, and rest requirements for flight crews. Additionally, this program supports national aviation preparedness planning by collecting field and laboratory data to characterize human behavior and the environment during the gate-to-gate travel experience, assisting in disease transmission risk modeling.

Alternative Fuels for General Aviation (GA) Program
(Climate and Sustainability, Decarbonization)

The Alternative Fuels for GA Program is testing 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 220,000 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 supports 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. Data will be obtained by engine testing of prospective fuels in fleet representative models; flight-testing on final candidate fuel formulations in fleet representative aircraft models; laboratory analysis on candidate fuels and lubricating oils; testing technologies that could have transformative impact in reducing harmful emissions from the GA aircraft fleet; and evaluation of key certification considerations for electric propulsion systems, including development of energy reserve requirements, environmental effects, electromagnetic compatibility and other requirements.

Digital System Safety
(Transformation, Integrated System-of-Systems)

Aircraft are increasingly dependent on highly integrated complex digital avionics and flight control systems, which continue to evolve due to technological innovations and a desire by the aviation industry to reduce costs and lessen the time it takes to get new products to the marketplace. This makes it difficult for researchers and standards-setting bodies to thoroughly test new technologies under various normal and abnormal operating conditions. If one of these critical systems were to fail, it could result in the loss of the aircraft and a loss of life.

Digital System Safety research will analyze the effectiveness of current approaches to certification of complex aviation digital systems and identify a path to certification and operational approval when safety-critical systems contain higher levels of decision making for functions previously assumed to be within the task domain of humans (using artificial intelligence (AI) and machine learning (ML), for example). The FAA will use the research results to develop standards, guidance, and training. The research will include systems development processes; requirements validation and integration; identification of missing or incorrectly specified requirements; use of commercial-off-the-shelf (COTS) devices in complex systems; use of new and novel software and electronics that include AI and ML; software implementation techniques, tools, methods, and processes; and ways to streamline development assurance cases for aircraft certification. The research will address how these technology advances will impact current certification processes and guidance, while providing a better understanding of methods to safely certify these complex digital systems.

Environment and Energy Program
(Climate and Sustainability, Sustainable and Resilient Infrastructure)

Aircraft noise is the primary environmental obstacle to aviation growth. The Environment and Energy Program created the Aviation Environmental Design Tool (AEDT) to model aircraft performance in space and time to estimate fuel use, emissions, noise, and air quality consequences. AEDT is at the core of a comprehensive suite of software tools the agency uses to assess the environmental effects of aviation. The FAA uses AEDT to facilitate the environmental review of federal actions associated with changes to airports, airspace, and other applicable aviation activities. AEDT is also a valuable tool for domestic and international aviation environmental policy analysis. The agency also sponsors research to improve the accuracy of AEDT and expand its modeling capabilities.

The current emissions dispersion model in AEDT will be updated to better represent and model aircraft-specific emissions to help airports demonstrate compliance with the National Environmental Policy Act and the Environmental Protection Agency's Clean Air Act requirements, streamlining the environmental review process and avoiding delays in airport construction and needed upgrades. AEDT development is supported by a robust research program through the Center of Excellence for Alternative Jet Fuels and Environment (ASCENT), which also includes several projects to evaluate the potential impacts of noise on sleep and health, as well as the effects of emissions on air quality and climate change. The resulting knowledge and enhanced modeling capabilities will be available to inform decision making by the FAA and others in the aviation and aerospace industries, enabling an international leadership role on environmental standards setting for aircraft noise and emissions at the International Civil Aviation Organization (ICAO).

Information Cybersecurity Program
(Safety, Cybersecurity)

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 FAA's Information Cybersecurity research and development program conducts research, analysis, demonstrations,

evaluations, and prototype development of cybersecurity data science (CSDS) tools, technologies, and methods to detect, prevent, and mitigate the effects of cyber-attacks on elements of the aviation ecosystem.

The program explores CSDS concepts focusing on AI and ML. Researchers will collaborate with the aviation industry to address stakeholder cybersecurity concerns. Applying CSDS with AI and ML concepts to individual aviation industry challenges — through prototyping, experimentation, and demonstration — will enable greater collaboration and assist the aviation industry with CSDS implementation decisions.
The primary research purpose is to accelerate the aviation industry's timely adoption of novel CSDS and AI/ML technologies to enhance cybersecurity for the airline, airport, and aircraft elements of the national aviation ecosystem to increase safety and resiliency (availability and reliability). Critical research results will include documented guidance for aviation industry stakeholders and standards-setting bodies. This multi-year collaborative effort will allow the aviation industry to use lessons learned from this research to strengthen their cybersecurity, both individually and collectively, making the broader aviation ecosystem more resilient and safer for the flying public.

NextGen Environmental Research – Aircraft Technologies and Fuels Program
(Climate and Sustainability, Decarbonization)

Through the Continuous Lower Energy, Emissions, and Noise (CLEEN) program, the FAA is working with the aviation industry to develop certifiable aircraft and engine technologies that increase fuel efficiency, while reducing noise, emissions, and aircraft operating costs. The goal of CLEEN is to achieve environmental protection that enables sustained aviation growth. The first ten years of the CLEEN program (2010 through 2020) are estimated to save the aviation industry 36 billion gallons of fuel by 2050, reducing airline costs by $73 billion, and resulting in carbon dioxide reductions equivalent to removing three million cars from the road from 2020 to 2050. The FAA will determine goals for the next phase of CLEEN (Phase IV) in the coming year, with an expected launch in 2024 to 2025.

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, including the ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Results of these efforts will allow knowledge to be shared across the full breadth of jet fuel and aviation stakeholders to support the development of jet fuels from alternative sources, including knowledge about fuel composition and its impact on engine operability, and transition to standard setting bodies to support certification/qualification of jet fuels from alternative sources.

Propulsion and Fuel Systems Program
(Safety, Data Driven System Safety)

Jet engines contain high-energy rotating parts, such as fan, compressor, and turbine rotors. When engine parts break due to abnormalities in the metal, fragments can escape the engine case and impact other parts of the aircraft. These uncontained engine failures pose a serious threat to passengers and the continued safe operation of the aircraft. The FAA's Propulsion and Fuel Systems Program and Southwest Research Institute, in collaboration with the aviation industry, developed a tool called Design Assessment of Reliability with Inspection, or DARWIN®, to determine the probability of failure of critical engine parts. Engine manufacturers use the software code to design and verify the compliance of life-limited engine parts that need to be replaced on a regular basis due to wear and tear during the life of an aircraft. Released in September 2022, DARWIN® 10.0 contains improved features, including the ability to conduct FAA certification assessments for rotor axial blade slots, updated titanium anomaly distributions, 3-D visualization improvements, speed and robustness enhancements, and data security features.

Current Propulsion and Fuel Systems Program research will focus on the effects of anomalies in engine components made of nickel and titanium, both of which are used to make critical rotating components. Research is motivated in part by a 2016 uncontained turbine engine failure in Chicago caused by a nickel anomaly and another uncontained failure in 2017 from a metallurgical condition known as cold dwell fatigue that can shorten the expected life of titanium engine components. The goal is to create updated versions of DARWIN® that can help prevent failures in nickel and titanium parts, as well as new regulatory guidance on nickel and titanium damage tolerance in high-energy rotors.

Unmanned Aircraft Systems (UAS) Program
(Transformation, New and Novel Technologies)

As the NAS continues to evolve, additional research, concept development, and validation are needed to reduce risk and identify technical and operational requirements that will provide improved services to increase its capacity, efficiency, system flexibility, and safety. As part of this evolution, work continues to integrate UAS (or drones, the fastest growing aviation segment in the U.S.) into the NAS, ensuring safe airport access, such as detect-and-avoid classifications that support beyond-visual-line-of-sight operations and cybersecurity and exploring the impact of lost link (when the pilot in command loses the communication link with the UAS aircraft). The UAS research program builds upon current UAS operations and informs data-driven policy decisions, safety assessments, rulemaking, and standards to enable the FAA to safely achieve full UAS and advanced air mobility (AAM) integration in the NAS.

Detecting unauthorized UAS activity at the nation's airports and removing that threat ensures the safety and security of the flying public. The program is assessing the challenge of retrofitting technologies for urban air mobility (UAM) into the NAS, while also identifying necessary regulations and standards for the safe use of counter-UAS technologies that do not adversely impact 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. Additional ongoing research focuses on increasing the use of UAS during emergencies, and for disaster preparedness and response by removing barriers to adoption and enhancing interagency communication, as directed by Congress in the Omnibus Budgets of 2018 and 2019.

Collaboration Efforts

In pursuit of our mission, the FAA maintains partnerships with over 350 stakeholders representing other federal agencies, academia, the aviation industry, international entities, and technical societies. 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	Air Force Research Laboratory, Department of Agriculture, Department of Defense, Department of Energy, Environmental Protection Agency, Federal Air Marshal Service, MIT Lincoln Labs, , NASA Ames, NASA Armstrong Flight Research Center, NASA Glenn, NASA Johnson, NASA Langley, National Oceanic and Atmospheric Administration, National Transportation Safety Board, National Weather Service, Naval Air Warfare Center Aircraft Division, Port of Seattle, Smithsonian Institution, Transportation Security Administration U.S. Air Force Research Laboratory, U.S. Army, U.S. Marshals Service, U.S. Navy, U.S. Coast Guard, and Volpe National Transportation Systems Center.
Academia	Clarkson University, Embry-Riddle Aeronautical University, Fairfield University, Florida International University, George Mason University, Massachusetts Institute

Category	Partnership Examples
	of Technology, Mississippi State University, New Mexico State University, Ohio State University, Pennsylvania State University, Purdue University, Rowan University, Rutgers University, Stanford University, University of Alabama Huntsville, University of California San Diego, University of Colorado Boulder, University of Dayton, University of Texas, University of Utah, University of Washington, Washington State University, and Wichita State University.
Industry	Acellent, Afton Chemical, Aircraft Owners and Pilots Association, Alaska Airlines, American Airlines, AMETEK, ASA, Astronics, ATECH, AURA, Boeing, Bombardier, Cirrus Aircraft, Columbia Helicopters, Delta Airlines, Diakon Solutions, FedEx, Garmin, General Electric, GSSL, Harris, Honeywell, JetBlue, Kerr Avionics, Lectromech, Metis Design, MOBIL, National Institute of Aerospace, NetJets, Nexteon, Raytheon, Rockwell Collins, Shell, Sikorsky, Society of Automotive Engineers, Southwest, Spirit, Team Eagle, United, and UPS.
International	Acellent, Adacel Systems, AirServices Australia, BlindSquare, Brazil Air Navigation Service Provider, Civil Aviation Authority of Singapore, CMC Electronics, Embraer, European Aviation Safety Agency, Eurocontrol, European Organization for the Safety of Air Navigation, International Civil Aviation Organization, Inventive, Japan Civil Aviation Bureau, National Research Council of Canada, SAAB, Single European Sky Air Traffic Management Research Joint Undertaking, Supernal, Team Eagle, Technical University of Denmark, Thales, Transport Canada, United Kingdom Civil Aviation Authority, 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, and Development (RE&D) Advisory Committee (REDAC)

The congressionally mandated REDAC is an important contributor to 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 and ensures that FAA research activities are coordinated with other government agencies and the aviation industry.

REDAC members include experts from aviation, aerospace, and related emerging technology-focused corporations, universities, associations, consumers, and Federally Funded Research and Development Centers 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 collaborative R&D with other government agencies, industry, and academia and disseminates federally funded research innovations for the benefit of the American public. The program fulfills three primary roles:

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

- Managing patent licenses and royalties.

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 Cooperative Research and Development Agreements (CRADAs,) intellectual property, and royalties. Although FAA partners do not receive government funds, they benefit substantially from access to unsurpassed facilities and expertise. In return, the agency can evaluate upcoming advanced technologies and processes to facilitate their certification and safe integration into the National Airspace System.

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

To improve the flying public's in-air experience, the agency conducts multiple research programs relative to weather and aircraft conditions. Commercial and general aviation aircraft frequently experience unexpected atmospheric turbulence. Though 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 NAS operations after thunderstorms, as airline pilots and dispatchers try to avoid routing aircraft through the unstable air.

Through its Weather Program, the agency is 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. The FAA will improve turbulence detection and forecasting, as well as translation of complex weather information for a safer, more efficient, and predictable National Airspace System. In 2024/2025, the agency plans to transition its high-resolution turbulence "Nowcast" capability to the National Weather Service and will transition its Turbulence Avoidance Model (TAM) capability to the FAA's NextGen Weather Processor.

In addition to turbulence, another concern for the flying public is cabin air quality. Reports of cabin air contaminants can often 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. Smoke, odors, and fumes can enter

the environmental control system used for ventilation, pressurization, and temperature control of the airplane. The FAA's Aeromedical Research Program 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. The agency plans to publish a final report and recommendations on airliner cabin air quality in 2024/2025.

The smoke, odors, and fumes that can leak into the aircraft cabin are often derived from aircraft fires, which can occur in tough-to-access areas, such as engines and cargo holds. They typically involve spilled jet fuel and a variety of other hazardous materials. Airports are required to have a minimum supply of fire extinguishing agents — known as aqueous film forming foams (AFFF) — available at all times for use in emergency situations. 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. The Airport Technology Research Program seeks 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. Expected outcomes from this program are identification and creation of standards for the use of PFAS-free replacement foams, compressed air foam systems, and ultra-high-pressure firefighting technology; as well as strategies for the use of high-reach extendable turrets to minimize disruption of thermal balance in post-crash fires. The agency will also develop guidance for the changeover and implementation from AFFF to PFAS-free replacement foams.

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 (T2) Record of Activity (ROA).

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 T2 Congressional Report provides T2 performance metrics including the number and status of CRADAs, invention disclosures, patent submittals, license agreements, Centers of Excellence (COE) grant awards, and associated funding.

FY 2024 RD&T Program Funding Details

RD&T Program Name	FY 2024 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	7,722	7,722				
Propulsion and Fuel Systems	6,374	6,374				
Advanced Materials /Structural Safety	2,526	2,526				
Aircraft Icing	3,960	3,960				
Digital System Safety	7,109	7,109				
Continued Air Worthiness	8,425	8,425				
Flight Deck/Maintenance/System Integration Human Factors	15,646	15,646				
System Safety Management/Terminal Area Safety	9,349	9,349				
Air Traffic Control/Technical Operations Human Factors	6,389	6,389				
Aeromedical Research	12,205	12,205				
Weather Program	19,220	19,220				
Unmanned Aircraft Systems	21,128	21,128				
Alternative Fuels for General Aviation	11,201	11,201				
Commercial Space Transportation Safety	6,157	6,157				
Next Gen - Wake Turbulence	4,680	4,680				
Information/Cyber Security	6,415	6,415				
Environment & Energy	21,305	21,305				
NextGen – Environmental Research – Aircraft Technologies and Fuels	70,774	70,774				
System Planning and Resource Management	5,097	5,097				
Aviation Grant Management	2,001	2,001				
William J. Hughes Technical Center Laboratory Facilities	5,447			5,447		
Aviation Accessibility Research	2,000	2,000				
William J. Hughes Technical Center Laboratory Sustainment	16,900			16,900		
William J. Hughes Technical Center Infrastructure Sustainment	10,000			10,000		

RD&T Program Name	FY 2024 President's Budget Request* ($000)	Applied ($000)	Technology Transfer ($000)	Facilities ($000)	Experimental Development ($000)	Major Equipment, R&D Equipment ($000)
Advanced Technology Development & Prototyping	34,440				34,440	
NextGen - Separation Management Portfolio	14,400				14,400	
NextGen - Traffic Flow Management Portfolio	10,000				10,000	
NextGen - On Demand NAS Portfolio	8,500				8,500	
NextGen - NAS Support Portfolio	5,000				5,000	
NextGen - NAS Infrastructure Portfolio	12,000				12,000	
NextGen Unmanned Aircraft Systems	14,000				14,000	
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	41,801	41,801				
Airport Cooperative Research Program	15,000	15,000				
Administrative	16,487				16,487	
Totals	**521,658**	**306,484**		**32,347**	**182,827**	

The AMRP reflects funding as found in the annual President's budget request per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning. The enacted numbers will be posted as part of the President's budget request for the ensuing fiscal year.

FY 2024 RD&T Program Budget Request by DOT Strategic Goal

RD&T Program Name	FY 2024 President's Budget Request* ($000)	SAFETY ($000)	ECONOMIC STRENGTH AND GLOBAL COMPETITIVENESS ($000)	EQUITY ($000)	CLIMATE AND SUSTAINABILITY ($000)	TRANSFORMATION ($000)	ORGANIZATIONAL EXCELLENCE ($000)
Fire Research and Safety	7,722	7,722					
Propulsion and Fuel Systems	6,374				6,374		
Advanced Materials /Structural Safety	2,526	2,526					
Aircraft Icing	3,960	3,960					
Digital System Safety	7,109					7,109	
Continued Air Worthiness	8,425	8,425					
Flight Deck/Maintenance/System Integration Human Factors	15,646	15,646					
System Safety Management/Terminal Area Safety	9,349	9,349					
Air Traffic Control/Technical Operations Human Factors	6,389	6,389					
Aeromedical Research	12,205	12,205					
Weather Program	19,220	19,220					
Unmanned Aircraft Systems	21,128	21,128					
Alternative Fuels for General Aviation	11,201				11,201		
Commercial Space Transportation Safety	6,157		6157				
Next Gen - Wake Turbulence	4,680	4,680					
Information/Cyber Security	6,415					6,415	
Environment & Energy	21,305				21,305		
NextGen – Environmental Research – Aircraft Technologies and Fuels	70,774				70,774		
System Planning and Resource Management	5,097						5,097
Aviation Grant Management	2,001			2,001			
William J. Hughes Technical Center Laboratory Facilities	5,447						5,447
Aviation Accessibility Research	2,000			2,000			
William J. Hughes Technical Center Laboratory Sustainment	16,900					16,900	
William J. Hughes Technical Center Infrastructure Sustainment	10,000					10,000	

RD&T Program Name	FY 2024 President's Budget Request* ($000)	SAFETY ($000)	ECONOMIC STRENGTH AND GLOBAL COMPETITIVENESS ($000)	EQUITY ($000)	CLIMATE AND SUSTAINABILITY ($000)	TRANSFORMATION ($000)	ORGANIZATIONAL EXCELLENCE ($000)
Advanced Technology Development & Prototyping	34,440					34,440	
NextGen - Separation Management Portfolio	14,400					14,400	
NextGen - Traffic Flow Management Portfolio	10,000					10,000	
NextGen - On Demand NAS Portfolio	8,500					8,500	
NextGen - NAS Support Portfolio	5,000					5,000	
NextGen - NAS Infrastructure Portfolio	12,000					12,000	
NextGen Unmanned Aircraft Systems	14,000					14,000	
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	41,801	12,534	8,833	3,608	7258	9568	
Airport Cooperative Research Program	15,000	6,000	1,500	550	750	6,000	200
Administrative	16,487					16,487	
Totals	**521,658**	**129,784**	**73,490**	**8,159**	**117,662**	**181,819**	**10,744**

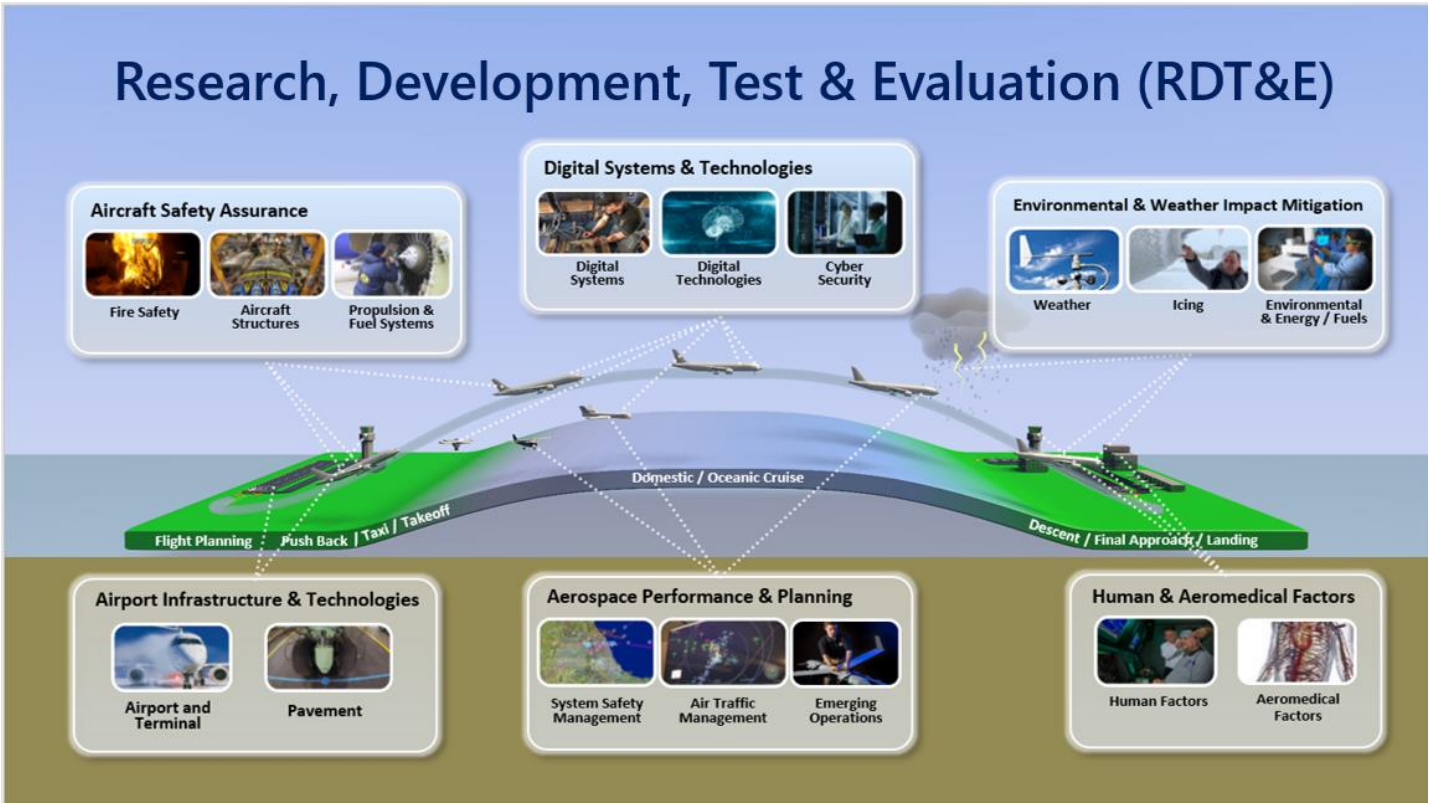
The AMRP reflects funding as found in the annual President's budget request per 49 U.S.C. Chapter 65 Sec. 6501 Research Planning. The enacted numbers will be posted as part of the President's budget request for the ensuing fiscal year.

Chapter 1 – FY 2024 RD&T Programs

FAA RDT&E 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, the flying public. The goals span six 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 2024 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:

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

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 2024 Annual Modal Research Plans

Airports Technology Research Program
Requested: ($41,801,000)

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 several 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 example, 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 emerging recycled/carbon neutral pavement materials at airports, tools to quantify environmental impact of airport pavement projects, and 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. ATR program research results and objectives are ultimately reflected in these AC's, which form the technical guidance used by airports across the nation.

On the infrastructure side, key FY 2024 objectives include the search for, testing, and applicability of various recycled and more low-embodied carbon (environmentally-friendly) pavement materials that may be integrated into the design and construction of airport pavements and extend the life of the airport pavements so that the use of new raw material will be reduced and airport pavement infrastructure 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 2024 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.

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 and other low-embodied carbon pavement materials
- Continue development and improvements in web-based Life Cycle Assessment (LCA) tool for quantifying environmental impacts of airport pavement projects

- Research studies to determine performance of 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
- Conduct the annual FAA Runway Incursion Mitigation analysis to identify locations at towered airports with airport design features that are considered at risk for runway incursions and track mitigated locations to ensure improved safety
- Continue research on 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 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 health impacts
- Continue Resilience Study of Vulnerable National Plan of Integrated Airport Systems (NPIAS) Airports for Climate Change and Severe Weather
- Research 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, and testing and evaluation of more resilient and environmentally-friendly/low-embodied carbon 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 2024, 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 and 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 2024, 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 expand 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 goals. Progress in the ATR program areas is made continuously, including 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-friendly pavement materials at the FAA's pavement research testing facilities.

Collaboration Partners:

In addition to the Research, Engineering and Development Advisory Committee (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 the 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 the FAA with access to a state-of-the-art facility.

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

Smithsonian Institute: This agreement enables collaboration between the 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 at airports.

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

Volpe Center: This agreement enables collaboration between the FAA and Volpe Center to develop prioritized, risk-based tools, and recommendations to address climate change and severe weather impacts at vulnerable airports.

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.

The Boeing Company: The FAA and the Boeing Company are in the beginning stages of forming a CRADA to determine if FAA airport design standards defined today can be safely modified to facilitate more efficient and sustainable future aircraft.

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 U.S. 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):

National Concrete Pavement Technology Center (CPTech): The FAA has a Cooperative Agreement with Iowa State University, National Concrete Pavement Technology Center to support research aimed at improving the design, construction, rehabilitation, and repair of concrete airfield pavements and to aid in making them safer, more cost effective, and durable. This agreement is in direct support of Section 744 of the 2018 FAA Reauthorization Act (P.L. 115-254).

National Asphalt Pavement Association (NAPA): The FAA has a Cooperative Agreement with NAPA to support research aimed at improving the design, construction, rehabilitation, and repair of asphalt airfield pavements and to aid in making them safer, more cost effective, and durable. This agreement is in direct support of Section 744 of the 2018 FAA Reauthorization Act (P.L. 115-254).

Aircraft Safety Assurance

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Fire Research and Safety
Requested: ($7,722,000)

Program Description:

The Fire Research and Safety Program conducts 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, who 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

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 certification cost for flammability requirements due to proposed improved flammability standards based on 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.

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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 system certification to progress within the FAA.

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Advanced Materials/Structural Safety
Requested: ($2,526,000)

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 civil aircraft evolution 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.

The Advanced Materials/Structural Safety 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 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 non-metal 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 these applications to support standards that ensure safe and efficient practices for the future.

This program supports the DOT'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 safety 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 knowledge gaps 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 the 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 new and 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:

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 FAA4, and aviation industry 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 advancing of transportation safety by building an evidence basis to support performance-based Federal safety standards and regulations for transportation technologies.

- 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 DOT strategic research and policy objective of Safe Technology by build an evidence basis to support performance-based Federal safety standards and regulations for transportation technologies. .

- 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 Safe Technology by developing test tools, procedures, and performance measures that enable improved crashworthiness evaluations of aircraft.

- 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 also uniquely evaluated. The research goal 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 with an emphasis on composite helicopter rotor blades, which have seen in-service failures.
- Evaluate fatigue and damage tolerance behavior of bonded structure and associated maintenance practices. Study safety and structural integrity issues of bonded repair performed on composite wing structure
- 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 technologies such as additive manufacturing and discontinues fiber composites 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). Program output supports multiple DOT safety research priorities and objectives to advance transportation safety by evaluating the safety of existing aviation technologies and supporting the safe integration of emerging technologies.

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 safe design limits that have not been explored with composite materials and structures to advance air transportation safety 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 publicly 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 publicly 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, 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 – 17 (CMH-17) working groups. The technology transfer of the research output and data generated by this research program is achieved through direct communication, FAA reports, and the CMH-17, which function as industry consensus standard.

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Continued Airworthiness
Requested: ($8,425,000)

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, the safety of electrical wiring interconnect systems and mechanical systems, and the safety of large rechargeable electrical energy storage 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); support development of material allowables for conventional and emerging materials.
- Examine the effects that different platform materials have on the results of rotorcraft fuel system drop testing.
- Research large electric energy storage systems
- Research high voltage aviation electrical systems.
- Evaluate fatigue and damage tolerance behavior of emerging structural materials.
- Evaluate aircraft structural loading of electrical vertical takeoff and landing (eVTOL) systems.
- Evaluate probabilistic damage tolerance-based fleet management for small airplanes.
- Development of Control Surface and Stabilizer Freeplay Limits.
- NASGRO enhancement, standardization, and material database generation for damage tolerance analysis.

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. This data is 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 manufacturers such as Boeing, Bombardier, Bell, Sikorsky, AirBus, Gulf Stream, Dassault, Embraer Honeywell, Teledyne, Astronics, Ametek GE, magniX, Supernal, Denso, 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.

Structural Integrity

- 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[1]. The Government Steering Group includes FAA, NASA, and

[1] For more information on metallic allowables, see mmpds.org.

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 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 from external partners by the FAA, 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 academic partners under contract with the FAA. Government partners include NASA Armstrong, NASA Ames, and NASA Langley. Industry partners include the Adaptive Aerospace Group, Systems Technology Inc., National Test Pilot School, and Flight Level Engineering. Academic partners include Purdue University, The Florida Institute of Technology, and Georgia Tech. No funding is received from external partners by the FAA, 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 academic 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 include; Boeing, Saft, Teledyne, Honeywell, Eagle Picher, University of Dayton Research Institute Systems, DNV-GL, Ametek, Astronics, magniX, Supernal, and Denso. No funding is received from external partners by the FAA, but cost sharing includes in-kind contributions from other government agencies, industry and academia as part of the collaborative research initiatives.

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Propulsion and Fuel Systems
Requested: ($6,374,000)

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 provides 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 Aerospace Industries Association (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. A series of FAA advisory circulars and a publicly available probabilistic software code will be developed to ensure that the industry is able to comply with the new safety rule.

The research objective 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:

- Research Advanced Damage Tolerance and Risk Assessment Methods for Engine Life Limited Parts
- Research Improved Nondestructive Evaluation to Prevent Uncontained Engine Failures

- Evaluate Advanced Analysis Methods for Impact of Aircraft Materials from Rotor Burst and Blade Release.
- Research Engine Safety Event Prevention thru Engine Health Monitoring (EHM)
- Perform Electric Engine Research for the Safe Implementation of Electric Propulsion

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 Uncontained Engine Debris Damage Assessment Model (UEDDAM), and 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 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
- magniX
- Denso
- Interagency Power Working Group

Digital Systems and Technologies

United States Department of Transportation
FY 2024 Annual Modal Research Plans

Digital System Safety
Requested: ($7,109,000)

Program Description:

Airborne system 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 of the Digital System Safety Program 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 program 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 pursues performance-based rather than prescriptive regulations.

Major Program Objectives:

The research conducted within the Digital System Safety 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 requirements 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 Digital Systems Safety research will develop policy, guidance, and training for new technologies and techniques to promote their safe use in aircraft systems; and processes and training material used to streamline the certification of complex digital systems. The program also seeks to understand, address, and provide an annual measurement indicator of Safety Data Sheets (SDS)-related ongoing operational safety issues.

Anticipated Program Activities:

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

Potential Program Outputs, Value Statement and Impacts:

The research will provide guidance to approve highly complex electronic systems by alternative means. The results of this research will have a significant impact on the development and use of AI/ML systems. This research will also help to ensure that AI/ML systems are safe, secure, and reliable by identifying and

mitigating associated safety risks. This will help to accelerate the adoption of AI/ML technologies to allow the agency to address some of the most pressing challenges in the implementation of AI/ML applications in airborne systems. Additionally, research results will improve the cyber resiliency of position, navigation, and timing (PNT) systems.

Potential Economic or Societal Impacts:

Potential economic or societal impacts can be realized by improving airborne system safety. 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 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 (SMEs) 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: ($6,415,000)

Program Description:

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.

Core research will be performed to enable breakthrough discoveries and new knowledge in the area of Predictive Analytics (PA) and other novel applications. The applied research topics that have the most value to the aviation community are identified through the collaboration with industry stakeholders, which currently support the aircraft, airlines and airports components of the ecosystem. The FAA is in varying stages of progress of transferring the knowledge to industry and has identified the following areas of interest to be the highest concern to industry:

- Aircraft Log Analysis
- Supply Chain Induced Threats
- Factory Automation
- Airport Operations

Research is expected to continue in these, and other high value areas, through FY24 and beyond

Major Program Objectives:

The purpose of this program is to accelerate aviation industry timely adoption and adaptation of novel CSDS and AI/ML technologies for enhancement of cybersecurity for the airline, airport and aircraft elements of the national aviation ecosystem to increase safety and resiliency (availability and reliability). Since improved cyber security will benefit all seven Transformation Objectives of the three major priorities identified in the U.S. Department of Transportation Strategic Plan, this program is paramount in building a better transportation future within the aviation ecosystem.

Within the major priority of Integrated System-of-Systems, several key “attributes” of the Transportation System of the Future are identified. The CSDS program will deliver results for at least the following attributes:

Data Driven – The Cyber Security Data Science program focuses on providing data driven solutions for improved cyber security practices. Solutions are explored that typically analyze an extreme amount of data, and one of the first successes of the program is to provide an Aircraft Log Anomaly Detection (ALAD) solution that evaluates millions of lines of aircraft data daily.

Intelligent – Processing and analyzing the huge amounts of data that are created in the aviation eco system places an unfathomable burden on human analysts and data scientists. By necessity, more intelligent tools must be created that review, categorize and prioritize potential cyber impacts, and recommend options for remediation. The CSDS program performs research to identify solutions that use Artificial Intelligence/Machine Learning to optimize the data analysis, improve learning algorithms and reduce the human cyber security workload to a manageable level.

Secure and Resilient – In order to accomplish this attribute, the CSDS program is focusing on the prevention and deterrence of disruptive cyber incidents that affect various components of the aviation ecosystem. The program also 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.

In addition to the priorities, objectives and attributes, the CSDS program also addresses at least two of the Critical Research Topics identified in the Transformation Grand Challenge. These are Cyber Security and Machine Learning which are essentially the definition of the CSDS program activities.

Furthermore, this program is designed to address numerous Federal directives, specifically including the following guidance:

- OMB Memorandum M-22-15 (2022), updates its two immediate predecessors M-20-29 (2020) and M-18-12 (2018), continuing to highly prioritize AI/ML research. It includes these two Presidential priorities:
    - "Agencies should collaborate to prioritize world-leading research and innovation in critical and emerging technologies, including trustworthy artificial intelligence (AI)…."
    - "Investments should prioritize resilient and secure… communications and should defend critical infrastructure and sensitive networks against cyberattacks and supply chain attacks. This includes funding research in… security and resilience of embedded systems, anomaly detection for critical infrastructure, software security, and intrusion detection."
    - " 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:

- Develop and demonstrate Predictive Analytics capabilities through protype experimentation and analysis
- Evaluate industry specific use case scenarios in collaboration with Aircraft, Airlines and Airport partners. The initial priorities of industry include aircraft log analysis, supply chain issues, factory automation and airport operations. These will be expanded as defined by industry priorities.
- Conduct top-down Analytical Exercise (AE) of single selected industry Use Case while increasing broader industry engagement in CSDS research

- Mature Aviation Architecture Framework (AAF)

Potential Program Outputs, Value Statement and Impacts:

This program will provide novel CSDS and AI/ML technologies to increase reliability, availability, safety, and resiliency of various components of the aviation ecosystem. This will be accomplished by performing research on the primary areas of concern that are identified by industry that are currently not being addressed by commercial technologies, and by presenting the results in the form of Stakeholder guidance and recommendations. The research results can be implemented directly by industry participants or incorporated into industry standards upon request.

Since the aviation industry has unique requirements that are often not addressed by commercial applications due to economies of scale, the research provided by this program will fill a critical gap in the novel technologies and ensure aviation components of Transportation System of the Future will have the cyber technologies to meet current and future challenges.

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, as well as disrupt ecosystem operations impacting both efficiency and resiliency (availability and reliability).

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.

Potential Progress Made Toward Achieving Strategic Goals:

In accordance with the guidance received in FY21, this program is focusing on resolving industry-defined cyber security challenges for components of the aviation ecosystem. With this focus, the most critical dependency exists with the ability to engage industry stakeholders and demonstrate effectiveness in resolving the challenges they face through adoption and adaptation of evolving CSDS and AI/ML technologies. In the early stages of CSDS program execution, the FAA has been highly successful in meeting this challenge through active engagement with BOEING, United Airlines, Port Authority of New York/New Jersey, Airline Industries Association (AIA) and the Cyber Safety Commercial Aviation Team (CS CAT) and other industry partners.

Since this new program direction in FY21, preliminary research has been performed in the area of Aircraft Log Anomaly Detection and the results have been coordinated with the relevant stakeholders. This enabled industry to see the value of the technology being generated by the FAA and identify future requirements to incorporate more complex AI/ML solutions. Significant progress is also being made with other stakeholders as they become aware of the programs value, and multi-year research plans are being identified as a result. Relationships with standards bodies also have been established, and they are requesting information to align with their objectives. Successful performance of these research plans will ensure that key elements of the aviation ecosystem will have Data-Driven, Intelligent cyber solutions that provide more Secure and Resilient systems now, and in the future.

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:

- BOEING – Aircraft Manufacturer
- United Airlines – Commercial Airline
- Jet Blue - Commercial Airline
- Port Authority of New York/New Jersey – Airport and metroplex operations for five airports, including three metroplexes
- Cyber Safety Commercial Aviation Team (CS CAT) – Consortium for research evaluation and requirements
- Airline Industries Association (AIA) – Consortium for research evaluation and requirements
- Airlines Electronic Engineering Committee (AEEC) – Standards and Guidelines
- Airports Council International - North America (ACI NA) – Airport Consortium, Advocacy
- Airlines for America (A4A) – Trade Association
- General Electric Aviation – Original Equipment Manufacturer (OEM)
- Astronautics Corporation of America (ACA) - OEM
- Raytheon Technologies – OEM
- Information Sharing and Analysis Center (A-ISAC) – Consortium for research evaluation and requirements
- International Civil Aviation Organization (ICAO) – Standards and guidelines
- Radio Technical Commission for Aeronautics (RTCA) – Standards and guidelines
- International Air Transport Association (IATA) - Trade Association
- 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

Environmental and Weather Impact Mitigation

United States Department of Transportation
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Aircraft Icing
Requested: ($3,960,000)

Program Description:

The FAA establishes rules for the certification and operation of aircraft in icing conditions. The agency uses the Aircraft Icing Program 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, data in support of new regulations and guidance materials, 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 information the FAA needs 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 accretion formations within engines in ice crystal icing environments
- 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:

Engine icing research will build on knowledge of engine ice accretion and shed parameters within engines, which is needed to develop and validate the tools needed to provide policy and guidance. This should reduce the ICI risk to all aircraft. The ground ice protection research will provide information for the annual ground icing notice used by the FAA's Flight Standards organization, improve aircraft dispatch efficiency, and improve 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 impact 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 impact on the environment through the reduced use of fluids.

Collaboration Partners:

The Aircraft Icing Program attends industry working groups and committees 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: ($19,220,000)

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. Beginning in FY 2024, the Weather Program will consist of two research programs: the Aviation Weather Research Program (AWRP) and the Weather Technology in the Cockpit (WTIC) Program. Collectively, these programs support DOT's strategic goal of Safety by reducing weather impacts on aviation and by enhancing flight safety.

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, 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 principles 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 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 passenger safety. 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 aviation weather infrastructure by using non-traditional sources to gather 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 required upfront (computer processing equipment, data retrieval, specialized personnel, etc.), and the fact that airlines and other users have limited budgets to spend on weather information leads to a low return on 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
- Improve Turbulence Avoidance
- Resolve Cockpit Weather Information Gaps – Automatic Dependent Surveillance-Broadcast (ADS-B) and Hands-Free Pilot Report (PIREP) Submittals

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.

- Technical transfer package of algorithms that derives turbulence information from aircraft equipped with ADS-B resulting in increased accuracy versus PIREPs and a ten-fold increase in the number of reports, providing better situational awareness to pilots and reducing injuries to aircrews and passengers.

- 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, enhancing efficiency and the safety of aircrews and passengers.

- Final report of cockpit interface to ADS-B and hands-free minimized entry technology to downlink PIREPs from general aviation (GA) aircraft which will improve the quality and quantity of PIREPs thus enhancing safety through enhanced situational awareness of adverse weather.

The outputs of WTIC research are anticipated to increase safety in adverse weather for all part type aircraft, enhance reroute efficiency resulting in reduced 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 industry competition 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 flight 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 service disruptions. 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:

The Weather Program has and will continue to develop and enhance analysis and forecast capabilities that will benefit the American public. This includes applied research on 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 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 flight efficiencies.
- 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.

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:

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 air traffic management (ATM). Weather Program convective weather research capabilities continue to be transitioned to FAA platforms for operational use by ATM. The operational implementation of these capabilities contributes to enhancing NAS safety.

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 and its ability to transition the research products for use by industry and pilots. These successes and processes are established in the WTIC Program, and this trend is expected 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. Much of the WTIC research is positioning the program for longer-term research and greater innovation.

Collaboration Partners:

Recommendations from attendees of annual weather research workshops, 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 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

- The FAA Center of Excellence for General Aviation
- RTCA
- Airlines

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Alternative Fuels for General Aviation
Requested: ($11,201,000)

Program Description:

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 general aviation (GA) aircraft are the single largest source of airborne lead emissions and contribute approximately 70 percent of total. There is no known safe exposure level of lead, and multiple studies have documented the health impacts of lead exposure on urban and other disadvantaged communities. In October 2022, the EPA issued a proposed determination that lead emissions from certain aircraft cause or contribute to lead air pollution, which may reasonably be anticipated to endanger public health and welfare under the Clean Air Act. In addition, the European Chemicals Agency (ECHA) has also proposed restrictions on the form of lead used in aviation gasoline. Due to these regulatory actions and corresponding market forces, the availability of leaded avgas will be eliminated in the near future. Safe alternatives must be in place before leaded gasoline becomes unavailable.

Through its research, the Alternative Fuels Program supports the DOT's strategic goal of Climate and Sustainability and Exec. Ord. No. 14008, "*Tackling the Climate Crisis at Home and Abroad.*" This is accomplished through the FAA's Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative, in which the FAA partners and collaborates with the EPA, and over 50 industry groups on the research, testing, and qualification of viable, safe, high-octane unleaded replacements for current leaded aviation gasoline in order to eliminate the use of leaded aviation gasoline by 2030. The FAA will issue fleet authorizations to those fuels that meet the technical and safety requirements for the hi-octane unleaded fuels as determined under the FAA Piston Aviation Fuel Initiative (PAFI).

Also under EAGLE, the FAA is committed to mid-term reductions in emissions, through the authorization of reduced octane unleaded fuels. The current fleet of over 220,000 general aviation aircraft operates on a wide range of engine and fuel system technologies. In collaboration with industry, research will examine engine modifications and other technologies that will allow for FAA authorization of available, sustainable, lower octane unleaded fuels in the segments of the fleet where they can be safely used. This will result in earlier reductions in lead emissions and assist in leading industry towards broader fuels infrastructure readiness for the future deployment of hi-octane unleaded fuels. Last, the program also supports accelerated research and development of fuel efficient, low or no emissions aircraft technologies for general aviation, including electric, and electric hybrid propulsion. In addition to the climate benefits, the research will assist in maintaining U.S. competitiveness in the global aviation industry. This research will provide necessary data to support FAA certification for the safe integration of these clean technologies into current and future aircraft.

Major Program Objectives:

The Alternative Fuels for General Aviation Program will support the EAGLE Initiative as it leverages and builds upon a continuing collaboration with industry. 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, climate impacting, 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 test assessment of unleaded aviation gasolines
- Materials compatibility assessment of unleaded aviation gasolines
- Evaluate minimum level of engine modifications to allow operation of low-octane unleaded aviation gasolines
- Durability evaluation of hydrogen fuel cells
- Identify hydrogen leakage and accumulation as a function of fuselage interior design characteristics

Potential Program Outputs, Value Statement and Impacts:

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 will serve to support authorization and certification of safe unleaded fuels that will eliminate lead emissions, as well as new technologies will reduce fuel burn, emissions, and climate impacts 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. Finally, 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 GA 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 flight safety 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:

At the end of 2023, the program will have completed screening and pre-qualification testing on multiple, candidate unleaded fuel formulations. 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 fuel 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 conducted in accordance with requirements of the FAA certification office (AIR), 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. Fuels that have successfully passed pre-qualification testing will have entered into the full-scale engine, aircraft, and materials compatibility phases of the program 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 institutions including Centers of Excellence (COEs). Under EAGLE, the program will continue with, and expand the list of collaborating partners as work towards the program goal of lead-free general aviation fuel by 2030 continues.

The current list of partners includes over 50 corporations, industry standards bodies, government agencies, and other organizations listed below.

- 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)
- Hypoint
- Innospec
- Lycoming Engines
- Lyondell Chemical Company
- magniX
- McCauley Propeller
- Meggitt Polymers & Composites
- Mooney Aircraft
- NASA
- 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
- Teledyne
- Textron Aviation
- TOTAL
- Transport Canada
- ZeroAvia

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Environment and Energy
Requested: ($21,305,000)

Program Description:

The FAA's long-term vision is to remove environmental constraints on aviation growth by achieving quiet, clean, and efficient air transportation. The Environment and Energy Program supports this vision by advancing an understanding of civil aviation noise and emissions at the 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. 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, the environment, and climate. By providing advanced system-level modeling capabilities, the tools 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.

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. Awareness has increased about the impacts of aviation emissions on local air quality as well as the need for environmental justice. 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 in addition to 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, thus supporting the need for environmental justice in line with Executive Order 12898. Funding provided to ASCENT - the FAA Center of Excellence (COE) for Alternative Jet Fuels – will continue to expand our understanding and underpin the development of technological innovations for the current fleet of aircraft that will mitigate climate change and address local environmental concerns. Continued support of the development of advanced modeling tools like the Aviation Environmental Design Tool (AEDT) via close collaboration with the DOT Volpe Center, will ensure that environmental concerns can be assessed on the basis of the latest science and data. Lastly,

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 the 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 consider 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. Industry understanding of aviation impacts on people has been expanding with some of the latest research addressing the impacts of aircraft noise to cardiovascular health and sleep as well as reassessing the standard for describing noise exposure-annoyance relationships to reflect societal changes since the last revision 30 years ago. A National Sleep Study is underway to acquire current U.S. data on sleep disturbance with the aim to determine the relationship between nighttime noise and the probability of awakening. In parallel, research is being conducted on alternative noise mitigation measures such as broadband sounds, ear plugs, and the benefits of increased vegetation. The economic impacts of aircraft noise on businesses and on residential property values are also being investigated via an empirical assessment.

Significant work is underway on aviation emissions both on the ground and in flight. Advancements are being made on modeling aircraft emissions at the airport and the way those emissions are dispersed in the atmosphere. An airport monitoring campaign is also underway that will measure the aviation pollutants contribution within the vicinity of an airport, as well as provide the data needed to validate the new dispersion modelling tool. Additional research is ongoing to improve the ability to understand and model condensation trails formation, their effect on the energy balance of the Earth and how their formation is

affected by technology, fuels, and operations. More research is also being conducted to evaluate and assess the current state of understanding of potential high altitude and commercial space vehicle emissions on the global environment and to develop the means to estimate their impacts.

A new version of AEDT continues to be released annually, with the upcoming release providing updates to several aspects of its emissions and dispersion modeling features and the implementation of supersonic aircraft full flight performance and fuel burn modeling. AEDT also continues to be the primary tool in support of the ongoing ICAO CAEP analysis work on an integrated carbon dioxide (CO2) emissions and noise dual-stringency standard.

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 and 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. Coordination and collaboration with NASA continues to expand with ongoing collaboration on Advanced Air Mobility (AAM), research on AAM noise and annoyance, community response test planning and conduct, and possible modeling approaches using AEDT. A strong data sharing partnership is ongoing with NASA and FAA exchanging data and information resulting from their respective research activities. 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. Additionally, ACRP funds 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: ($70,774,000)

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 (SAF). 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,[2] which is supported by NextGen Environmental Research – Aircraft Technologies and Fuels, 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 deliver 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.[3]

This program also supports the Commercial Aviation Alternative Fuels Initiative (CAAFI) in its efforts to engage with commercial aviation and emerging alternative fuels industries.[4]

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

[2] For more information on the CLEEN Program, please see http://faa.gov/go/cleen
[3] For more on the ASCENT COE, please see http://ascent.aero
[4] 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 climate impacts 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
- Initiate CLEEN Phase IV
- 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 be 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 pandemic. Assessment of the benefits from the introduction of CLEEN I and II technologies is being conducted under ASCENT. Modeling estimates that CLEEN Phase I and II technologies combined will save 36.1 billion gallons of fuel by 2050 and reduce CO2 emissions by 420 million metric tons over this time period – equivalent to removing 3 million cars from the road from 2020 to 2050. The study also calculated that CLEEN I technologies will contribute to a 14% decrease in land area exposed to DNL 65 dB and greater. Results on the analysis of CLEEN II noise and CLEEN I and II NOx benefits are being finalized. Additional ASCENT research is being conducted on technical aspects pertaining to noise reduction technology modeling and development, system-level modeling and design considerations, propulsion-airframe integration, combustion, turbomachinery, supersonics, and alternative energy sources.

Progress on SAF has also continued with seven pathways and two co-processing already certified under the ASTM process and annual domestic procurements having tripled between 2021 and 2022. Six additional pathways and two more co-processing are currently at different stages of the ASTM approval process. Research efforts under this program have also resulted in significantly reduced fuel volumes required for new approvals. Additional research continues to address supply chain evaluation, collaborative research on global supply chains development, and compatibility of SAF with current technologies.

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 nine industry cost-share partners: Aurora Flight Sciences; Boeing; the team of Delta Tech Ops, America's Phenix, MDS Coating Technologies, and GKN Aerospace; General Electric (GE) Aerospace; Honeywell Aerospace; Pratt & Whitney; Rolls-Royce; Collins Aerospace; and Safran Nacelles. The CLEEN Program is also conducted in a collaborative manner with NASA through the Sustainable Flight National Partnership and also with 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. The program also coordinates across the U.S. Federal Government as well with local authorities and international organizations and nations.

Human and Aeromedical Factors

United States Department of Transportation
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Flight Deck/Maintenance/Systems Integration Human Factors
Requested: ($15,646,000)

Program Description:

The Flight Deck/Maintenance/Systems Integration Human Factors Program addresses research, engineering, and development (RE&D) requirements defined by technical sponsors in the FAA's Aviation Safety (AVS) organization. These requirements are driven by the human factors needs of the Aircraft Certification Service (AIR) and Flight Standards Service (FS) personnel who are responsible for the certification and approval of equipment and continued airworthiness of aircraft, as well as the certification of pilots and mechanics, and approval of certain flight operations. This human-centered approach will address the issues associated with regulatory aspects of design, training, operations, and maintenance, including complex systems and human-system integration, and it will provide strategic solutions to improve aviation safety. This program directly supports the DOT's strategic goal of Safety and corresponding human factors research priority.

Major Program Objectives:

The Flight Deck/Maintenance/Systems Integration Human Factors Program provides a research foundation which informs AVS personnel who develop, update, and utilize human factors-related regulations, guidance material, procedures, standards, orders, job aids, and other aviation safety documentation.

The Flight Deck/Maintenance/Systems Integration Human Factors Program supports the DOT's strategic goal of Safety by managing research that provides AVS personnel a "scientific and engineering basis for policy decisions." Research data supports integration of human factors in the "development of training [and] policy guidance" as well as "performance-based standards, policies, and regulations." The Flight Deck/Maintenance/Systems Integration Human Factors Program supports safe integration of technology and operations into the NAS. Research managed by this program will "assess safety incident trends and causes to enhance safety…", "improve the understanding of how human interactions with technology…" "to support the development and use of safer technologies and designs", "human factors challenges related to…cockpit digitization" as well as human capabilities, limitations, and other factors.

Anticipated Program Activities:

- Human Factors Design Standards for New and Advanced Flight Deck Alerting Systems – Aircraft Certification Safety, and Accountability Act (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 – ACSAA related

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/Systems 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 better integrate human factors throughout the design and certification of aircraft.

Potential Economic or Societal Impacts:

The Flight Deck/Maintenance/Systems Integration Human Factors program will provide research, engineering, and operational data that informs Aircraft Certification Service (AIR) and Flight Standards Service (FS) technical sponsors in the Aviation Safety (AVS) organization. These sponsors will clarify and expand aviation safety policy, guidance, processes, procedures, and criteria to facilitate the holistic integration of human factors throughout design, evaluation, and certification of aircraft; and innovative technologies, advanced flight deck operations, training, and procedures. This is intended to facilitate positive societal impacts which relate to safe integration of technology and operations into the NAS.

Potential Progress Made Toward Achieving Strategic Goals:

The Flight Deck/Maintenance/Systems 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 in November 2021, at a U.S. Senate hearing. The public comment period on draft AC 120-FPM concluded in March 2022. The final AC was published in November 2022 and is titled "AC 120-123 Flightpath Management". Outputs from this program are also being applied by AVS technical sponsors to support FAA contributions to an ICAO Air Navigation Commission workgroup titled "Automation Dependency" under the Personnel Training and Licensing Panel (PTLP). This program is also managing research which relates to multiple sections of HR 133-3 – 116th Congress (2021) Consolidated Appropriations Act, 2021 Division V - Aircraft Certification, Safety, and Accountability Act (ACSAA).

Collaboration Partners:

The Flight Deck/Maintenance/Systems 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, industry, and academia. These partnerships have contributed significantly to the program's success. 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)

United States Department of Transportation
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Air Traffic Control/Technical Operations Human Factors
Requested: ($6,389,000)

Program Description:

The purpose of the Air Traffic Control/Technical Operations (ATC/TO) Human Factors program is to provide scientific and technical information that the Air Traffic Organization technical sponsors will apply in their work to improve the safety and efficiency of complex ATC systems. The research will produce 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 present human factors challenges 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 the flying public today and in the decades to come. Research addresses workforce challenges that are especially acute in the large terminal radar air traffic control facilities (TRACONs) 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 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:

- Develop facility operational guidance and training for recognition and mitigation of workload effects on controller fatigue and performance
- Develop ATC maintenance task guidance and user interface standards for Technical Operations personnel performing Remote Maintenance Monitoring functions, to include use of augmented reality/virtual reality (AR/VR) capabilities
- Update the Human Factors Design Standard (FAA HF-STD-HF-001) to incorporate the latest scientific information in design requirements for automated ATC systems, information display and management, workstation arrangement and display characteristics
- Define human supervisory control interactions and performance measures for shared computer-human ATC methods using advanced artificial intelligence decision aiding approaches

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 AR/VR 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 levels 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 air traffic controller training. Specific products include:

- Human Autonomy Teaming: A Literature Review
- A Handbook for Signal Design: Alarms Alerts, and Warnings in Air Traffic Control
- A Structured Interview for Alarm Design – peer reviewed journal submission
- Completed update to FAA HF-STD-001 on requirements for displays, testing, maintenance, and training

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 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

The program has partnerships with grant recipients, COE participants, and Federally Funded Research and Development Center (FFRDC) employees. and has provided support to COE participants and FFRDC employees by providing them access to simulation or testing equipment, designing scenarios, helping them gain access to research participants, collecting data, providing output files for use, and in some cases – analyzing data.

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Aeromedical Research
Requested: ($12,205,000)

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 airline passenger health safety improvements during future disease outbreaks by developing and validating modeling and simulation tools for estimating infectious disease transmission risks in the gate-to-gate travel environment. Additionally, the program will support improvements in the pilot's safety by continuing to develop the evidence base supporting aeromedical risk analysis for use in certification decision-making, and development of biomarker-based methods for fatigue and drug use detection. Lastly, the program will support aircraft survivability improvements and aircraft design innovations 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 human performance 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. Research outputs 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 reliably 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
- Cabin Health Safety During an Epi/Pandemic Safety Standards Development for Omnidirectional Seats to Support Advanced Air Mobility
- Modeling and Simulation Guidance to Support Performance Based Rules for Aircraft Seating Systems

Potential Program Outputs, Value Statement and Impacts:

One research activity supports the DOT Safety objective of Safe Workers. Research to develop a biomarker-based metric for performance impairment due to 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 National Transportation Safety Board (NTSB). Another research activity supports the DOT Safety objective of Safe Public. Research into the risk analysis of disease transmission in the airline transport cabin will result in a modeling, simulation, and analysis tool set and associated model parameterization data to facilitate data-driven, risk-based, decision-making on disease control measures. Research outputs will be transitioned for use in inter-agency preparedness planning activities, as well as for use in airline safety management systems.

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 injury criteria and test methods development to evaluate 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 into modeling and simulation guidance to support performance-based rules for aircraft seating systems will evaluate existing model credibility standards and develop new standards focusing on individual aircraft structural design features. The research outputs will equip airworthiness certification with analytical data (i.e., modeling and simulation derived) t to determine compliance with dynamic impact test standards.

Potential Economic or Societal Impacts:

The public will benefit from better protection and survivability 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. 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. Research outcomes 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 outputs of the disease transmission risk modeling activities to inform the National Aviation Preparedness Plan, and transition tools and data for use in airline safety management systems. The Aircraft Certification Service will certify obliquely oriented seats through new injury criteria and test methods. Lastly, the Aircraft Certification Service will accept analytic data to certify aircraft seating systems.

Collaboration Partners:

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

- *Government:* Department of Transportation Secure Data Commons; National Transportation Safety Board; National Aeronautics and Space Administration; Department of Defense; Department of

Homeland Security; Centers for Disease Control and Prevention; National Institute of Occupational Safety and Health; and National Highway Traffic Safety Administration
- *Academia:* University of Pennsylvania & ASCENT Center of Excellence; and Johns Hopkins University School of Medicine
- *Industry:* Boeing; Mayo Clinic; and SAE International
- *International:* National Research Council of Canada

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Aviation Accessibility Research
($2,000,000)

Program Description:

The Aviation Accessibility Research Program was established to support the Air Carrier Access Act (14 CFR Part 382), and pursuant to requests from members of the disability community.

Major Program Objectives:

The program investigates the feasibility of enabling passengers to stay in their personal wheelchairs while travelling on commercial aircraft. Specifically, this program builds on the Access Board/Transportation Research Board (TRB) Report on the Feasibility of Wheelchair Securement Systems on Passenger Aircraft to support potential future rulemaking by the FAA. The research will evaluate occupant safety/crashworthiness aspects of installing wheelchairs on commercial aircraft.

Anticipated Program Activities:

- Report on the crashworthiness test results of selected wheelchairs when affixed using one or more of the recommended methods of affixing them to the aircraft floor
- Report on the physical/ engineering aspects of aircraft evacuation issues that may be introduced by the introduction of securing personal wheelchairs into aircraft cabins

Potential Program Outputs, Value Statement and Impacts:

Existing research projects and data will be combined to create guidance material on how to integrate wheelchairs into the passenger cabin. This guidance will aid industry by providing the necessary framework for how to approve their various designs.

Potential Economic or Societal Impacts:

The societal impact is that the FAA will demonstrate the safety case for securing personal wheelchairs into aircraft cabins.

Potential Progress Made Toward Achieving Strategic Goals:

In support of the DOT strategic goal of Safety, the FAA has begun the necessary data collection and will continue to collect additional data that will be incorporated into the development of guidance material.

Collaboration Partners:

The FAA is collaborating with the University of Wichita through a grant to conduct specific testing and data collection to achieve the goals. Additionally, the FAA is collaborating with the University of Michigan Transportation Research Institute (UMTRI) though Health and Human Services via a grant from National Institute on Disability, Independent Living, and Rehabilitation Research.

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Aviation Grant Management
Requested: ($2,001,000)

Program Description:

The Aviation Grant Management Program supports grant lifecycle administration and management including pre-award, post-award, closeout, records management, program management, and information technology.

Major Program Objectives:

The program will aid in building and sustaining an infrastructure that encompasses the entire lifecycle of grant management. Program priorities support the FAA's strategic goals by ensuring a comprehensive approach to award grants to the next generation of aviation professionals, while supporting aviation-related research.

The Program enables collaboration and coordination between government, academia, and industry to advance aviation technologies, expand FAA research capabilities, support professional development of aircraft pilots, and increase interest in aviation maintenance careers.

The Aviation Grant Management Program will provide support to administer grants for eligible projects that educate, develop, and recruit aviation professionals, as directed by Congress in Section 625 of the FAA Reauthorization Act of 2018. The Aviation Grant Management Program will assist with conducting research that focuses on a broad range of aviation technologies. Funding will be used for program management support to include a grants management system and associated resources.

Anticipated Program Activities:

- Create and deliver curriculum designed to provide high school students with meaningful aviation education that is designed to prepare them to become aircraft pilots, aerospace engineers, or unmanned aircraft systems operators
- Support teacher professional development to address the projected shortages of aircraft pilots by using the aviation curriculum
- Establish new educational programs that teach technical aviation maintenance skills, including purchasing equipment to improve existing programs
- Establish scholarships or apprenticeships for individuals pursuing employment in the aviation maintenance industry
- Support aviation maintenance industry career outreach to primary, secondary, and post-secondary school students; or to underrepresented communities in the industry
- Support educational opportunities related to aviation maintenance careers in economically disadvantaged geographic areas
- Support transition to careers in aviation maintenance, including for members of the Armed Forces

Potential Program Outputs, Value Statement and Impacts:

The Aviation Grant Management Program will support projects creating pathways into the aviation workforce in order to maintain a safe and efficient national airspace system (NAS). The Program benefits the flying public by increasing the number of grant awards to create a pipeline of aviation professionals and by conducting research to enhance the NAS and to support the next generation of aviation technologies. The Program is necessary to meet the congressional mandate of the FAA Reauthorization Act of 2018.

Potential Economic or Societal Impacts:

The Aviation Grant Management Program will benefit the next generation of aircraft pilots and maintenance technicians by cultivating a workforce pipeline. 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 federal transportation objectives.

Potential Progress Made Toward Achieving Strategic Goals:

In the past two years, over 50, awards have been issued to grant recipients with a 12-month period of performance. The program is in the early stages of assessing performance.

Collaboration Partners:

Not Applicable

Aerospace Performance and Planning

United States Department of Transportation
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System Safety Management/ Terminal Area Safety
Requested: ($9,349,000)

Program Description:

The System Safety Management/Terminal Area Safety 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 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 performs 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 affect 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 Collision Risk Modeling, 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

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 are 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, data driven safety risk management, to accelerate the use of new technologies for aerospace vehicles and improve human performance.

Potential Economic or Societal Impacts:

The National Airspace System (NAS) 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 NAS needs to expand to meet the needs of today's customer and the flying public. Therefore, research conducted to enhance pilot training, use enhanced vision systems, engage in the use of data science tools for more effective oversight and modeling of the NAS can potentially reduce delays, accidents and bring efficiency to the NAS 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. Higher fidelity simulators and virtual reality will be leveraged to support enhanced pilot training and certification.

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

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Commercial Space Transportation Safety
Requested: ($6,157,000)

Program Description:

The Commercial Space Transportation (CST) Safety Program 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 United States, 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 safety improvement 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. This research benefits all actors within different CST industry segments.

By focusing research on issues directly related to AST's standards, regulations, and ways the industry can comply with the regulations, AST can better focus on the right kinds of regulations at the right time. This ensures public safety and allows for innovation within the industry. Additionally, these efforts help ensure that the FAA continues to lead the world on commercial space standards and keeps the U.S. space industry at the forefront of this exciting field.

Anticipated Program Activities:

- Explosive Yield Research Project
- Human Spaceflight Participant Research
- Functioning Research Alliance
- Orbital Debris Mitigation.

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., those 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 an increase in the number of launch operators, and increasing numbers of standards for human spaceflight. In general, CST research enables better standards and regulations that protect the public while ensuring continued innovation in the industry. This work increases the CST contribution to economic growth while the number of safe operations continues to grow.

Collaboration Partners:

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

Specific program partners include:

- Contractors (ARCTOS)
- FFRDCs (Aerospace Corp., MITRE/CAASD)
- Trade Organizations (ASTM, COMSTAC, CSF)

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NextGen – Wake Turbulence
Requested: ($4,680,000)

Program Description:

The NextGen - Wake Turbulence Research 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 program is wake mitigation separation. NextGen - Wake Turbulence research analyzes and collects the data to establish the wake mitigation separations that will be applied by ATC to a 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 NAS service. 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

Potential Program Outputs, Value Statement and Impacts:

Wake Turbulence research, engineering, and development (RE&D) 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. This program will provide future reduced flight delays for passengers and air cargo flights when ATC is using instrument flight rule wake risk mitigation procedures, as well as decreased time in the air for passengers due to more ATC flight capacity efficient, en route wake risk mitigation using enhanced wake risk mitigation procedures.

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 mitigation 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: ($21,128,000)

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 on 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 reap potential societal UAS 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 Congressional mandates.

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 updates.

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 Risk of Collision between Unmanned Air Mobility (UAM) vehicles and Unmanned Aircraft
- Develop Bird Strike Avoidance Requirements for UAS and Remotely Piloted Passenger Transport Develop small Unmanned Aircraft Detect and Avoid Human Factors Requirements

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)
- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- 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

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Advanced Technology Development & Prototyping
Requested: ($34,000,000)

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 and the NAS, with integration of resource management support.

Major Program Objectives:

Individual projects under the ATDP program develop and maintain mathematical and 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.

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 airline operations performance and provides the objective data to support the need for improved traffic flow and efficiency measures within the NAS. Projects under the ATDP 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 the program will allow for continued assessment of NAS innovation performance and ensure that those technologies achieve the transformations as planned.

Additionally, ATDP includes integrated services and analysis functions to provide a wide array of support services for more than 55 implementation programs and over 20 pre-implementation programs. This is accomplished through four key mission areas: Integrated Resource Management; Program Acquisition Support; Program Health Management; and Planning, Analysis, and Integration. All program management office (PMO) programs such as Safety, Information Security, Human Factors, Integrated Logistics Support, Requirements Management, Configuration Management, and Risk/Issues/Opportunity Management use technical services provided by ATDP.

Anticipated Program Activities:

- Complete annual technical and operational test and evaluation report of an advanced ground surveillance sensor to drive the activation of direct to pilot annunciator. Runway safety assessment studies such as runway incursion prevention shortfall analysis to identify candidate small-to-medium sized airports with historically high rates of runway incursions. Develop concept of operations for preventing wrong surface operations using prototype taxi conformance monitoring technologies

- Produce joint performance benchmarking reports with Asia-Pacific partners, including the Civil Aviation Authority of Singapore (CAAS)
- Using performance-based measurement systems and operations research capabilities, quantify the efficiency of the NAS to form the basis of recommendations for system improvements
- Develop methods for correlating airline schedules, weather events, and FAA actions with outcomes such as flight delay, cancellations, diversions, or extended routing, with dashboard-style reporting tools for these relationships provided to both FAA management and commercial airlines
- 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 assessments 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
- Provide support to Radio Technical Commission for Aeronautics (RTCA)
- Continue implementation of airspace redesign efforts that frequently result in changes in the number and shape of operational positions, sectors, or facility boundaries
- Provide a variety of technical services used by all PMO programs such as Safety, Information Security, Human Factors, Integrated Logistics Support, Requirements Management, Configuration Management, and Risk/Issues/Opportunity Management
- Develop major airspace design changes supporting the new Airspace Modernization Roadmap initiative

Potential Program Outputs, Outcomes and Impacts:

ATDP 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 will 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, with proposals developed to address those gaps. NAS data outputs will support international performance benchmarking. The FAA, in coordination with other air navigation service providers, has 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. Additionally, the integrated services and analysis will leverage technical safety, information security, human factors, integrated logistics support, and management services.

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. The System Capacity, Planning, and Improvements Program provides a collaborative means for experts from the FAA, academia, and industry to develop recommendations for improving system capacity and efficiency and for ways to reduce delays at specific airports. System improvement recommendations lead to efficiency of the NAS. Methods for correlating airline schedules, weather events, and FAA actions with outcomes such as flight delay, cancellations, diversions, or extended routing are developed with dashboard-style reporting tools for both FAA management and commercial airlines created to harmonize performance metrics.

Potential Progress Made Toward Achieving Strategic Goals:

ATDP is continually assessing emerging technologies for possible inclusion in the NAS in order to provide further enhancements that result in 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 manufacturer, 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 to improve traffic flow initiatives in the Asian Pacific region, as well as to assess performance and develop business cases for International Civil Aviation Organization in the North Atlantic.

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NextGen - Separation Management Portfolio
Requested: ($14,400,000)

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 identify improvements to runway access through use of improved aircraft technology, and update 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.

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
- 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

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 aircraft throughput 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. INDP Program work is 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 mitigation using enhanced wake risk mitigation procedures.

Potential Progress Made Toward Achieving Strategic Goals:

NextGen capabilities continue to bring positive effects to the aviation industry and the flying public 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.

- The 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: An 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.

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NextGen – Traffic Flow Management Portfolio
Requested: ($10,000,000)

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 –TFM Portfolio is to improve 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. TFM provides greater flexibility to flight planners and makes the best use of available airspace and airport capacity.

Anticipated Program Activities:

- Engineering analysis of mobile applications for integration with future NAS infrastructure
- Exploring emerging technology for applications or services for surface movements and standardized information exchange into FAA flow systems for strategic planning
- Complete and deliver prototype capability for an Artificial Intelligence Traffic Flow Management application, and provide a recommendations report
- Research and development of a prototype service and procedures for in-flight coordination and strategic reroute between pilots
- Modeling and simulation for mobile information exchange with future FAA services
- Improvement of departure demand predictions through collection of strategic departure intent information and machine learning methods
- Non-TFDM CFR Time Coordination Field Evaluation
- Initial model development for additional TFM capabilities
- Identify which capabilities can be used to predict demand and develop solutions (including those for machine learning) incorporating earlier findings

Potential Program Outputs, Outcomes and Impacts:

The Surface Tactical Flow program under this portfolio will 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. In addition, the program will conduct field prototyping and evaluation of terminal data

exchange capabilities, and utilize mobile technologies through demonstration wrap-up, industry engagements, and technology transfer.

Strategic Flow Management application will include engineering activities for TFM Capability Modeling to include platform development and proof of concept activities. As future TFM concepts are identified, the FAA will need a modeling platform in order to thoroughly evaluate them and continue development.

The Advanced Methods program will include developing a protype capability for the advanced automation learning/data mining capability that utilizes historical and real-time data, as well as the 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 air 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 NAS 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 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. Additional partners include:

- 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.
- FAA Lines of Business (including program management offices and NATCA): 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.
- 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.

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

Program Description:

The NextGen 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 conditions changes 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 NextGen – ODNI 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 micro services, 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:

- Research and development of a prototype service and procedures for in-flight coordination and strategic reroute between pilots
- Develop concept of operations for a resilient infrastructure in support of the Info-Centric NAS Vision.
- Conduct engineering analysis on information architecture to support information exchange to meet performance, security requirements
- Complete flight deck clearance application development and testing
- Develop flight deck aircraft parameter exchange application concept and engineering artifacts

- 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
- Initiate planning for laboratory evaluation for resilient network technologies

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 a resilient and adaptable micro services 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 IoT 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. Additional partners include:

- 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.
- 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: ($12,000,000)

Program Description:

The NextGen 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 NAS operations. The main goal of the NextGen – NAS Infrastructure Portfolio is to support the NextGen goals of improved capacity, efficiency, and safety.

Anticipated Program Activities:

- Exploration of 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
- Research and development of a prototype service and procedures for in-flight coordination and strategic reroute between pilots
- 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 performance requirements for Ubiquitous Communications framework
- Identify and replace obsolete weather products with more efficient weather information already available from the meteorological community to ensure capability with existing FAA systems.
- 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

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: Capabilities 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.

Additional partners include:

- 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 NAS research 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

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:

Not Applicable

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 of 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:

- 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 (CONOPs)
- Develop an update to the NAS Vision 2035 2.0 CONOPs

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:

To be determined.

Collaboration Partners:

This program utilizes input from FAA stakeholders, airspace users, and industry. This program works collaboratively with all 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. Partners include:

- 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: ($12,000,000)

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:

- Complete UAS Traffic Management (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

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 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.

Efforts 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:

The UAS Portfolio has made the following progress towards achieving Strategic Goals:

- The Urban Air Mobility (UAM) ConOps V2.0 was published in April 2023.
- The UAM project released a Technical Paper on Cooperative Volumes in April 2023.
- The Unmanned Traffic Management (UTM) Project conducted the UTM field test showcase events at the New York UAS Test Site and Virginia Tech Mid-Atlantic Aviation Partnership Test Site in April 2023.
- The Crosscutting Operations Strategy and Technical Assessment Project completed their live flight data collection in May 2023, and their xTM Reference Architecture in July 2023.

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. Additional partners include:

- FAA Lines of Business and 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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System Planning and Resource Management
Requested: ($5,097,000)

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 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 manages the portfolio planning, formulation, presentation, and review activities to ensure the FAA meets the President's criteria for R&D, increases program efficiency, 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 SPRM program manages the RE&D portfolio and submits the mandatory R&D planning documents to Congress each year. Through the REDAC's findings, 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 enhancing U.S. global leadership in aviation.

Anticipated Program Activities:

- Develop annual statutory deliverables for Congress
- Develop Departmental (OST) R&D program planning and performance reporting requirements
- Develop and submit of the FAA's R&D investment portfolio

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.

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William J. Hughes Technical Center Laboratory Facilities
Requested: ($5,447,000)

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). These associated 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. This program is aligned to the DOT strategic goal of Organizational Excellence.

The laboratory network operating center provides an environment to maintain, monitor status and cyber events, and operate the NPN and customer networks. The Laboratory Facilities Program 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

Potential Program Outputs, Value Statement and Impacts:

Research and Development laboratories will facilitate safety enhancements and minimize operational costs. Early R&D activities help enhance National Airspace System safety 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
- *Federally Funded Research and Development Centers (FFRDCs):* MITRE, MIT Lincoln
- *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
FY 2024 Annual Modal Research Plans

William J. Hughes Technical Center Laboratory Sustainment
Requested: ($16,900,000)

Program Description:

This program sustains the William J. Hughes Technical Center (WJHTC) laboratories. This centralized set of laboratories supports the Acquisition Management System (AMS) lifecycle from concepts and requirements 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. Capabilities developed in these laboratories reduce the 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. This program is aligned to the DOT strategic goal Transformation.

Anticipated Program Activities:

- Support Laboratory Space & Infrastructure Improvements
- Support Laboratory Equipment Technology Refresh
- Support NAS Modernization for Equipment

Potential Program Outputs, Outcomes 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, aligned to DOT's strategic goal of Transformation.

Collaboration Partners:

Not Applicable

William J. Hughes Technical Center Infrastructure Sustainment
Requested: ($10,000,000)

Program Description:

Infrastructure sustainment at the William J. Hughes Technical Center (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 WJHTC facilities, site utilities, and infrastructure. WJHTC 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. This program is aligned to the DOT strategic goal of Transformation.

Anticipated Program Activities:

Support WJHTC Facility Infrastructure

Potential Program Outputs, Outcomes 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 2025 Program Descriptions

The AMRP FY 2025 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 2025 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.

Anticipated Program Activities:

- The ACRP Oversight Committee will meet in summer of 2023 to determine FY2025 research funding, projects, and priorities

FY 2025 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 several 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 example, 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 emerging recycled/carbon neutral pavement materials at airports, tools to quantify environmental impact of airport pavement projects, and 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. ATR program research results and objectives are ultimately reflected in these AC's, which form the technical guidance used by airports across the nation.

On the infrastructure side, key FY 2024 objectives include the search for, testing, and applicability of various recycled and more low-embodied carbon (environmentally-friendly) pavement materials that may be integrated into the design and construction of airport pavements and extend the life of the airport pavements so that the use of new raw material will be reduced and airport pavement infrastructure 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 2024 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.

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 or longer lasting
- Research performance studies to determine pavement surface treatment application and locations at the airfield
- Initiate semi accelerated concrete pavement testing to validate extended pavement life models
- Develop pavement material characterization for advanced pavement life prediction modeling

- Integration of FAA Pavement software to create one unified suite of software tools for pavement design and pavement management

Aircraft Safety Assurance

FY 2025 Program Descriptions
Fire Research and Safety

Program Description:

The Fire Research and Safety Program conducts 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, who 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. This standard was requested by the International Civil Aviation Organization (ICAO) 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 have 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:

- Research Aircraft and Occupant Survivability
- Perform Cargo Safety Research
- Research Propulsion, Fuels, and the Environment

FY 2025 Program Descriptions
Advanced Materials/Structural Safety

Program Description:

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 non-metal 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 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.

Major Program Objectives:

The Advanced Materials and Structural Safety 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 is to support development of standardized certification protocols and safe manufacturing and maintenance practices for advanced materials and structural applications. 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 compared to that achieved with current operational aircraft. In this context, the program focuses on potential issues with material and structural performance, manufacturing quality control and assurance, and operational support/maintenance needs. Research results are used by FAA personnel, in combination with certification experiences and industry interface, to develop policy, guidance, and training, and inform continued operational safety evaluations. As materials and structures are a common technology across all product types and new applications, this program supports DOT safety research priorities and objectives to advance transportation safety by evaluating the safety of existing transportation technologies and supporting the safety integration of emerging technologies. Specifically, major program objectives include:

- Development of guidelines for characterizing and controlling new material forms and assessing manufacturing maturity. As new materials are introduced, the FAA, and aviation industry needs to characterize and control these materials in a way that produces a consistently sound structure to protect public from safety risks.
- 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.
- Evaluation and characterization of dynamic or crashworthiness behavior of advanced structures to drive certification standards and guidelines. An aspect of this research is investigating new applications, such as electric vertical takeoff and landing (eVTOL) aircraft as they will have different design and impact requirements.

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.

Anticipated Program Activities:

- Evaluate Long-Term Aging Behavior of Advanced Materials and Associated Maintenance Practices
- Evaluate Fatigue and Damage Tolerance Behavior of Bonded Composite Structure and Associated Maintenance Practices
- Develop Guidelines to Characterize New Material Forms and Assess Manufacturing Maturity

FY 2025 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, the safety of electrical wiring interconnect systems and mechanical systems, and the safety of large rechargeable electrical energy storage 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:

- Next Level NAS Oversight
- Identify, Detect, and Mitigate Loss of Control Inflight (LOC-I) for Rotorcraft/Vertical Flight Platforms
- Evaluate the Certification and Continued Airworthiness Issues Associated With Emerging Technologies

- Large Energy Electrical System Research and Testing
- Develop a Method of Compliance to Support Certification of Advanced Flight Controls in General Aviation and Hybrid Vehicles
- Development of Control Surface and Stabilizer Freeplay
- Effect of Turbulence on Aircraft Structural Loading
- Reliability of Structural Health Monitoring (SHM)
- MMPDS Support and Design Values for Emerging Materials
- Thermal Residual Loads in Metal-Composite Hybrid Structures
- Airframe Structure Model and Simulation Validation
- NASGRO Enhancement, Standardization, and Material Database Generation for Damage Tolerance Analysis

FY 2025 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 provides 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 Aerospace Industries Association (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. A series of FAA advisory circulars and a publicly available probabilistic software code will be developed to ensure that the industry is able to comply with the new safety rule.

The research objective 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 (NDE) 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 2025 Program Descriptions
Digital System Safety

Program Description:

Airborne system 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 of the Digital System Safety Program 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 program 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 pursues performance-based rather than prescriptive regulations.

Major Program Objectives:

The research conducted within the Digital System Safety 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 requirements 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 Digital Systems Safety research will develop policy, guidance, and training for new technologies and techniques to promote their safe use in aircraft systems; and processes and training material used to streamline the certification of complex digital systems. The program also seeks to understand, address, and provide an annual measurement indicator of Safety Data Sheets (SDS)-related ongoing operational safety issues.

Anticipated Program Activities:

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

FY 2025 Program Descriptions
Information/Cyber Security

Program Description:

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.

- Core research will be performed to enable breakthrough discoveries and new knowledge in the area of Predictive Analytics (PA) and other novel applications. The applied research topics that have the most value to the aviation community are identified through the collaboration with industry stakeholders, which currently support the aircraft, airlines and airports components of the ecosystem. The FAA is in varying stages of transferring CSDS knowledge to industry in an expanding list of Industry Key Interest Areas (IKIA). Research is expected to continue in these, and other high-value areas for multiple years beyond FY25.

Major Program Objectives:

The purpose of this program is to accelerate aviation industry timely adoption and adaptation of novel CSDS and AI/ML technologies for enhancement of cybersecurity for the airline, airport and aircraft elements of the national aviation ecosystem to increase safety and resiliency (availability and reliability). Since improved cyber security will benefit all seven Transformation Objectives of the three major priorities identified in the U.S. Department of Transportation Strategic Plan, this program is paramount in building a better transportation future within the aviation ecosystem.

Within the major priority of Integrated System-of-Systems, several key “attributes” of the Transportation System of the Future are identified. The CSDS program will deliver results for at least the following attributes:

Data Driven – The Cyber Security Data Science program focuses on providing data driven solutions for improved cyber security practices. Solutions are explored that typically analyze an extreme amount of data, and one of the first successes of the program is to provide an Aircraft Log Anomaly Detection (ALAD) solution that evaluates millions of lines of aircraft data daily.

Intelligent – Processing and analyzing the huge amounts of data that are created in the aviation eco system places an unfathomable burden on human analysts and data scientists. By necessity, more intelligent tools must be created that review, categorize and prioritize potential cyber impacts, and recommend options for remediation. The CSDS program performs research to identify solutions that use Artificial Intelligence/Machine Learning to optimize the data analysis, improve learning algorithms and reduce the human cyber security workload to a manageable level.

Secure and Resilient – In order to accomplish this attribute, the CSDS program is focusing on the prevention and deterrence of disruptive cyber incidents that affect various components of the aviation ecosystem. The program also 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.

In addition to the priorities, objectives and attributes, the CSDS program also addresses at least two of the Critical Research Topics identified in the Transformation Grand Challenge. These are Cyber Security and Machine Learning which are essentially the definition of the CSDS program activities.

Furthermore, this program is designed to address numerous Federal directives, specifically including the following guidance:

- OMB Memorandum M-22-15 (2022), updates its two immediate predecessors M-20-29 (2020) and M-18-12 (2018), continuing to highly prioritize AI/ML research. It includes these two Presidential priorities:
    - "Agencies should collaborate to prioritize world-leading research and innovation in critical and emerging technologies, including: trustworthy artificial intelligence (AI)…." "Investments should prioritize resilient and secure… communications and should defend critical infrastructure and sensitive networks against cyberattacks and supply chain attacks. This includes funding research in… security and resilience of embedded systems, anomaly detection for critical infrastructure, software security, and intrusion detection.
    - "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
- Finalize Aviation Architecture Framework (AAF)
- Continue Evaluation of Industry Specific Use Cases in The Area of: Aircraft Log Analysis, Supply Chain Induced Threats, Airport Automation,
- Evaluate Industry -Specific Use Case Scenarios in Collaboration with Aircraft, Airlines, and Airport Partners: Expanding list of Industry Key Interest Areas (IKIA)
- Execute three independent BAA research efforts to support industry top-down analysis

Environmental and Weather Impact Mitigation

FY 2025 Program Descriptions
Aircraft Icing

Program Description:

The FAA establishes rules for the certification and operation of aircraft in icing conditions. The agency uses the Aircraft Icing Program 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, data in support of new regulations and guidance materials, 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 information the FAA needs 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:

- Anti-icing / Deicing Fluid Protection Time for Mixed Phase Ground Icing Conditions
- Ice Protection of Aircraft Vertical Stabilizer Prior to Takeoff
- Scaling Effects On Ice Accretion Formations Within Engines In Ice Crystal Icing (ICI) Environments
- Urban Air Mobility (UAM) Icing research
- Terminal Area Icing Diagnostic Forecast

FY 2025 Program Descriptions
Weather Program

Program Description:

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., and performs Human in the Loop studies to ensure these enhancements are properly integrated into cockpits to support pilot adverse weather avoidance decision making. 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 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 passenger safety. The WTIC Program is developing

weather training using augmented, virtual, and mixed reality that can be presented on personal computers with minimal additional technology.

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 required upfront (computer processing equipment, data retrieval, specialized personnel, etc.), and the fact that airlines and other users have limited budgets to spend on weather information leads to a low return on 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 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 Forecasts for Aviation
- Inflight Icing Diagnosis and Forecasts to align with Aircraft Certification Criteria
- Develop Probabilistic Forecasts for Turbulence Severity in support of ICAO World Area Forecast System (WAFS) requirements
- Resolving Cockpit Weather Information Gaps - Automatic Dependent Surveillance-Broadcast (ADS-B) and Hands-Free Pilot Report (PIREP) Submittals

FY 2025 Program Descriptions
Alternative Fuels for General Aviation

Program Description:

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 general aviation (GA) aircraft are the single largest source of airborne lead emissions and contribute approximately 70 percent of total. There is no known safe exposure level of lead, and multiple studies have documented the health impacts of lead exposure on urban and other disadvantaged communities. In October 2022, the EPA issued a proposed determination that lead emissions from certain aircraft cause or contribute to lead air pollution, which may reasonably be anticipated to endanger public health and welfare under the Clean Air Act. In addition, the European Chemicals Agency (ECHA) has also proposed restrictions on the form of lead used in aviation gasoline. Due to these regulatory actions and corresponding market forces, the availability of leaded avgas will be eliminated in the near future. Safe alternatives must be in place before leaded gasoline becomes unavailable.

Through its research, the Alternative Fuels Program supports the DOT's strategic goal of Climate and Sustainability and Exec. Ord. No. 14008, "*Tackling the Climate Crisis at Home and Abroad.*" This is accomplished through the FAA's Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative, in which the FAA partners and collaborates with the EPA, and over 50 industry groups on the research, testing, and qualification of viable, safe, high-octane unleaded replacements for current leaded aviation gasoline in order to eliminate the use of leaded aviation gasoline by 2030. The FAA will issue fleet authorizations to those fuels that meet the technical and safety requirements for the hi-octane unleaded fuels as determined under the FAA Piston Aviation Fuel Initiative (PAFI).

Also under EAGLE, the FAA is committed to mid-term reductions in emissions, through the authorization of reduced octane unleaded fuels. The current fleet of over 220,000 general aviation aircraft operates on a wide range of engine and fuel system technologies. In collaboration with industry, research will examine engine modifications and other technologies that will allow for FAA authorization of available, sustainable, lower octane unleaded fuels in the segments of the fleet where they can be safely used. This will result in earlier reductions in lead emissions and assist in leading industry towards broader fuels infrastructure readiness for the future deployment of hi-octane unleaded fuels. Last, the program also supports accelerated research and development of fuel efficient, low or no emissions aircraft technologies for general aviation, including electric, and electric hybrid propulsion. In addition to the climate benefits, the research will assist in maintaining U.S. competitiveness in the global aviation industry. This research will provide necessary data to support FAA certification for the safe integration of these clean technologies into current and future aircraft.

Major Program Objectives:

The Alternative Fuels for General Aviation Program will support the EAGLE Initiative as it leverages and builds upon a continuing collaboration with industry. 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, climate impacting, 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 Formulas in Fleet Representative Aircraft Models
- Research and Test Emission-Reducing Technologies, and Sustainable Fuels and Components for General Aviation
- Research actual performance effects and physical damage impacts of engine knock
- Evaluate Key Certification Considerations for Electric Propulsion Systems, Including Development of Energy Reserve Requirements, Environmental Effects, Electromagnetic Compatibility, and Other Requirements

FY 2025 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. The Environment and Energy Program supports this vision by advancing an understanding of civil aviation noise and emissions at the 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. 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, the environment, and climate. By providing advanced system-level modeling capabilities, the tools 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.

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. Awareness has increased about the impacts of aviation emissions on local air quality as well as the need for environmental justice. 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 in addition to 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, thus supporting the need for environmental justice in line with Executive Order 12898. Funding provided to ASCENT - the FAA Center of Excellence (COE) for Alternative Jet Fuels – will continue to expand our understanding and underpin the development of technological innovations for the current fleet of aircraft that will mitigate climate change and address local environmental concerns. Continued support of the development of advanced modeling tools like the Aviation Environmental Design Tool (AEDT) via close collaboration with the DOT Volpe Center, will ensure that environmental concerns can be assessed on the basis of the latest science and data. Lastly, 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:

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

FY 2025 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 (SAF). 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,[5] which is supported by NextGen Environmental Research – Aircraft Technologies and Fuels, 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 deliver 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.[6]

This program also supports the Commercial Aviation Alternative Fuels Initiative (CAAFI) in its efforts to engage with commercial aviation and emerging alternative fuels industries.[7]

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.

[5] For more information on the CLEEN Program, please see http://faa.gov/go/cleen
[6] For more on the ASCENT COE, please see http://ascent.aero
[7] 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'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 climate impacts 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 Program
- ASCENT Technology Innovation
- Ensure Novel Jet Fuels are Safe for Use
- Move Beyond the 50% SAF Blend Wall and 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 2025 Program Descriptions
Flight Deck/Maintenance/System Integration Human Factors

Program Description:

The Flight Deck/Maintenance/Systems Integration Human Factors Program addresses research, engineering, and development (RE&D) requirements defined by technical sponsors in the FAA's Aviation Safety (AVS) organization. These requirements are driven by the human factors needs of the Aircraft Certification Service (AIR) and Flight Standards Service (FS) personnel who are responsible for the certification and approval of equipment and continued airworthiness of aircraft, as well as the certification of pilots and mechanics, and approval of certain flight operations. This human-centered approach will address the issues associated with regulatory aspects of design, training, operations, and maintenance, including complex systems and human-system integration, and it will provide strategic solutions to improve aviation safety. This program directly supports the DOT's strategic goal of Safety and corresponding human factors research priority.

Major Program Objectives:

The Flight Deck/Maintenance/Systems Integration Human Factors Program provides a research foundation which informs AVS personnel who develop, update, and utilize human factors-related regulations, guidance material, procedures, standards, orders, job aids, and other aviation safety documentation.

The Flight Deck/Maintenance/Systems Integration Human Factors Program supports the DOT's strategic goal of Safety by managing research that provides AVS personnel a "scientific and engineering basis for policy decisions." Research data supports integration of human factors in the "development of training [and] policy guidance" as well as "performance-based standards, policies, and regulations." The Flight Deck/Maintenance/Systems Integration Human Factors Program supports safe integration of technology and operations into the NAS. Research managed by this program will "assess safety incident trends and causes to enhance safety…", "improve the understanding of how human interactions with technology…" "to support the development and use of safer technologies and designs", "human factors challenges related to…cockpit digitization" as well as human capabilities, limitations, and other factors.

Anticipated Program Activities:

- Next Level NAS Oversight
- Human Factors Design Standards for New and Advanced Flight Deck Alerting Systems – Aircraft Certification Safety and Accountability Act (ACSAA)- Related
- Advances and Innovation in Equipment, Technology, Systems, and Operations – ACSAA- Related
- Research human factors data to address policy guidance and evaluation of aviation maintenance training (ACSAA-Related)

FY 2025 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 Air Traffic Organization technical sponsors will apply in work to improve the safety and efficiency of complex ATC systems. The research produces information supporting the ATO's needs by measuring and enhancing the performance of individual controllers and specialists, improving the integration of 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. Specific subject matter identified in 49 USC 445 underpins the human factors R&D program, while ATO human factors research needs are also driven by DOT priorities, evolution of the workforce, and advancing technologies and associated procedures that are expected to be implemented in the National Airspace System (NAS) over the next several years. Research addresses workforce challenges that are especially acute in the large terminal radar air traffic control facilities (TRACONs) 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, while avoiding the need for costly and time-consuming rework. 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.

ATO human factors challenges currently center on evolution of the workforce and the advancing technologies and associated procedures that will be implemented in the NAS over the next several years. The FAA is challenged to hire, place, and train several thousand new air traffic controllers in the coming years,

while continuing to provide safe and efficient air traffic services to the users of the NAS. Considerable hiring and training of several hundred technical operations specialists, essential for maintaining and certifying systems and services for use in the air traffic control system, are additional challenges. This program will help our ATO customers improve the efficiency with which they can hire and train new aviation professionals.

In support of system acquisitions that are managed within the ATO Program Management Office (PMO), this program will focus on integration of human factors considerations to enhance user-system design. Human performance research will contribute to enhancing the overall system's 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 assures that the proper roles and responsibilities are assigned to the ATO workforce to assure that controller and technician capabilities are compatible with the advanced technology they use in their jobs, and that the resulting level of air traffic system performance meets operational requirements and fulfills the safety and efficiency objectives. This program continues to provide human factors subject matter expertise to the Joint Resources Council and will coordinate with the PMO human factors office for reviewing how acquisitions have complied with human factors design requirements.

Anticipated Program Activities:

- Research Stress and Performance
- Research Controller Job Performance Standards
- Research Expanded Use of Alternative Training Delivery Systems
- Perform Human Factors Research To Support Adoption and Implementation of Virtual and Augmented Reality Applications
- Research Continued Exploration of Automation Impacts on Controller Performance and Development of Mitigations
- Research Display Input Display End Coordination Alternatives for the Tracon Environment

FY 2025 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 airline passenger health safety improvements during future disease outbreaks by developing and validating modeling and simulation tools for estimating infectious disease transmission risks in the gate-to-gate travel environment. Additionally, the program will support improvements in pilot safety by continuing to develop the evidence base supporting aeromedical risk analysis for use in certification decision-making, and development of biomarker-based methods for fatigue and drug use detection. Lastly, the program will support aircraft survivability improvements and aircraft design innovations by enhancing passenger safety during adverse events and streamlining the certification process for safety equipment and cabin designs.

Anticipated Program Activities:

- Fatigue Biomarker Panel: Identify a Metric for Performance Impairment Due To Sleep Loss
- Cabin Health Safety During an Epi/ Pandemic
- Develop Omnidirectional Seat Safety Standards to Support Advanced Air Mobility
- Modeling and Simulation Guidance to Support Performance Based Rules for Aircraft Seating Systems

FY 2025 Annual Modal Research Plans
Aviation Accessibility Research

Program Description:

The Aviation Accessibility Research Program was established to support the Air Carrier Access Act (14 CFR Part 382), and pursuant to requests from members of the disability community.

Program Objectives:

The program investigates the feasibility of enabling passengers to stay in their personal wheelchairs while travelling on commercial aircraft. Specifically, this program builds on the Access Board/Transportation Research Board (TRB) Report on the Feasibility of Wheelchair Securement Systems on Passenger Aircraft to support potential future rulemaking by the FAA. The research will evaluate occupant safety/crashworthiness aspects of installing wheelchairs on commercial aircraft.

Expected Program Outcomes:

- Report of the results of testing the crashworthiness of selected wheelchairs when affixed using one or more of the recommended methods of affixing them to the aircraft floor
- Report on the physical/ engineering aspects of aircraft evacuation issues that may be introduced by the introduction of securing personal wheelchairs into aircraft cabins
- Report on the physical/ engineering aspects of aircraft evacuation issues that may be introduced by the introduction of securing personal wheelchairs into aircraft cabins

FY 2025 Annual Modal Research Plans
Aviation Grant Management

Program Description:

The Aviation Grant Management Program supports grant lifecycle administration and management including pre-award, post-award, closeout, records management, program management, and information technology.

Major Program Objectives:

The program will aid in building and sustaining an infrastructure that encompasses the entire lifecycle of grant management. Program priorities support the FAA's strategic goals by ensuring a comprehensive approach to award grants to the next generation of aviation professionals, while supporting aviation-related research.

The Program enables collaboration and coordination between government, academia, and industry to advance aviation technologies, expand FAA research capabilities, support professional development of aircraft pilots, and increase interest in aviation maintenance careers.

The Aviation Grant Management Program will provide support to administer grants for eligible projects that educate, develop, and recruit aviation professionals, as directed by Congress in Section 625 of the FAA Reauthorization Act of 2018. The Aviation Grant Management Program will assist with conducting research that focuses on a broad range of aviation technologies. Funding will be used for program management support to include a grants management system and associated resources.

Anticipated Program Activities:

- Aviation Research and Workforce Grants

Aerospace Performance and Planning

FY 2025 Program Descriptions
System Safety Management/Terminal Area Safety

Program Description:

The System Safety Management/Terminal Area Safety 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 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 performs 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:

- Next Level NAS Oversight
- Evaluation of Tools and Techniques to Support Pilot Training
- Develop Runway Safety Monitoring and Surveillance Tool and Sector Risk Profile for Airport Surface Safety and Develop Predictive Analytics

- Implement and Improve Integrated Safety Assessment Model (ISAM) Capability. Management techniques
- Evaluate and Promote Helicopter Safety Technologies (i.e., Enhanced Flight Vision Systems, Flight Data Monitoring, Virtual/Augmented Reality, and Improved Helicopter Simulation Models)

FY 2025 Program Descriptions
Commercial Space Transportation Safety

Program Description

The Commercial Space Transportation (CST) Safety Program 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:

launch and reentry operations only to the extent necessary to ensure compliance with international obligations of the United States, 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 safety improvement 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. This research benefits all actors within different CST industry segments.

By focusing research on issues directly related to AST's standards, regulations, and ways the industry can comply with the regulations, AST can better focus on the right kinds of regulations at the right time. This ensures public safety, and allows for innovation within the industry. Additionally, these efforts help ensure that the FAA continues to lead the world on commercial space standards and keeps the U.S. space industry at the forefront of this exciting field.

Anticipated Program Activities:

- Explosive Yield Research Project
- Human Spaceflight Participant Research
- Orbital Debris Mitigation
- Research Alliance

FY 2025 Program Descriptions
NextGen – Wake Turbulence

Program Description

The NextGen – Wake Turbulence 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. 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 Program is wake mitigation separation. NextGen - Wake Turbulence research analyzes and collects the data to establish the wake mitigation separations to be applied by ATC to new series of aircraft entering operational service. The program's analysis capability was used to establish separations 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). 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 begin operations in the NAS.

NextGen - Wake Turbulence research also addresses the role that wake separation standards will play in NextGen ATC operations. The program'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:

- Absolute Metric Models to Predict an En Route Aircraft's Wake Encounter Response
- Airport/Airspace Specific ATC Wake Hazard Mitigation Procedural Solutions and Associated Infrastructure Modification Recommendations
- Concept Development for ATC Dynamic Wake Hazard Mitigations - Terminal Area and En Route
- Redeployments/Repairs/Upgrades to Ground-Based Wake Data Collection Suites
- Wake Hazard Mitigation Separation Recommendations for New Aircraft Types Entering the NAS
- Wake Hazard Safety Assessments of Proposed Changes to ATC Separation Services
- Wake Track Data Collections, Analyses, and Modeling for ATC Wake Hazard Mitigations

FY 2025 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 on 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 reap potential societal UAS 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 Congressional mandates.

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 updates.

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
- Analyze Drone Traffic and Collision Risks
- Derive Safety Requirements for Beyond Visual Line of Sight System Mode Transitions
- Derive Requirements for Multi-vehicle Architectures

FY 2025 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 and the NAS, with integration of resource management support.

Major Program Objectives:

Individual projects under the ATDP Program develop and maintain mathematical and 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 airline operations performance and provides the objective data to support the need for improved traffic flow and efficiency measures within the NAS. Projects under the ATDP 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 the program will allow for continued assessment of NAS innovation performance and ensure that those technologies achieve the transformations as planned.

Additionally, ATDP includes integrated services and analysis functions to provide a wide array of support services for more than 55 implementation programs and over 20 pre-implementation programs. This is accomplished through four key mission areas: Integrated Resource Management; Program Acquisition Support; Program Health Management; and Planning, Analysis, and Integration. All program management office (PMO) programs such as Safety, Information Security, Human Factors, Integrated Logistics Support, Requirements Management, Configuration Management, and Risk/Issues/Opportunity Management use technical services provided by ATDP.

Anticipated Program Activities:

- Complete technical transfer to industry for a prototype, cockpit-based taxi conformance monitoring system to reduce runway incursions at controlled airports
- Create a collaborative means for experts from the FAA, academia, and industry to develop recommendations for improving system capacity and efficiency and for ways to reduce delays at specific airports

- Create dashboards that align and harmonize performance metrics for use during joint operational reviews
- Bi-annual assessment of aviation operational performance with Europe and Asia-Pacific regions
- Populate the Common Metrics Dashboard which is a reporting tool that allows for joint review of FAA traffic management initiatives and airline performance outcomes and is a key component of FAA/airline engagement
- Develop and validate NAS-level operational concepts that are key to the FAA NAS modernization efforts and understand the opportunities and challenges faced by the ATO as new concepts evolve
- Develop concepts of use to describe the operational use of proposed communication, navigation, automation, surveillance, and flight deck capabilities
- Infrastructure changes and analyses to determine airspace structure requirements

FY 2025 Program Descriptions
NextGen - Separation Management Portfolio

Program Description:

The NextGen - 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, 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.

Anticipated Program Activities:

- Conduct safety analysis and assessment for new Closely Spaced Parallel Operations concepts and provide technical reports
- Conduct Wake and TCAS Assessments of new CSPO Concept
- Commence next PBN Initiatives Safety Analysis (e.g., MARS Phase III)
- Compile Safety Risk Management artifacts to support NAS-wide separation standard change (e.g., MARS Phase II)

FY 2025 Program Descriptions
NextGen - Traffic Flow Management Portfolio

Program Description:

The NextGen - 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, such as special activity airspace and weather, 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 TFM Portfolio is to improve 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, helps reduce passenger delays leading to a better traveling experience, and contributes 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:

- Explore emerging technology for development of applications or services for surface movements and standardized information exchange into FAA flow systems for strategic planning
- Engineering analysis of mobile applications for integration with future NAS infrastructure
- Non-TFDM CFR time coordination tech transfer to FAA/Industry
- Mobile IFR Services standards exploration

Strategic Flow Management Applications:

- Develop services to support airspace and congestion management by applying data analytics of early intent data to support dynamic resource management and flow management initiatives. Continuous monitoring and advisory of demand and resources to provide recommendation of flow management initiatives.
- Research and development of a prototype service and procedures for in-flight coordination and strategic reroute between pilots/TMC (e.g., FF-ICE R2 services such as post departure negotiation service between flight deck and TMC, Re-evaluation process pre and post departure, trajectory update service to multiple airspace navigation service providers and airspace user, etc.)

Advanced Methods:

- Complete prototype capability for an Artificial Intelligence Traffic Flow Management application
- Conduct analysis leading to the development of responsible AI for aviation
- Use ML/AI to develop POC for tactical flow management

FY 2025 Program Descriptions
NextGen - On Demand NAS Portfolio

Program Description:

The NextGen - 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 examines concepts and matures capabilities through validation activities, demonstrations conducted with stakeholders, and human systems engineering to mitigate adverse impacts to 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 and works toward developing an international data standard allowing more users to share flight information and coordinate various flight activities to support collaborative decision-making.

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 to support trajectory-based operations (TBO). 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 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.

Anticipated Program Activities:

Flight Object:

- Develop and complete draft Developmental Release version of FIXM core to include initial data requirements based on ICAO FF-ICE/Release 2 concept; can be used for research and validation activities, while maintaining a stable baseline for Release 1
- Complete FIXM Developmental Release package including logical model to reflect the analysis and development based on ICAO FF-ICE/Release 2 concept
- Conduct Engineering Study to identify additional Flight Object functional requirements for services to support NAS automation modernization and Info-centric NAS architecture based on ICAO FF-ICE/Release 2 concept

Common Status and Structural Data:

- Define airspace, starting from available standard (e.g., AIXM) to support the restriction/constraint information exchange and cooperative areas for new entrants at all classes of airspace
- Conduct capability assessment to better understand the impact of the ICAO NOTAM Replacement Operational Concept on potential new capabilities could be required in the future system

Dynamic Airspace:

- Continue concept development for a resilient infrastructure beyond legacy systems
- Develop Scenarios and Use Cases for a resilient infrastructure beyond legacy systems
- Develop Data Performance Requirements for resilient network technologies
- Conduct laboratory evaluation or proof of concept activity for resilient network technologies

Flight Deck Collaborative Decision Making:

- Develop flight deck aircraft parameter exchange prototype application concept of use document
- Develop flight deck aircraft parameter exchange prototype application engineering artifacts
- Complete flight deck aircraft parameter exchange prototype application concept and engineering development
- Develop flight deck aircraft parameter exchange prototype application prototype environment

FY 2025 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:

Weather Forecast Improvements:

- ATM-Weather Integration: Produce business case analysis for Cloud Services for Aviation Weather and Cost estimate for Dynamic Weather use case
- Weather Community of Interest - Produce Final EOY Technical Report
- International: Continue to develop and coordinate globally harmonized requirements for the production and dissemination of meteorological information to support international air navigation for adoption as ICAO SARPs and inclusion in ICAO Annex 3, the PANS-MET, and other guidance documents

New Air Traffic Management (ATM) Requirements:

- Weather Transition - Develop an initial list of prioritized FY 2025 WIMAT/WRS/EWRS program support capabilities, activities, and candidates for change. Analyze current aviation weather information support capabilities in operation to determine unmet FAA needs for 2025 and develop report
- Advanced Air Ground Communications (Connected Aircraft):
  - Conduct Hyper Connected ATM Systems Test/Analysis
  - Analyze capabilities/services described in TBO relative to CA articulated performance and architecture
  - Conduct engineering analysis of domestic & international communication architectures
  - Identify, evaluate, and document capabilities from Data Decomposition
  - Develop Data Decomposition toolkit framework
  - Develop Concept Framework for Aircraft-to-Aircraft information exchange to expand from procedural "visual separation" to digital maneuvers
- Digital Communications - Develop translator between FANS and ATN message set

Information Management:

- Develop prototype of information services on a cloud environment.

- Complete an alternatives analysis for future information sharing enhancements
- Complete use-cases of enhanced analytical capabilities using various sources of FAA data
- Develop shortfall analysis of enhanced cloud-enabled capabilities

FY 2025 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 NAS research environments without affecting actual NAS operations.

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.

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 2025 Program Descriptions

NextGen– Enterprise, Concept Development, Human Factors & Demonstrations Portfolio

Program Description:

The NextGen - 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 will provide air traffic controllers with tools and procedures to separate aircraft with technologically advanced navigation equipment and wake performance capabilities to enhance system capacity, efficiency, and ensure safe aircraft separation while reducing workload for controllers and flight crews. Concept development identifies early NextGen concepts and maturation activities that will transform the NAS into the NAS's next generation. 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:

Enterprise Concept Development:

- Finalize update to Vision 2035 2.0 Concept of Operations
- Finalize functional analysis and Concept of Operations for Smart Airports
- Develop Responsible Artificial Intelligence Framework

Enterprise Human Factors Development:

- Continue research into human factors effects of NextGen traffic management innovations. Includes expected follow-on project(s) extending work on PBFM to additional areas of the CONOPS and addressing emerging areas of interest
- Begin execution of research into future vision (Charting Aviation's Future) automation enhancement concepts. Follow-on to identification of innovations with possible human factors effects and research plans for addressing them
- Address emerging, short-term human factors research needs other than those related to the ATC and traffic management concepts in lines 1 and 2. Lines 1 and 3 in the Program / System Interdependencies table in section 1.3, above are examples of this sort of work

Stakeholder Demonstrations:

- Urban Air Mobility (UAM) Demonstration: The demonstration will plan and execute a demonstration of these emerging flight operations and their interaction with UTM and ATM by validating the UAM concept of operation through simulations, completing a gap analysis, developing the necessary system prototypes, and executing the necessary demonstrations in partnership with industry stakeholders to support the advancement and implementation of UAM
- Class E (Upper Airspace) Traffic Management: This project will validate the ETM Concept of Operations and assess new capabilities needed to integrate high altitude operations in Class E

Airspace (i.e., weather monitors, pseudo-stationary Unmanned Aircraft Systems (UAS), pseudo space vehicles, etc. over Flight Level (FL) 600 and through transition airspace) into the NAS. This funding will be utilized to validate the ETM concept with government/industry partners, conduct a safety assessment, and develop the demonstration plan for slow moving vehicles (ETM I)

- ALFRD: Demonstrate an automated digital assistant function that can determine relevant information and provide recommended action to improve strategic up to tactical flow operation and performance. ALFRD will evaluate flight, weather, aeronautical information in-time to provide details on challenges to the projected operating environment to internal and external stakeholders. It will also compare information against projected demand profiles and continually assess whether a TMI is the correct course of action; if so, what combo of TMIs and configuration would be most effective
- EPP v Flight Intent Info: Showcase multiple architecture/technologies to share flight intent information through data collection flights and analyses will show the delta between these architecture/technologies
- Demo Steering Group: Will approve a project in FY25 to be conducted in the FY26 timeframe

FY 2025 Program Descriptions
NextGen - Unmanned Airspace Systems (UAS)

Program Description:

The NextGen - Unmanned Aircraft System (UAS) Program play a critical role in enabling UAS operations in the NAS. The activities in this program support research that allows integration of UAS without impact to manned aircraft operations or creating disruptions or delays and will ensure NAS operations will be as safe as they are today. Through this program, UAS operators will be allowed more operations that cost less, are better for the environment, and can operate in extreme conditions, lowering the risk to human life. 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. 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.

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 impacting manned aircraft operations (e.g., creating disruptions or delays) and ensuring NAS operations will be as safe or safer than they are today.

Standardized regulations, policy, procedures, guidance material, and training requirements are needed to allow routine UAS operations in the NAS. Additionally, existing Air Traffic Management (ATM) automation systems are not adapted to enable UAS integration. The activities in this program support research that allows integration of UAS without impact to manned aircraft operations or creating disruptions or delays, and will ensure NAS operations will be as safe as they are today.

Anticipated Program Activities:

Concept Validation and Requirements Development:

- Develop prototype communications infrastructure and services to support large UAS BVLOS
- Integrate communications prototype into test environment for large UAS BVLOS
- Evaluate and analyze prototype communications infrastructure performance requirements
- Explore alternative surveillance technologies, location services, and infrastructure for UAS position triangulation and tracking

Flight Information Management:

- Complete UTM Data Exchange Requirements for Integrated UTM Operations Version 4.0 (e.g., BVLOS)
- Complete UTM Functional Allocation Version 4.0 (e.g., BVLOS)
- Complete Reference Implementation Version 3.0 (e.g., Operations Over People and at Night, Security)
- Complete UTM System Prototype Version 4.0 (e.g., BVLOS)

FY 2025 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 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 manages the portfolio planning, formulation, presentation, and review activities to ensure the FAA meets the President's criteria for R&D, increases program efficiency, 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 SPRM program manages the RE&D portfolio and submits the mandatory R&D planning documents to Congress each year. Through the REDAC's findings, 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 enhancing U.S. global leadership in aviation.

Anticipated Program Activities:

- Develop Annual Statutory Deliverables for Congress
- Develop Departmental (OST) R&D Program Planning and Performance Reporting Requirements
- Develop and Submit of the FAA's R&D Investment Portfolio

FY 2025 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). These associated 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. This program is aligned to the DOT strategic goal of Organizational Excellence.

The laboratory network operations center provides an environment to maintain, monitor status and cyber events, and operate the NPN and customer networks. The Laboratory Facilities Program 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

FY 2025 Program Descriptions
William J. Hughes Technical Center Laboratory Sustainment

Program Description:

This program sustains the William J. Hughes Technical Center (WJHTC) laboratories. This centralized set of laboratories supports the Acquisition Management System (AMS) lifecycle from concepts and requirements 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. Capabilities developed in these laboratories reduce the 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. This program is aligned to the DOT strategic goal Transformation.

Anticipated Program Activities:

- Support Laboratory Space & Infrastructure Improvements
- Support Laboratory Improvements alongside VoICE Program Installation
- Support Laboratory Equipment Technology Refresh
- Support NAS Modernization for Equipment

FY 2025 Program Descriptions
William J. Hughes Technical Center Infrastructure Sustainment

Program Description:

Infrastructure sustainment at the William J. Hughes Technical Center (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.

Program Objectives:

This program sustains the WJHTC facilities, site utilities, and infrastructure. WJHTC 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. This program is aligned to the DOT strategic goal of Transformation.

Anticipated Program Activities:

- Support WJHTC Facility Infrastructure

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
ACI	Aircraft Cyber Initiative
ACI-NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADS-B	Automatic Dependent Surveillance-Broadcast
AEDT	Aviation Environmental Design Tool
AEEC	Airline Electronic Engineering Committee
AFFF	Aqueous Film-Forming Foams
AFRL	Air Force Research Lab
AI	Artificial Intelligence
AIA	Aerospace Industries Association
AIR	Aircraft Certification Service
AJI	Safety and Technical Training Organization
AJM	Program Management Organization
AL	Abstraction Layer
ALPA	Air Line Pilots Association
AMRAC	Aerospace Medicine Research Alignment and Collaboration
AMRP	Annual Modal Research Plan
AM	Additive Manufacturing
AMS	Acquisition Management System
ANG	Office of NextGen
ANSP	Air Navigation Service Provider
AOPA	Aircraft Owners and Pilots Association
AOC	ACRP Oversight Committee
APT	Advanced Persistent Threats
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

ACRONYM	DEFINITION
ASEB	Aeronautics and Space Engineering Board
AST	Office of Commercial Space Transportation
ASTM	American Society for Testing Materials
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
ATO	Air Traffic Organization
AVS	Office of Aviation Safety
B	
BLI	Budget Line Item
C	
CAA	Civil Aviation Authority
CAAFI	Commercial Aviation Alternative Fuels Initiative
CAAS	Civil Aviation Authority of Singapore
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
CFR	Code of Federal Regulations
CLEEN	Continuous Lower Energy, Emissions and Noise
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
CPTech	National Concrete Pavement Technology Center
CRADA	Cooperative Research and Development Agreements
CRM	Crew Resource Management
CSF	Cockpit Simulation Facility or Commercial Spaceflight Federation
CST	Commercial Space Transportation
CVRD	UAS Concept Validation and Requirements Development
D	
DARWIN®	Design Assessment Of Reliability With Inspection
DAC	Drone Advisory Committee
DataComm	Data Communications

ACRONYM	DEFINITION
DGAC	Direction Generale de l'Aviation Civil
DHS	Department of Homeland Security
DO	Domain
DOC	U.S. Department of Commerce
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
E	
EAA	Experimental Aircraft Association
EASA	European Aviation Safety Agency
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
ERAU	Embry Riddle Aeronautical University
ERDC	U.S. Army Engineer Research and Development Center
ETM	Engineering Test Model
EUROCAE	European Organization for Civil Aviation Equipment
EXCOM	Executive Committee
F	
F&E	Facilities and Equipment Appropriation
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation
FASTER	Full-Scale Aircraft Structural Test Evaluation and Research
FD-CDM	Flight Deck Collaborative Decision Making
FF-ICE	Flight and Flow – Information Collaborative Environment
FFRDC	Federally Funded Research and Development Center
FICAN	Federal Interagency Committee on Aviation Noise
FIMS	UAS Flight Information Management System
FIXM	Flight Information Exchange Model
FPM	Flightpath Management
FTB	Florida NextGen Test Bed
FY	Fiscal Year
G	
GA	General Aviation
GAMA	General Aviation Manufacturers Association

ACRONYM	DEFINITION
GE	General Electric
H	
H-EFVS	Helicopter Enhanced Flight Vision System
HF	Human Factors
HITL	Human In The Loop
HUD	Department of Housing and Urban Development
I	
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IoT	Internet of Things
IP	Intellectual Property (also, Internet Protocol)
IRB	FAA Institutional Review Board
J	
JAMS	Joint COE for the Advanced Materials and Structures
JAT	Joint Analysis Team
JENQC	Jet Engine Nickel Quality Committee
JETQC	Jet Engine Titanium Quality Committee
JPL	Jet-Propulsion Labs
K	
L	
LL	Lincoln Laboratory
LOC-I	Loss of Control Inflight
LS-DYNA	An advanced general-purpose multiphysics simulation software package developed by the Livermore Software Technology Corporation
M	
MARS	Multiple Airport Route Separation
MET	Minimum Cockpit Meteorological
MinWxSvc	Minimum Weather Service
MIT	Massachusetts Institute of Technology
ML	Machine Learning
MMPDS	Metallic Materials Properties Development and Standardization
MOU	Memorandum of Understanding
N	
NAC	NextGen Advisory Committee
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

ACRONYM	DEFINITION
NAWCWD	Naval Air Warfare Center Weapons Division
NDE	Nondestructive Evaluation
NextGen	Next Generation Air Transportation System
NI	NAS Infrastructure
NIA	National Institute of Aerospace
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
NRC	National Research Council Canada
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
ORA	Operational Risk Assessment
ORTA	Office of Research and Technology Applications
OST	Office of the Secretary
OTA	Other Transaction Authority
P	
PAFI	FAA Piston Aviation Fuels Initiative
PEGASAS	Center of Excellence Partnership to Enhance General Aviation Safety, Accountability and Sustainability
PBN	Performance Based Navigation
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances
PHMSA	Pipelines and Hazardous Materials Safety Administration
PIREPs	Pilot Reports
PMO	Program Management Office
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

ACRONYM	DEFINITION
RNP	Required Navigation Performance
RoMan	Rotor Manufacturing
RTCA	Radio Technical Commission for Aeronautics
RTT	Research Transition Team
S	
SAE	Society of Automotive Engineers International
SDO	Standards Development Organizations
SE	Safety Enhancement
SME	Subject Matter Expert
SPRM	System Planning and Resource Management
SSM	System Safety Management
SVGS	Synthetic Vision Guidance Systems
SWAC	System-Wide Analysis Capability
T	
TAC	Technical Advisory Committee
TAS	Terminal Area Safety
TCRG	Technical Community Representative Groups
TBO	Trajectory Based Operations
TFM	Traffic Flow Management
TGF	Target Generation Facility
TRACON	Terminal Radar Air Traffic Control
TRB	Transportation Research Board
TSO	Technical Standard Orders
U	
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
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
UTM	UAS Traffic Management
V	
VFR	Visual Flight Rules
W	
WFD	Widespread Fatigue Damage Rule
WJHTC	William J. Hughes Technical Center
WTIC	Weather Technology in the Cockpit