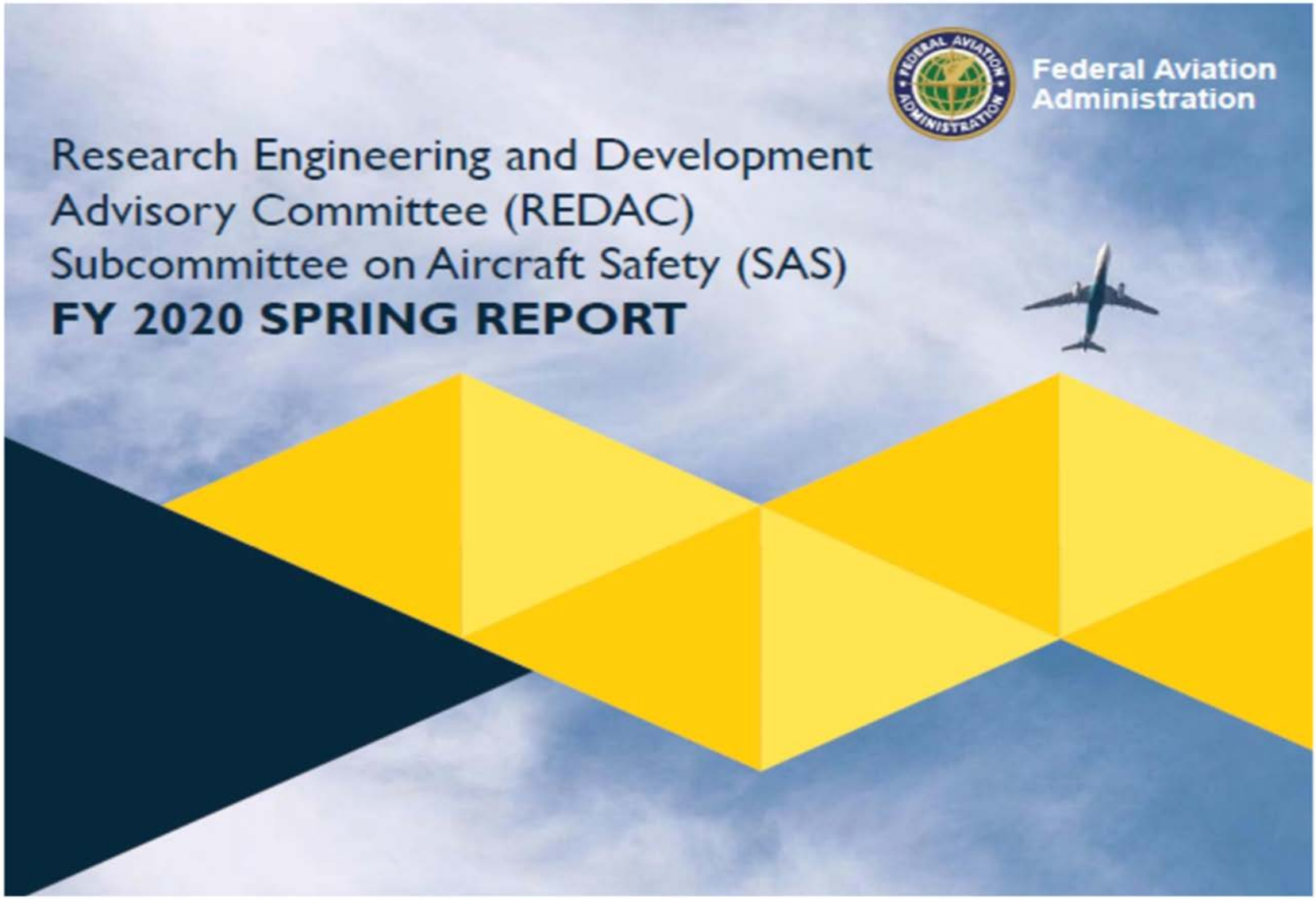
Federal Aviation Administration
Research Engineering and Development Advisory Committee (REDAC)
Subcommittee on Aircraft Safety (SAS)
FY 2020 SPRING REPORT

Table of Contents

FY22 Budget Table ($K unless noted)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aircraft Safety Assurance									
Fire Research and Safety (A11A)	$7,200	$3,212	$7,200	$2,787	$7,200	$2,588	$7,136	$2,513	$3,500
Propulsion and Fuel Systems (A11B)	$2,100	$1,534	$2,100	$1,091	$2,100	$1,083	$4,215	$1,948	$0
Advanced Material/Structural Safety (A11C)	$10,500	$9,250	$14,720	$13,203	$14,720	$12,685	$1,003	$0	$0
Continued Airworthiness - Systems (A11E.SYS)	$10,773	$4,273	$11,269	$4,055	$10,269	$2,754	$9,642	$4,102	$1,380
Continued Airworthiness - Structures (A11E.STR)		$2,765		$3,368		$1,762		$1,568	$130
Aircraft Catastrophic Failure Prevention Research (A11F)	1570	$1,070	$1,570	$1,433	$1,565	$1,438	$0	$0	$0
Terminal Area Safety (A11H.TAS)	$2,080	$778	$2,790	$1,330	$3,043	$1,842	$3,162	$1,631	$0
Domain subtotal =	**$34,223**	**$22,882**	**$39,649**	**$27,267**	**$38,897**	**$24,152**	**$25,158**	**$11,762**	**$5,010**
Digital Systems and Technology									
Digital System Safety (A11D.SDS)	$5,197	$3,392	$4,767	$2,902	$4,444	$2,579	$4,931	$3,319	$1,450
Domain subtotal =	**$5,197**	**$3,392**	**$4,767**	**$2,902**	**$4,444**	**$2,579**	**$4,931**	**$3,319**	**$1,450**
Environment & Weather Impact Mitigation									
Aircrft Icing (A11D.AI)	$4,056	$2,790	$4,486	$3,171	$4,458	$3,143	$1,315	$0	$820
Alternate Fuels for General Aviation (A11M)*	$0	$0	$1,900	$758	$1,900	$697	$2,524	$2,242	$5,888
Domain subtotal =	**$4,056**	**$2,790**	**$6,386**	**$3,929**	**$6,358**	**$3,840**	**$3,839**	**$2,242**	**$6,708**
Human Performance & Aeromedical Factors									
Flight Deck/Maintenance/System Integratio Human Factors (A11G)	$7,095	$3,626	$7,305	$2,710	$7,300	$2,587	$7,469	$2,681	$5,636
Aeromedical Research (A11J)	$9,686	$4,024	$9,080	$2,178	$7,919	$2,419	$10,235	$3,136	$3,620
Domain subtotal =	**$16,781**	**$7,650**	**$16,385**	**$4,888**	**$15,219**	**$5,006**	**$17,704**	**$5,817**	**$9,256**
Aviation Performance & Planning									
System Safety Management (A11H.SSM)	$3,520	$2,217	$2,710	$1,251	$1,201	$0	$2,323	$792	$2,035
Unmanned Aircraft Systems Research (A11L)	$24,035	$20,931	$24,035	$21,503	$24,035	$20,774	$24,035	$22,436	$10,305
Domain subtotal =	**$27,555**	**$23,148**	**$26,745**	**$22,754**	**$25,236**	**$20,774**	**$26,358**	**$23,228**	**$12,340**
Total Aviation Safety RE&D Portfolio =	**$87,812**	**$59,862**	**$93,932**	**$61,740**	**$90,154**	**$56,351**	**$77,990**	**$46,368**	**$34,764**
% of total FAA RE&D Appropriation/Request	46.5%		49.2%		46.5%		40.8%		
Total FAA RE&D Appropriation/Request	$189M		$191M		193M		$170M		$170M

**NOTE: GA Fuels funded from NEXTGEN budget through FY18*

Domain: Aircraft Safety Assurance

Program Area: Fire Research and Safety (A11A)

Technologies, procedures, test methods, and fire performance criteria that can prevent and, where necessary, mitigate aircraft fires and improve survivability during a post-crash fire.

Project: Aircraft Fire Safety (A11A.FCS.1)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11A.FCS.1	Reduction in fire fatalities and injuries in the event of an accident, and reduced risk of accidents due to fire, based on improved regulatory standards, and no reduction in fire safety as a result of new materials and technologies. Quantifying the improvements is difficult as the existing fatality rates are very low. However the potential for the operational environment to change significantly, e.g., UAM, with different potential fire sources, e.g., lithium batteries tends to offset the current level of safety for conventional aircraft and operation.	Aircraft Fire Safety (AIR/ANG-E2)	Yes	FY15	FY30	$3,500

Project Output: Aircraft Fire Safety anticipated research outputs in FY22 (A11A.FCS.1)

Assess the ramifications of carriage of hazardous goods on aircraft fire protection methods and equipment, and consider technical feasibility of addressing such goods at the aircraft level 2018-2023.

- Develop criteria and test methodologies for detection of fires inside unit load devices. FY19-22
- Develop standardized methods for evaluating nonmetallic engine components FY18-22, and publish a report

Program Resources ($K): Fire Research and Safety (A11A)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aircraft Safety Assurance									
Fire Research and Safety (A11A)	$7,200	$3,212	$7,200	$2,787	$7,200	$2,588	$7,136	$2,513	$3,500

People	Facilities	Partnerships
• 22 GOV FTEs and 16 CTR FTEs in various technical disciplines including engineering, analytics, material science, chemistry, lab testing, etc.	• FAA Full Scale Fire Test Facility • FAA Component Fire Test Facility • FAA Fire Chemistry Lab • FAA Material Fire Test Facility • FAA Pressure Vessel • B-747, B-737, and B-727 aircraft.	• FAA Office of Hazardous Materials (AXH), • NIST • ICAO • SAE • EASA • Boeing • Airbus • University of Maryland • University of Massachusetts • Rutgers University

Program Area: Propulsion and Fuel Systems (A11B)

This research develops and/or enhances technologies, procedures, test methods, and risk assessment methods to enhance airworthiness, reliability, and performance of engines, propellers, fuels, and fuel systems.

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
	Currently below Mendoza					

Program Resources ($K): Propulsion and Fuel Systems (A11B)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aircraft Safety Assurance									
Propulsion and Fuel Systems (A11B)	$2,100	$1,534	$2,100	$1,091	$2,100	$1,083	$4,215	$1,948	$0

People	Facilities	Partnerships
• 1 FTE	• None	• Rotor Integrity Subcommittee (RISC) Roto Manufacturing (RoMan) Sub-team

Program Area: Advanced Materials / Structural Safety (A11C)

This research assesses safety implications and techniques associated with composites and structures that can help to reduce aviation fatalities.

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
	Currently below Mendoza					

Program Resources ($K): Advanced Materials / Structural Safety (A11C)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aircraft Safety Assurance									
Advanced Material/Structural Safety (A11C)	$10,500	$9,250	$14,720	$13,203	$14,720	$12,685	$1,003	$0	$0

People	Facilities	Partnerships
• 7 FTEs in various technical disciplines including engineering, analytics, material science, non-destructive evaluation, etc.	• FAA Aircraft Structural Test Evaluation and Research Lab (FASTER) • FAA Structures and Materials Lab (SML)	• Academia (FAA Joint Centers of Excellence for Advance Materials, COE JAMS): Wichita State University, University of California, University of Washington, Oregon State University, Florida International University, University of Utah, Mississippi State University, Auburn University. • Industry: Boeing, Hexcel, Cytec, United Airlines, Airbus, Textron Cessna, Delta Airlines, Spirit Aero systems, SAE International, ASTM, CMH-17, America Makes, TenCate-US, Bell Helicopters. • Government: NASA, Army, Air Force Research Lab • International/Government: - The European Aviation Safety Agency (EASA), Transport Canada Civil Aviation (TCCA); (Academia) Technical University of Denmark

Program Area: Continued Airworthiness – Systems (A11E.SYS)

This research enhances the decision making processes and addressing safety risks related to aircraft structures, engines, and systems.

Project: A Systems Approach to Automated Flight Decks (A11E.HF.2)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11E.HF.2	AVS will use this research to develop and update regulatory and guidance material (i.e., ACs, TSOs, Handbooks, etc.) to facilitate the review and approval of emerging technologies. We will: validate the intended safety function(s), Identify what the certification requirements are, Publish advisory circular or share results with other industry group for incorporation into industry standards, Create comprehensive guidelines and best practices	A Systems Approach to Automated Flight Decks (AIR/ANG-E2)		FY22	FY25	$750

Project Output: A Systems Approach to Automated Flight Decks anticipated research outputs in FY22 (A11E.HF.2)

Automated systems crew interfaces: Address pilot interaction/interface with automated systems. Examine pilot recognition, workload, and responses to certain failures and operational situations.

Outputs:

- Develop methods to examine and validate these assumptions about pilot recognition and responses to support system safety assessments. [FY22-25]
- Design experimental research plan [FY23]
- Conduct human-in-the-loop simulation and data analysis [FY23-24]
- Create final report with interface recommendations and pilot performance considerations [FY25]
- [Exit criteria: Completed research plan, analysis and reports.]

Reduced crew operations: We are developing the framework for this work under this requirement.

Outputs:

- Design experimental research plan [FY22]
- Conduct human-in-the-loop simulation and data analysis [FY23-24]
- Create final report with pilot performance considerations and recommendations [FY25]
- [Exit criteria: Completed research plan, analysis and reports.]

Project: Development of Control Surface and Stabilizer Freeplay Limits (A11E.SIM.13)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11E.SIM.13	Revise AC 25.629-1B: "Aero elastic Stability Substantiation of Transport Category Airplanes" and eliminate need for issue papers. Published a FAA guidance material, with newly developed freeplay criteria for transport airplanes, and stop using limits published in Military handbooks, such as JSSG-2006, "The Department of Defense Joint Service Specification Guide - Aircraft Structures" (which has replaced MIL-A-8870C).	Development of Control Surface and Stabilizer Freeplay Limits (AIR/ANG-E2)		FY19	FY25	$630

Project Output: Development of Control Surface and Stabilizer Freeplay Limits anticipated research outputs in FY22 (A11E.SIM.13)

This activity focuses on obtaining data and developing the methodology and nonlinear models required to establish safe and realistic limits that will support the development of consensus standards for transport category aircraft; with the objective to preclude freeplay-induced vibrations (also known as limit cycle flutter) in operating airplanes and thereby eliminating related dangerous COS issues. The limits will be established for both legacy aircraft and new airplanes equipped with emerging technologies of active flutter suppressions. The result will include numerical models and a fully aero elastic aircraft wind-tunnel model that could be used as a testbed for developing consensus standards for aero elastic-related COS issues.

This activity will be conducted in three phases:

PHASE 1. FY 19. Build a fully aero elastic model with capability to introduce controlled degrees of freeplay in to the control surfaces. Initiate developing aero elastic numerical model of the test model. Initiate gathering the existing non-linear aero elastic models and initiate performing finite element analysis (FEA) and computational fluid dynamic (CFD) analysis

PHASE 2. FY 22-23. Modify the test model based on simulations, if necessary. Perform a baseline wind-tunnel test and correct the numerical model. Perform numerical analyses to estimate freeplay limits and identify the best nonlinear models capable of capturing the main characteristics. Study the effects of freeplay limits on the performance of active flutter systems.

PHASE 3. FY 23-24. Conduct the wind-tunnel and gather the required data. Evaluate and update the analytical and numerical models by comparison to gathered test data. Use the up-dated non-linear models and perform stability and probabilistic analyses to estimate the limits.

Program Resources ($K): Continued Airworthiness – Systems (A11E.SYS)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Continued Airworthiness - Systems (A11E.SYS)	$10,773	$4,273	$11,269	$4,055	$10,269	$2,754	$9,642	$4,102	$1,380
Continued Airworthiness - Structures (A11E.STR)		$2,765		$3,368		$1,762		$1,568	$130

People	Facilities	Partnerships
• 5 FTEs in various technical disciplines including engineering, mathematics, material science, sensor technology, etc.	• FAA Air Fault Evaluation Lab/More Electric Aircraft Lab, POWER Lab, Electric Flight Controls Test Capabilities	• 5 FTEs in various technical disciplines including engineering, mathematics, material science, sensor technology, etc.

Program Area: Continued Airworthiness – Structures (A11E.STR)

This research enhances the decision making processes & addressing safety risks related to aircraft structures, engines, and systems.

Project: MMPDS Support and Design Values for Emerging Materials (A11E.SIM.4)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11E.SIM.4	Standardized acceptable design and certification compliance data and tools necessary to enable the FAA to operate in cost effective and efficient manner, while providing a level-playing field and uniform standards for all certification agents.	MMPDS Support and Design Values for Emerging Materials (AIR/ANG-E2)		2012	2030	$130

Project Output: MMPDS Support and Design Values for Emerging Materials anticipated research outputs in FY22 (A11E.SIM.4)

This requirement develops standardized acceptable design and certification compliance data and tools necessary to enable the FAA and industry to operate in cost effective and efficient manner, while providing a level-playing field and uniform standards for all certification agents. This requirement leverages FAA resources through government – industry consortia in the development of the Metallic Materials Properties Development and Standardization (MMPDS), recognized worldwide as the premier source of metallic allowable. As part of the FAA's charter to maintain international leadership role, the effort fulfills commitments to manage and develop metallic material and joint design standards on which aerospace industry depends. This ongoing requirement leverages resources with other stakeholders including DoD, NASA, and Industry to supports the core activities of developing and maintaining the MMPDS process and handbook. The current project tasking and output are summarized below:
The current project phases include the following (exit criteria for each phase provided below):

Task: Development of the MMPDS:

- Provide for the planning, coordination, and implementation activity which is necessary to develop and maintain the core MMPDS Process and Handbook in establishing statistically-based allowable that comply with material strength requirements in §2X.613.Spring and Fall Coordination Meetings, April 2022 and September 2022, respectively.

Output:

- Meeting Agenda and Minutes from Spring and Fall Meetings, due 60 days after meeting
- Annual update of MMPDS Handbook and Derivative Products, September 2022

Program Resources ($K): Continued Airworthiness – Structures (A11E.STR)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Continued Airworthiness - Systems (A11E.SYS)	$10,773	$4,273	$11,269	$4,055	$10,269	$2,754	$9,642	$4,102	$1,380
Continued Airworthiness - Structures (A11E.STR)		$2,765		$3,368		$1,762		$1,568	$130

People	Facilities	Partnerships
• 4 (3 filled and 1 open) FTEs in various technical disciplines including engineering, analytics, material science, non-destructive evaluation, etc.	• FAA Full-scale Aircraft Structural Test Evaluation and Research (FASTER) Lab • FAA Structures and Materials Lab • FAA Airframe Beam Structural Test (ABST) fixture	• Industry: Boeing, Airbus, Arconic, Bombardier, Constellium, Embraer, Textron, Spirit Aerospace • Gov't: NASA, DoD, DHS • Consortia and SDOs: MMPDS, KART, AmericaMakes,

Program Area: Aircraft Catastrophic Failure Prevention Research (A11F)

Standardize analysis methods and tools for evaluating anticipated hazards and risks related to engine rotor burst and fan blade failure to assure that regulatory compliance findings are accurate and consistent.

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
	Currently below Mendoza					

Program Resources ($K): Aircraft Catastrophic Failure Prevention Research (A11F)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aircraft Safety Assurance									
Aircraft Catastrophic Failure Prevention Research (A11F)	1570	$1,070	$1,570	$1,433	$1,565	$1,438	$0	$0	$0

People	Facilities	Partnerships
• 2.33FTEs	• Via FAA CASSIE and High Performance Computing.	• NASA

Program Area: Terminal Area Safety – TAS (A11H)

Anticipation of system-wide operational risks, Additional data-driven approaches, Lower accident rate due to loss-of-control, Fewer runway excursions and Improved helicopter safety, Support Risk-Based Decision Making for oversight of the Air Traffic Organization.

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
	Currently Below the Mendoza Line					

Program Resources ($K): Terminal Area Safety – TAS (A11H)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aircraft Safety Assurance									
Terminal Area Safety (A11H.TAS)	$2,080	$778	$2,790	$1,330	$3,043	$1,842	$3,162	$1,631	$0

People	Facilities	Partnerships
• 2.5 Govt. FTEs and 3 CTR FTE in various technical disciplines including engineering, computer science, statistics, safety and risk management, etc.	• WJHTC Labs (i.e., NextGen Integration and Evaluation Capability) • Mike Monroney Aeronautical Center (MMAC) Flight Operations Simulation Lab • NASA Ames Boeing 747 Level D simulator	• NASA • United States Helicopter Safety Team (USHST) • Sikorsky, Leonardo, Airbus Helicopters • U.S. Coast Guard • NJ State Police • FAA Flight Program • MaxVis • Thales • Elbit Systems • Rockwell Collins

Domain: Digital System Safety

Program Area: Digital System Safety (A11D.SDS)

This research enhances the understanding of risks of failures or malfunctions of software and digital systems.

Project: Complex Digital Systems (A11D.SDS.6)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11D.SDS.6	Expected outcome is new, less prescriptive, risk-based guidance for assurance approaches, methodologies, and techniques used to implement and criteria to assure complex digital systems.	Complex Digital Systems		FY20	FY24	$1450

Project Output: Complex Digital Systems anticipated research outputs in FY22 (A11D.SDS.6)

FY22Tasks will address the following areas:

(1) Implementation Methodologies for Automation using Artificial Intelligence

Current systems, software, and electronic hardware assurance processes are based on explicit, somewhat invariable, detailed, prescriptive approaches using "objectives" that must be satisfied to demonstrate compliance with applicable regulations for aircraft certification. These processes may not necessarily address different methodologies, tools or COTS products proposed for use in civil aircraft development. Further, the aircraft certification service is using a risk-based approach to certify products and existing prescriptive standards do not adapt to allow a risk-based approach.

Additionally, standards and guidance for safe use in civil aircraft do not exist for implementation methodologies using artificial intelligence, autonomy, non-determinism, use of assurance cases, commercial-off-the-shelf components. Further, these methodologies may be used in conjunction with other methodologies for which we do not have standards or guidance. For example, a product may include use of artificial intelligence in autonomous (non-piloted), non-deterministic systems using assurance cases in lieu of an existing, prescriptive development assurance standard that is recognized as an acceptable means in guidance. Depending on available funding and results from previous research, this research will assess use of artificial intelligence in safety critical aircraft systems. Artificial intelligence in this effort is as defined in the 4/22/19 Memo in prioritizing AI research from the Undersecretary of Transportation to Modal Administrators and Heads of Secretarial Offices. In this memo, AI exists along a spectrum of conventional automation that requires explicit programming of rules and behavior while AI, of which Machine Learning (ML) is a subset, focuses on imitating human intelligence such as reasoning, learning, and self-improvement. Research task(s) will be identified to include individually or in combination with others. Follow on efforts to AVSI AFE 87 on use of AI. Certification of products using non-deterministic methodologies including demonstration of intended behavior and when testing is complete. Autonomous (non-piloted) systems. Issues identified by SAE G-34 development of a standard for safe use of AI. Assessment across multiple domains (systems, software, and airborne electronic hardware) in order to identify and address issues that may arise in one domain differently from another. Neural networks including different learning types. Development Assurance Leveling (DAL) across the safety continuum.

Output:

Research output will include reports (final and interim) identifying safety issues related to system certification, delineation of mitigation techniques, and validating effectivity of such techniques. Expected final report date is identified in parenthesis. (10/1/26)

(2)Pilot Programs

In an effort to identify other approaches to the current acceptable means of compliance, a set of Overarching Properties (OPs) was developed that identifies the fundamental characteristics of any product being certified whether it is a complete system, a subsystem, a software item or a hardware item. A guide for understanding the OPs was published and a methodology for their use based on assurance cases is in development. Further discussion on other approaches resulted in plans to develop an Abstraction Layer (AL) based on existing and recognized standards. While the OPs are considered a top-down approach based on the regulations, the AL is a bottom-up approach more closely resembling, but less prescriptive than, the current standards. The criteria for the AL are currently in development. Since other approaches may be developed and proposed, this task will also consider these additional approaches as potential to allow flexibility in the certification process. In addition, use of approaches such as OPs or AL does not necessarily preclude use of new methodologies, e.g., artificial intelligence, for which we currently do not have standards or understand safety implications with their use in civil aircraft.

Pilot programs are needed to evaluate the use of other approaches to the currently recognized but prescriptive and restrictive standards for systems, software, and electronic hardware. Overarching Properties (if further pilots are needed beyond FY21 funding), an Abstraction Layer, and other approaches will be assessed in tasks that mimic real-world aircraft certification projects. The task will assess the OPs, Abstraction Layer, and other approaches for completeness, consistency, and feasibility of use in a certification environment identifying potential improvements, clarifications, gaps, and issues with their use.

Output:

Research outputs for this topic will include reports (final and interim) identifying issues in certifying a product using the overarching properties, abstraction layer, or other means in lieu of the current, more prescriptive, system, software, or electronic hardware standards. The outputs will include proposed changes to the approach assessed to support their use in a civil certification environment. Expected final report date is identified in parenthesis. (10/1/26)

Program Resources ($K): Digital System Safety (A11D.SDS)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Digital Systems and Technology									
Digital System Safety (A11D.SDS)	$5,197	$3,392	$4,767	$2,902	$4,444	$2,579	$4,931	$3,319	$1,450

People	Facilities	Partnerships
• SDS- 2 GOV FTE, 1 vacancy and partnerships from other organizations and contractors in Systems Engineering, Computer Engineering, and Computer Science disciplines	• Boeing 757 Aircraft	• NASA Langley • Aerospace Vehicles Systems Institute (AVSI)

Domain: Environment & Weather Impact Mitigation

Program Area: Aircraft Icing (A11D.AI)

This research enhances the understanding of risks of failures or malfunctions of software and digital systems.

Project: Safe Operations and Take-off in Aircraft Ground Icing Conditions (A11D.AI.2)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11D.AI.2	The AI-02 R&D provides wind tunnel, cold chamber, and outdoor winter weather (snow) test methods and analysis tools which will promote safer winter weather ground operations. The outcome of this R&D also provides research results (data, analyses, and other information) that support the development of guidance that Flight Standards writes and includes in their annual notice for "FAA-Approved Deicing Program Updates."	Safe Operations and Take-off in Aircraft Ground Icing Conditions (AFS/ANG-E2)		FY10	FY24	$520

Project Output: Safe Operations and Take-off in Aircraft Ground Icing Conditions anticipated research outputs in FY22 (A11D.AI.2)

The major milestone annually is to provide Flight Standards the technical data and information needed from the results of previous winter research testing and analyses. These results are used by Flight Standards to provide updates for the annual winter notice on ground deicing. The research results play a crucial role in supplying key technical information to Flight Standards for annual notice updates – these results are used by airline operators to incorporate into their ground deicing plans, which must be submitted and approved each year under §121.629. The research results are essential to maintaining current safe ground operations.
The FAA also addresses environmental conditions and operational changes that may come up as urgent needs. An example of this is research on ice pellet conditions that required re-direction of research resources to address revenue service aircraft ability to release in ground icing conditions that were not provided for in that current year winter operations notice. The result is that the FAA must sometimes meet an immediate need not identified in current milestones that addresses an imminent safety concern. Milestones can move from one year to another based on these tasks that may occur due to safety concerns growing out of in-service events or a number of other factors: Early completion of a task, changing funding levels from our partner Transport Canada, etc. The FAA research is strongly leveraged through our international agreement PA-17 with Transport Canada, which shares the funding for some of the research tasks.

Task 1: Artificial Snow Generation System ("Snow machine"): Natural environmental conditions are often unstable, not readily measurable, uncontrolled events. To successfully capture, record, and analyze the impact of environmental conditions, we need to continually improve test methods to address repeatable, accurate measurements that are

representative of actual environmental conditions. Evaluate and improve the capability of a snow generation system (""snow machine"") to simulate specified outdoor conditions.

Milestones:

- Report on evaluation of capability of snow machine and improvements needed. (September 2019).
- Redesign of show machine. (Completed September 2020)
- Report on calibration (frequency of bit sharpening, etc.) of redesigned snow machine. (September 2021)
- Comparison endurance time testing of snow machine versus snow testing in natural conditions at matched snow conditions. (November 2021 – March 2022)
- Report on analysis of results of comparison endurance time testing. (September 2022)

Output: Redesigned snow machine validated for expanded use in determination of endurance times and holdover times. (September 2022)

Task 2: Aerodynamic Issues: Investigate aerodynamic issues relating to performance of anti-icing fluids, contaminated and uncontaminated.

Milestones:

- Report or briefing on issues to be investigated and research plan to carry out the investigations. (September 2022).

Output: Reports or briefing (September 2022)

Task 3: Operational issues: Identify technical and operational issues important to the safety and efficiency of ground operations in winter conditions and amenable to research investigation. This includes the protection afforded by anti-icing fluids on vertical surfaces such vertical stabilizers and rudders. Questions have been raised about protection of vertical stabilizers, fuselage upper surfaces, and the effect of strong cross winds on anti-icing procedures and effectiveness. It is anticipated that, as has happened every year, new issues will be raised reflecting operational experience and concerns of manufacturers and airlines.

Conduct research with wind tunnel aircraft wing simulated take offs using a mid-speed ramp with a rotation speed of 85 kts. A model wing will be tested with anti-icing fluids and with frozen and/or freezing contamination using ice pellets alone and mixed with other forms of frozen precipitation.

Conduct similar research using the lowest rotation speed associated with commercial airliner de-rated take offs typically 95 kt. This initiative will identify possible changes in allowance times associated with the 95kt rotation value. Monitor and evaluate innovative research into the performance and feasibility of coatings such as paints containing carbon microfibers which, when subjected to an electric current, raise the temperature of aircraft surface construction material surfaces for anti-icing applications.

Conduct, Monitor, and evaluate research into the performance and durability of ice phobic coatings applied to aircraft surface construction materials. This innovative approach may prove useful in keeping difficult to anti-ice surfaces such as vertical stabilizers free of frozen contamination.

Milestones:

- Report or briefing on survey of selected technical and operational issues and their priority / importance to the safety and efficiency of ground operations in winter conditions. (September 2022)
- Investigate technical and operational issues identified in Milestone for Task 1. Investigation of selected technical and operational issues identified under Milestone for Task 1 (December 2021 – September 20222)
- Analyze findings from investigations of selected technical and operational issues described under Milestone for Task 2. (September 2022)

Output: Reports on findings from investigations of selected technical and operational issues. Reports may include recommendations for advisory material to be incorporated into annual ground icing notice. (May 2022)

Project: Research on Ice Crystal Icing Conditions to Address Fundamental Knowledge of High Altitude Icing on Turbine Engine Damage and Power loss (A11D.AI.1)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11D.AI.1	Mitigate the hazardous impact of ice accretions on engine operation and core components, such as compressors, due to ice crystal ingestion.	Research on Ice Crystal Icing Conditions to Address Fundamental Knowledge of High Altitude Icing on Turbine Engine Damage and Power loss (AIR/ANG-E2)		FY17	FY24	$300

Project Output: Research on Ice Crystal Icing Conditions anticipated research outputs in FY22 (A11D.AI.1)

The research plans to address this shortfall is to develop new capabilities in fundamental understanding of ICI conditions; new physics-based models that represent the underlying physics of ice crystal trajectory, particle centrifuging and sticking efficiency (adherence to surfaces), impact and fracturing, accretion, and release; all of which better represent engine event conditions. Understanding facility-test capabilities representative of altitude conditions to better understand scaling and representative capabilities for flight configurations from known events will also be addressed.
This research will support two tasks of the Aviation Rulemaking Advisory Committee (ARAC) Engine Harmonization WG (EHWG) Technology Plan: Experimental studies and simulation development (EHWG Task 3), and Data and technical information for rulemaking (EHWG Task 4).

Task 1: Fundamental study using a static rig of important variables and simulation methods for ice crystal ingestion and ice formation inside a turbine engine compressor.
Status: Completed. National Research Council Canada (NRC) developed spray cloud generation techniques for ice crystals in engine test cells and NRC developed refined highly accurate grinding techniques to deliver ice crystals in their research altitude test facility. Static model test results established variables of influence and physical models were developed to represent sticking efficiency and ice crystal growth. NRC published their results in public forums

Task 2: Develop a new innovative physics-based ICI accretion model using a small-scale model rotating rig to conduct simulated compressor studies. Examine altitude-scaling physics to develop similitude methods to compensate for these conditions in sea-level test facilities.
FAA and NRC will collaborate in the design and fabrication of this new and innovative scale model test rig. This rig will provide the ability to conduct test studies in altitude conditions for ice crystal ingestion in environments representing an engine compressor operating in ICI to evaluate the variables that influence internal ice crystal formation mechanisms.
Milestone #1: complete fabrication of a small-scale test rig (complete).
Milestone #2: initiate study of altitude scaling effects to determine first order effects and primary variables of influence
Status: The majority of the rig hardware has been fabricated and is being assembled to date

Task 3: Investigate using a small-scale rotating rig the key drivers that cause internal engine ice accretions due to ice crystal icing conditions.
Milestone #1: conduct ground facility testing in altitude conditions with simulated ice crystal generation to study particle movement in a rotational field: study centrifuging effects, accretion dynamics, and perform parametric studies on the influences of velocity, altitude, ice particle size and content, melt ratio, and wet bulb temperature in a model representative of an engine compressor (FY19-21).
Milestone #2: conduct ground facility testing in altitude conditions with simulated ice crystal generation to study particle melting, adhesion and erosion of liquid water from melting, heat transfer and energy balance and energy changes in a control volume, required for accretion (FY-22-24).
Output: Results to be delivered in technical reports and conference presentations.

Program Resources ($K): Aircraft Icing (A11D)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Environment & Weather Impact Mitigation									
Aircrft Icing (A11D.AI)	$4,056	$2,790	$4,486	$3,171	$4,458	$3,143	$1,315	$0	$820

People	Facilities	Partnerships
• 5 FTEs in various technical disciplines including engineering, analytics, atmospheric science, etc.	• FAA CASSIE (For CFD modeling)	• NASA Glenn Research Center • Transport Canada • National Research Council (NRC) of Canada • Environment and Climate Change Canada (ECCC) • ONERA (France)

Program Area: Alternate Fuels for General Aviation (A11M)

This research evaluates unleaded aviation gasolines to provide data to support FAA Authorization of the use of the unleaded fuel in general aviation engines and aircraft, using the authority granted to the FAA in the FAA Reauthorization Act of 2018 Public Law No: 115-254, Passed 10/05/2018.

Project: Alternative Fuels for General Aviation A11M.PS.5

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11M.PS.5	The safe deployment of alternative GA avgas and approved mitigating safety measures and/or equipment for exempted aircraft models. The issuance of ASTM fuel production specification(s), and the issuance of procedures and regulations (the PAFI process) for the qualification and authorization of new, future unleaded fuels.	Alternative Fuels for General Aviation (AIR/ANG-E2)	Yes	FY2021	FY2029	$5,888

Project Outcome: Alternate Fuels for General Aviation anticipated research outputs in FY22 (A11M.PS.5)

The FAA will perform this research to continue the current PAFI program.

- Research in FY22 includes test and evaluation on final fuel formulation candidates and includes test cell engine tests, aircraft flight testing, materials compatibility testing and laboratory analysis of fuels and lube oils in accordance with the program schedule and approved PAFI test plans. Research performers will conduct testing to generate data demonstrating the safe operation of engines and aircraft on unleaded fuels. This data will support 1) the FAA issuance of a fleet authorization for an unleaded fuel, 2) the fuel company to obtain an ASTM International production specification and 3) provide information necessary to address any necessary lube oil specification changes for piston aircraft through the SAE E38 committee.
- Engine testing will be conducted in engine test cells at ground level and using altitude simulation capabilities as required by specific PAFI test plans to measure engine performance, detonation, durability and other operating characteristics showing if unleaded fuels meet the applicable requirements of FAA 14 CFR Parts 33.45, 33.47, 33.49, 33.55, and 33.57. Engine tests will be performed on fleet representative engine models and may include development and evaluation of modifications that will mitigate any limitations of PAFI fuels.
- Aircraft flight testing will be conducted to document ground and flight operational characteristics and to verify if the performance of aircraft on candidate fuels meet the PAFI applicable requirements of FAA 14 CFR Part 23 and ASTM D7826. Flight Tests will be performed on fleet representative aircraft models and may include development and evaluation of modifications that will mitigate any limitations of PAFI fuels.
- Materials research testing will include cooperative research in the areas of laboratory rig and materials compatibility testing with the novel fuels and potential fuel additives. Research will be comprised of tests to simulate a variety of conditions and include testing for materials degradation, aging conditions, performance

characteristic changes, and property changes from exposure to heat and cold. Materials will be assessed after exposure to the novel fuels for conformance to FAA Technical Standard Orders (TSO), ASTM test criteria and compatibility with Parts Manufacturer Approval (PMA) engine and fuel system components including elastomeric materials, bladders, seals, and other fuel system materials. Individual tests range from a few weeks to over 6 months

- Candidate fuels and lube oils used in the engine, aircraft and flight-testing will be subject to chemical and physical properties analysis in accordance with ASTM International test standards. Laboratory analysis will also be performed on fuel deliveries for the engine, aircraft, and materials test segments to verify that fuel elemental compositions are consistent with proposed fuel formulation specifications.

The outputs in FY22 include:

- Research reports on materials compatibility tests
- Updated test-cell testing procedures and engine/fuel system research reports
- Flight test procedures and flight test research reports
- Certificate of analyses reports

Program Resources ($K): Alternate Fuels for General Aviation (A11M)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Environment & Weather Impact Mitigation									
Alternate Fuels for General Aviation (A11M)*	$0	$0	$1,900	$758	$1,900	$697	$2,524	$2,242	$5,888
**NOTE: GA Fuels funded from NEXTGEN budget through FY18*									

People	Facilities	Partnerships
• 6 GOV FTEs and 10 CTR FTEs in various technical disciplines including engineering, analytics, material science, chemistry, lab testing, etc.	• FAA Aviation Fuel Research Lab (AFRL) • FAA Propulsion & airpOWer Engineering Research (POWER) Lab	• **INDUSTRY: Aircraft Owners and Pilots Association (AOPA),** • **American Petroleum Institute (API)** • **Experimental Aircraft Association (EAA)** • **General Aviation Manufacturers Association (GAMA)** • **National Business Aviation Association (NBAA)** • **National Air Transportation Association (NATA)** • **Shell Global** • **Afton Fuels/Phillips 66** • **Mobil/Exxon** • **BP-Total/Hjelmco (JV)** • **Swift Fuels** • **Calumet Operating, LLC** • **Lyondell Chemical Company** • **Lycoming Engines** • **Continental Motors Group** • **BRP-Rotax GmbH & Co KG** • **Textron Aviation** • **Robinson Helicopter Company** • **Cirrus Aircraft** • **Cape Air** • **McCauley Propeller Systems** • **Hartzell Propeller** • **Radial Engines Ltd** • **ACADEMIA: Purdue University-PEGASAS Center of Excellence,** • **Embry Riddle Aeronautical University** • **GOVERNMENT: Environmental Protection Agency**

Domain: Human Performance & Aeromedical Factors

Flight Deck/Maintenance/System Integration Human Factors (A11G)

This research enhances decision making related to human factors for flight deck systems, and establishing data to support risk management programs to address hazards in the maintenance environment.

Project: Advanced Vision Systems (A11G.HF.4)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11G.HF.4	Increase terminal area safety, access, efficiency, capacity, and throughput in low visibility conditions using advanced vision systems, head-up displays, and head-mounted displays. Expanding the use of these technologies will enable more flight operations to occur in low visibility conditions with less ground infrastructure while maintaining an appropriate level of safety during approach, landing, taxi, and takeoff operations.	Advanced Vision Systems (EFVS, EVS, SVS, CVS), Head-Up Displays (HUD), and Head Mounted Displays (HMD): Operational Standards & Approval Criteria (AFS/ANG-C1)	Yes	FY15	FY24	$1,300

Project Output: Advanced Vision Systems anticipated research outputs (A11G.HF.4)

Synthetic Vision Guidance System (SVGS) Research
Project Title: SVGS Operations to Lower than Standard Localizer Performance with Vertical Guidance (LPV) Minima
Scope/Description: A human-in-the-loop (HITL) simulation will be conducted to determine the contribution of an SVGS to a pilot's visual search and acquisition of a runway environment when conducting a non-precision LPV approach in lower than standard minima, like 150' decision height (DH) and 1400 runway visual range (RVR), similar to Special Authorization (SA) Category (CAT) I instrument landing system (ILS) minima. This HITL will identify the pilot performance, human factors, and operational impacts associated with this concept of operation, and whether pilot performance is sufficiently comparable to the baseline condition.
Outputs: Research Design and Test Plan; HITL Simulation Data; Final Technical Report
Impact: Through forums such as RTCA SC-213, industry has expressed an ongoing interest in the use of SVGS for lower than standard LPV minima, starting with 1400 RVR and 150' DH (similar to SA CAT I ILS) down to 1200 RVR and 100' DH (similar to CAT II ILS). This research will enable the FAA to maintain and update (where appropriate) the policy, rules, guidance, and other materials needed to approve certification applications that will be submitted by original equipment manufacturers (OEMs) to extends the use of existing SVGS technologies to new concepts of operation. This includes: Flight Standards policy and operational criteria; Operational safety assessments; Conditions, limitations, and mitigations; Operational approval processes and job aids for Principal Inspectors; Training, recent flight experience, and proficiency requirements for pilots, dispatchers, and

other persons authorized to exercise operational control; FAA orders and Advisory Circulars (ACs); Operations Specifications (OpSpecs), Management Specifications (MSpecs), and Letters of Authorization (LOAs); Charting standards; Airmen information publications; Safety Alerts for Operators (SAFOs) and Information for Operators (InFOs); Aircraft Evaluation Group (AEG) evaluation criteria; and Pilot performance considerations, conditions, and limitations associated with applications for waiver and petitions for exemption from operating rules.

Enhanced Flight Visions Systems (EFVS) Research

Project Title: EFVS Operations conducted to 100 Feet above the Touchdown Zone Elevation Using a Head-down Display (HDD)

Scope/Description: A HITL simulation will be conducted to determine the contribution of an EFVS head-down-display (HDD) to a pilot's visual search and acquisition of a runway environment 100' above touchdown zone elevation. This HITL will identify the pilot performance, human factors, and operational impacts associated with this concept of operation, and whether pilot performance is sufficiently comparable to pilot performance obtained when using an EFVS head-up display (HUD). In current operations, the EFVS rule does not permit EFVS operations without using a HUD.

Outputs: Research Design and Test Plan; HITL Simulation Data; Final Technical Report

Impact: OEMs and industry are developing and investing in EFVS head-down display technologies. This research will provide the FAA with the human factors data needed to potentially expand the existing EFVS rule to include EFVS head-down operations. The EFVS rule currently limits OEMs and industry to costly, and sometime space prohibitive (e.g. smaller aircraft), EFVS head-up display (HUD) operations. This research will enable the FAA to maintain and update (where appropriate) the policy, rules, guidance, and other materials including: Operating rules; Flight Standards policy and operational criteria; Operational Safety Assessments; Conditions, limitations, and mitigations; Operational approval processes and job aids for Principal Inspectors; Training, recent flight experience, and proficiency requirements for pilots, dispatchers, and other persons authorized to exercise operational control; FAA orders and ACs; OpSpecs, MSpecs, and LOAs; Airmen information publications; SAFOs and InFOs; AEG evaluation criteria; and Pilot performance considerations, conditions, and limitations associated with applications for waiver and petitions for exemption from operating rules.

Project: Human Factors Considerations and Emerging Trends Associated with Helicopter Air Ambulance Operations (A11G.HF.13)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11G.HF.13	Reduce the number of accidents and incidents in helicopter air ambulance operations attributable to human factors. Update and inform the FAA's understanding of current industry risks and emerging issues and trends. Improve strategies and procedures for addressing human factors risks. Enable the development of fatigue risk measures that will inform improvements in the strategic use of rest facilities, fitness for duty requirements, and scheduling practices.	Human Factors Considerations and Emerging Trends Associated with Helicopter Air Ambulance Operations (AFS/ANG-C1)	Yes	FY21	FY26	$1,000

Project Output: Human Factors Considerations and Emerging Trends Associated with Helicopter Air Ambulance Operations (A11G.HF.13)

Helicopter Air Ambulance (HAA) Research
Project Title: Evaluation of HAA Accidents and Incidents (2014 – Present) to Identify Causal and Contributing Human Factors
Scope/Description: This research will focus on the development of a validated rotorcraft human factors analysis framework to identify human factors issues across the HAA domain. This is inclusive of human factors issues during normal operations, non-normal operations, accidents, and incidents. This research will result in the development of a technical report that identifies high priority HAA human factors issues. This report will serve as a distribution channel to engage high priority stakeholders who will apply this data to formulate a field study aimed at developing and evaluating human factors mitigations/interventions.
Outputs: Validated Human Factors Analysis Framework, HAA Human Factors Accident and Incident Data, Final Technical Report
Impact: Unlike other domains, rotorcraft does not have a mature set of safety tools, such as a human factors analysis framework, to identify underlying factors that impact operational human performance. This research will provide the FAA with scientific data, analysis, and recommendations to address the continued increase in HAA accidents and incidents. The FAA will also apply human factors data to inform and update (where appropriate) policy, regulations, standards, and guidance, including AC 120-96, AC 135-14, AC 00-64, FAA Order 8900.1 (FSIMS), Aeronautical Information Manual (AIM), SAFOs and InFOs, as well as operating requirements, conditions, limitations, mitigations, technical focus areas for surveillance, and risk analysis tools and methods.

Project Title: Helicopter Air Ambulance Fatigue Risk Baseline
Scope/Description: This research will focus on the development of a draft fatigue risk baseline for the HAA industry. First, researchers will collect schedule-based fatigue data and operational fatigue data to develop the draft baseline. Second, a field study will be conducted to validate the draft baseline (i.e. actigraphy data, PVT data) from a representative sample of HAA pilots and mechanics. Lastly, the research team will use fatigue risk assessment algorithms to identify improvement opportunities for HAA scheduling practices, fitness for duty requirements, and use of rest facilities.
Outputs: Draft Fatigue Risk Baseline; Validated Fatigue Risk Baseline; Final Report
Impact: This research will provide the FAA with scientific data, analysis, and recommendations to address the contribution of fatigue to HAA accidents and incidents. The FAA will also apply human factors data to inform and update (where appropriate) policy, regulations, standards, and guidance, including AC 120-96, AC 135-14, AC 00-64, FAA Order 8900.1 (FSIMS), Aeronautical Information Manual (AIM), SAFOs and InFOs, as well as operating requirements, conditions, limitations, mitigations, technical focus areas for surveillance, and risk analysis tools and methods.

Project: Pilot Training, Qualification, Procedures and Flight Operations (A11G.HF.11)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11G.HF.11	Training and operational effectiveness- recommendations for inspectors as well as operators on the capabilities and limitations of contemporary training methods strategies and devices, with specific guidance on new technologies (e.g., virtual reality or augmented reality) and emerging risks.	Pilot Training, Qualification, Procedures and Flight Operations (AFS/ANG-C1)		FY22	FY25	$3,336

Project Output: Pilot Training, Qualification, Procedures and Flight Operations anticipated research outputs in FY22 (A11G.HF.11)

Phases and exit criteria are described below for each of the following research areas:

Pilot Training, Qualification, Procedures, and Flight Operations Research
Project Title: Training and Operational Effectiveness
Scope/Description: A literature review will be completed to identify aviation and non-aviation techniques for incorporating operational lessons learned into training programs. Upon completion, researchers will survey industry to understand how Part-121 operators include lessons learned from unexpected events into pilot training programs. Researchers will examine the effectiveness of those techniques and provide generalizable recommendations to improve learning from positive and negative event outcomes and including those lessons learned in pilot training curriculums.
Outputs: Literature Review Report, Final Report
Impact: The FAA will add human factors data, as appropriate, training related rules, guidance, policy, and other materials including 14 CFR Part 121: AC 120-54 Advanced Qualification Program, AC 120-51 Crew Resource Management Training, AC 120-(FPM) Flight Path Management, AC 91-79A Mitigating Risks of a Runway Overrun Upon Landing, AC 120-71 Standard Operating Procedures and Roles and Responsibilities of Pilot Monitoring AC 120-35 Line Operational Simulation.

Project Title: Development of a Flight Standards-focused Human Factors General Guidance Document (GGD)
Scope/Description: This research will focus on the development of a Flight Standards (AFS) focused GGD. This document will be a single source reference for human factors related rules, guidance, and standards that are frequently applied by AFS personnel to evaluate and approve the operational use of flight deck technologies and pilot procedures. Based on technical inputs from field personnel, industry, working groups, and others, this document will also include examples of human factors-related issues experienced by AFS field personnel when applying existing rules, guidance, standards, and other materials to evaluate training, flight deck procedures, and emerging flight deck systems/technologies. This document is not intended to replace FAA rules, guidance, or industry accepted standards.
Outputs: Research Plan, Flight Standards-focused General Guidance (PDF, E-Book, Interactive Website)
Impact: This research will provide the FAA a baseline of human factors-related issues experienced by AFS field personnel when applying existing rules, guidance, standards, and other materials to evaluate training, flight deck procedures, and emerging flight deck systems/technologies. This research will result in a single source reference document that could reduce the impact of human factors information accessibility issues experienced by AFS field personnel. Further, as appropriate, the FAA could apply findings from this research to update and/or maintain rules, guidance, policy, and other materials including 14 CFR Part 121: AC 120-54 Advanced Qualification Program, AC 120-51 Crew Resource Management Training, AC 120-(FPM) Flight Path Management, AC 91-79A Mitigating Risks of a Runway Overrun Upon Landing, AC 120-71 Standard Operating Procedures and Roles and Responsibilities of Pilot Monitoring AC 120-35 Line Operational Simulation.

Project Title: Crew Resource Management
Scope/Description: This research will focus on the development of a human factors research plan to validate proposed indicators of pilot performance in CRM. This includes generalizable training markers, unique observable behaviors, and cognitive indicators of pilot performance in CRM. To inform this research plan a survey will be administered and guided discussions will be completed with Part-121 operators and/or industry experts.
Outputs: Survey/Guided Discussion Report, Research Plan

Impact: The FAA will use this research as a first step in addressing potential CRM gaps in operations. Further, as appropriate, the FAA could apply findings from this research to update and/or maintain rules, guidance, policy, and other materials including 14 CFR Part 121: AC 120-54 Advanced Qualification Program, AC 120-51 Crew Resource Management Training, AC 120-(FPM) Flight Path Management, AC 91-79A Mitigating Risks of a Runway Overrun Upon Landing, AC 120-71 Standard Operating Procedures and Roles and Responsibilities of Pilot Monitoring AC 120-35 Line Operational Simulation.

Project Title: Performance Based Airmen Certification

Scope/Description:

Phase 1: Identify characteristics of job screening for training programs to be incorporated into FAA guidance materials.

Phase 2: Examine current training programs (to include civilian, military and international programs) and collect data on their effectiveness.

Outputs: Research Plan, Draft Training Baseline Report

Impact: As appropriate, the FAA could apply initial findings from this research to update and/or maintain rules, guidance, policy, and other materials including 14 CFR Part 121: AC 120-54 Advanced Qualification Program, AC 120-51 Crew Resource Management Training, AC 120-(FPM) Flight Path Management, AC 91-79A Mitigating Risks of a Runway Overrun Upon Landing, AC 120-71 Standard Operating Procedures and Roles and Responsibilities of Pilot Monitoring AC 120-35 Line Operational Simulation.

Project Title: Adapting Training and Flight Operations to Emerging Risks

Scope/Description:

Phase 1: Collect, analyze, and identify aircraft accident and incident data where a contributing factor and/or causal factor of the event was attributed to a pilot's response time to an automated flight deck system. Evaluate each set of accident and incident data to understand the role and impact of interdependent systems to pilot performance, including failure mode detection and pilot response time.

Phase 2: Develop a research plan to evaluate pilot response time(s) to automated flight deck systems. An emphasis will be placed on interdependent flight deck systems (e.g. within and between disparate systems), multiple equipment failures, and varying levels of pilot experience. Execute the FAA approved research plan and conduct a human-in-the-loop (HITL) study with current line pilot participants. Evaluate study results to identify potential human-system performance gaps.

Outputs: Research Plan, Technical Report

Impact: As appropriate, the FAA could apply initial findings from this research to update and/or maintain rules, guidance, policy, and other materials including 14 CFR Part 121: AC 120-54 Advanced Qualification Program, AC 120-51 Crew Resource Management Training, AC 120-(FPM) Flight Path Management, AC 91-79A Mitigating Risks of a Runway Overrun Upon Landing, AC 120-71 Standard Operating Procedures and Roles and Responsibilities of Pilot Monitoring AC 120-35 Line Operational Simulation.

Project Title: Pilot Training and Procedures for Runway Safety

Scope/Description:

Phase 1: Conduct a literature review of airport and runway safety studies. Compile and analyze runway safety event data to identify causal and contributing factors.

Phase 2: Evaluate existing FAA runway safety data (e.g. incursion statistics, excursion statistics), and FAA and industry training materials to identify potential gaps and human factors issues. Identify generalizable human factors interventions, including training and procedural mitigations that aim to reduce runway safety events.

Outputs: Literature Review Report; Technical Report

Impact: As appropriate, the FAA could apply initial findings from this research to update and/or maintain rules, guidance, policy, and other materials including 14 CFR Part 121: AC 120-54 Advanced Qualification Program, AC 120-51 Crew Resource Management Training, AC 120-(FPM) Flight Path Management, AC 91-79A Mitigating Risks of a Runway Overrun Upon Landing, AC 120-71 Standard Operating Procedures and Roles and Responsibilities of Pilot Monitoring AC 120-35 Line Operational Simulation.

Program Resources ($K): Flight Deck/Maintenance/System Integration Human Factors (A11G)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Human Performance & Aeromedical Factors									
Flight Deck/Maintenance/System Integratio Human Factors (A11G)	$7,095	$3,626	$7,305	$2,710	$7,300	$2,587	$7,469	$2,681	$5,636

People	Facilities	Partnerships
• FAA project managers and principal investigators along with researchers and industry partners through contracts and agreements that include Human Factors Subject Matter Experts, Flight Deck Professionals, and Air Traffic Controllers	• Civil Aerospace Medical Institute (CAMI) • William J Hughes Technical Center (WJHTC) • Private Industry	• Industry • NASA • Volpe • Radio Technical Commission for Aeronautics (RTCA) • Universities

Program Area: Aeromedical Research (A11J)

Provide up-to-date guidance and standards to enhance human safety, security, and survivability in civilian aerospace operations.

Project: System Failures that result in Air Contamination (A11J.FCMS.2)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11J.FCMS.2	This research is in response to Congressional direction mandated in Section 326 of the 2018 FAA Reauthorization, in which Congress requires the FAA to deliver a report on the feasibility, efficacy, and cost-effectiveness of certification and installation systems to evaluate bleed air quality, by commissioning a study by the Airliner Cabin Environment Research Center of Excellence. The outcome will be the aforementioned report.	System Failures that result in Air Contamination (AIR/AAM)	Yes	FY21	FY24	$750

Project Output: System Failures that result in Air Contamination anticipated research outputs in FY22 (A11J.FCMS.2)

AIR and the RITE-ACER COE have developed a research proposal that recommends a combination of research review, analysis and ground testing, and limited flight tests to provide the most cost effective response to the congressional mandate. The report identifies 12 potential tasks. Key decision points are established to determine whether to proceed to certain task. Representatives from AIR, AAM, and ANG support Tasks 1 through 8 to address Section 326, subpart(c). Tasks 1 through 8 include research review, analysis, and ground testing. These tasks involve RITE-ACER COE, FAA, and industry participants; are conservatively estimated to range in cost from $750K to $1400K; and take up to 54 months to complete.

AIR has secured management approval and funding ($496K) to begin the research (Tasks 1 through 3). Funding is in progress and we estimate completion of these tasks by the end of FY'20. Additional funding in FY'21 will be needed to continue the research prior to the start of funding provided in this proposal (FY'22).

Project: CAMI Human Protection & Survival (A11J.AM.3)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11J.AM.3	AM.3 will improve the protection and survival of humans involved in aerospace operations by: 1. Identifying new cognitive screening tools to determine which pilots have adequate cognitive function to be medically certified to fly. This is being done to replace our previous cognitive screening tool that was compromised. 2. Research the effects of various medications on pilot performance at altitudes using CAMI's research chambers. A report will be produced that recommends medical certification strategies based upon the results. 3. Continue our review of passenger evacuations with a focus on mitigation of injuries associated with egress from a wide-body aircraft and the associated slides. A report will be produced, detailing the most effective strategies to egress quickly and minimize the risk of injuries. 4. Continue research to harmonize the construction of the anthropomorphic test devices (ATDs, a.k.a. Test Dummies) used in aerospace crash testing. This will improve the testing to reduce injuries to the spine. The report produced will be used to enhance certification processes and standards for assessing spine injury risk.	CAMI Human Protection & Survival (AAM/AAM)		FY22	FY22	$1,620

Project Output: CAMI Human Protection & Survival anticipated research outputs in FY22 (A11J.AM.3)

Cognitive Screening Test Categorization and Assessment Report

Objective: To identify and evaluate valid and reliable cognitive screening tests to be used for aeromedical certification and research, and to provide valid, reliable norms for more than one commercially –available neurocognitive test for civilian airmen certification and research.

Tasks: Form a joint cross-organizational, cross-agency, and cross-departmental working group to perform a literature review immediately initiate a literature review to identify all acceptable cognitive tests. Make interim recommendations (such as conservative cut scores where norms do exist) within two years. Undertake normative data collection for the most promising test or tests in years three through five, provided funding is allocated via FAA's RE&D Prioritization Process.

Effects of Medications on Human Performance at Altitude Report

Objective: Develop and validate a standardized aerospace medical testing protocol(s) to address the effect of certain medications and other substances on human performance in the aviation environment, to include norm baric (PROTE) and hypobaric hypoxia (altitude chamber), flight simulation tasks (use of simulator(s) or other tools) to assess human performance, and reproducible neuropsychological/functional tests. Substances of interest include: long-term-acting insulin, diphenhydramine (Benadryl), pseudoephedrine (Sudafed), and alcohol. Assessment of continuous glucose monitoring devices and insulin pumps will be included in the hypobaric research protocol.

Passenger Evacuation Review – Wide Body Aircraft Slide Egress Report and Recommendations

Objective: To gain a better understanding of the history of evacuation slides used for passenger egress from aircraft and to review the techniques for the utilization of the evacuation slides to minimize the risk of injury to the user. Researchers, regulators, and manufacturers of aircraft slides have long noted injuries during the use of evacuation slides for egress from aircraft. This project will be an extensive review of the history of evacuation slides and will review the large amount of recorded usage of evacuation slides at CAMI events and those made available to the researchers from aircraft manufacturer and slide manufacturer certification tests. As the information is available, injuries reported (e.g., at minimum for those at CAMI) will be quantified, described, and their potential root cause and mitigation strategies for both training and emergency egress situations will be discussed. This project will allow the researchers to better understand and quantify the techniques that both lead to and prevent injury to users during an evacuation. This project will be a literature and archival review and will not require human subjects.

ATD Construction Harmonization Phases I – II Reports

Objective: Results of a previous project identified ATD construction variability as a factor in inconsistent vertical impact response. This resulted in a recommendation that the Hybrid-III pelvis (which currently has the tightest construction tolerance) be installed on any ATD used to evaluate lumbar load. This action should improve test consistency significantly, however, current ATD specifications do not ensure all parameters that can affect vertical response are adequately controlled. Harmonizing pelvis and lumbar spine construction between current (and future) ATD manufacturers is necessary to ensure consistent response. Also, since the pelvis force injury criteria was derived using a specific (1970's era) ATD construction, these criteria may need to be re-evaluated once ATD construction is standardized with respect to vertical response. Long lead times for design and production of prototype and standard ATD parts require this project be accomplished over a span of 5 years.

Tasks:

1. Phase I**:** Evaluate the pertinent characteristics of current production ATD pelvis assemblies.
2. Phase II**:** Develop part performance standards to establish harmonization requirements and assess the effect of harmonized parts on spine injury criteria measurement.

Project: CAMI Aerospace Medical Systems Analyses (A11J.AM.1)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11J.AM.1	There have been recent advances in the treatment and maintenance of many pathologies. This requirement examines the long-term data to assist in determining the risk of medically certifying pilots with certain medical conditions or pathologies, and recommends criteria to assist in making this determination. One FY22 project will look specifically at the 5 year prognosis for airmen with Cystic Fibrosis. The outcome of the study will be a report making the recommendation for if, and under what conditions it may be safe to allow pilots with this condition to continue to be medically certified for flight. This Aeromedical Requirement performs research to "right-size" our aeromedical regulations by using available evidence to allow as many pilots with pathologies or medical diagnoses to continue flying where it can be shown that it is safe to do so.	CAMI Aerospace Medical Systems Analyses (AAM/AAM)	Yes	Unknown or FY22	FY22	$1,002

Project Output: CAMI Aerospace Medical Systems Analyses anticipated research outputs in FY22 (A11J.AM.1)

An Inclusive Aerospace Medicine Data Table and Feasibility Report
Objective: The goal of this project is to construct a non-normalized, single-table of a very large amount of aerospace medical data that will both test the usefulness of such an approach, for use in planned research, and allow for much more timely responses to "pop-up" data calls**. Output:** Draft report of Methodology and Data Table. PI: Dr. Mills. Sponsor: AAM-1. REQ: AM-1BEST

Medical Transport Method Selection Tool and Report
Objective: This research will increase the FAA's understanding of helicopter operations and provide insight as to the best and most efficient method of medical transport for a patient, given a set of known factors. **Output:** Abstract, Tool, and Draft Report. PI: Dr. Greenhaw. Sponsor: AAM-1 REQ: AM-1

Cystic Fibrosis in Airmen, 5-Year Prognosis Report and Recommendations
Objective: Study the 5-year prognosis of a Cystic Fibrosis in airmen, to assist in determination of the aerospace medical certification physicians of pilots with these path codes to continue to fly.

Intermediate Visual Acuity in Older Third-Class Pilots Report

Objective: To determine the prevalence of uncorrected intermediate vision in older third-class medical certificate holders – and the prevalence and methods of correcting intermediate vision in this group Intermediate visual acuity for each subject will be measured with a standard vision testing target

Acquiring Aviation Data from Textual Analysis of Social Media Code and Report

Objective: This is an exploratory project and demonstration of the use of social media for collecting important safety-related aviation data that is not currently available to the FAA. Method: Explore and develop the initial software tools and techniques needed to capture aviation related events that are mentioned on a major social media site (e.g. Twitter) and to monitor selected aviation topics and associated sentiment on twitter as well as aviation-oriented discussion forums. Specific targets of this study would include some of the following possibilities

- Real time data gathering for specific accidents and comparison with current manual searches.
- Developing automatic methods to identify accident location locals and witnesses which may assist FAA accident investigators.
- Surveillance of aviation forums to identify AMEs and BasicMed physician providers who are outliers and may require further investigation.
- Exploration of the social media data related to the recent Boeing 737-MAX issues including evaluating the public opinion related to safety concerns, topics of discussion and variations of these topics over the time, etc.

Safety Experience of Pilots Holding Sport Pilot Certificates Report

Objective: This research will investigate the safety of flight operations that do not require the pilot to possess a current FAA medical certificate for Sport Pilots.

Project: Effects of cabin seat pitch and alternative seat configurations on evacuation (A11J.FCS.7)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11J.FCS.7	New regulatory requirements and guidance concerning seating arrangements for transport category airplanes.	Effects of cabin seat pitch and alternative seat configurations on evacuation (AIR/AAM)	Yes	FY19	FY22	$223

Project Output: Effects of cabin seat pitch and alternative seat configurations on evacuation anticipated research outputs in FY22 (A11J.FCS.7)

PHASE 1: Develop specific protocol to address seat size and spacing to support the Act-2019;

- Phase 1a, perform testing, FY20;
- Phase 1b write report on seat size and spacing FY20/21

PHASE 2: Identify relevant nontraditional configurations and Develop experimental protocols FY21

- Draft test plan March 2021;
- Identify test subject source
- Perform testing FY22;
- February 2021 Configure test articles
- May 2022 Conduct tests
- September 2023 Deliver Report

Project: Passenger Retention of Cabin Safety Information (A11J.FCS.14)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11J.FCS.14	New regulatory requirements and guidance concerning passenger safety briefings, flight attendant actions, and carry-on baggage stowage provisions for transport category airplanes.	Passenger Retention of Cabin Safety Information (AIR/AAM)		FY22	FY24	$25

Project Output: Passenger Retention of Cabin Safety Information anticipated research outputs in FY22 (A11J.FCS.14)

Develop study plan:

- Understanding and Retention of Cabin Safety Information by Passengers
- Conduct Study Review results
- Develop means to address deficiencies
- Phased implementation of means

Program Resources ($K): Aeromedical Research (A11J)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Human Performance & Aeromedical Factors									
Aeromedical Research (A11J)	$9,686	$4,024	$9,080	$2,178	$7,919	$2,419	$10,235	$3,136	$3,620

People	Facilities	Partnerships
• 51 In-House at the Civil Aerospace Medical Institute (CAMI): 44 GOV FTE; 7 CTR FTE • Physicians, Scientists, and Engineers: Associate (19%); Baccalaureate (71%), Master (49%), and Doctorate (27%). • Disciplines: Medicine, Human Factors, Cabin Safety, Genomics, Bioinformatics, Biodynamics, Radiobiology, Physiology, Physics, Chemistry, Toxicology, Mathematics, Computer Science, and Knowledge Management	> 20 at CAMI • 747 Aircraft Environment Research Facility (AERF) • Flexible Aircraft Cabin Evacuation Simulator (FlexSim) • Water Survival Research Facility (WSRF) • Biodynamics Impact Sled • Anthropomorphic Test Device Staging Area • Altitude Chambers (Research and Training) • Forensic Toxicology Analytical Research Laboratory • Functional Genomics Research Laboratory • Friedberg Numerical Sciences Laboratory	• 40 National: OK Medical Research Foundation, Naval Medical Research Unit-D, USAFSAM, Wichita State University. Walter Reed Army Institute of Research, SW Research Institute, Medical College of Wisconsin, University of Michigan Transportation Research Institute, Cleveland Clinic Foundation, Transportation Safety Institute, United States Helicopter Safety Team (USHST), National Oceanic and Atmospheric Administration (NOAA), US Dept. of Homeland Security, National Transportation Safety Board, US Customs and Border Protection, Airlines for America, Cleveland Clinic, ASME, NASA., Children's Hospital of Philadelphia Research Institute, Center for Child Injury Prevention Studies (CChiPS), NHTSA, Aerospace Medical Association (AsMA), NIOSH, UTMB Health, MedAire, SAFE Association, General Aviation Joint Steering Committee, Canadian Royal Air Force, US Marshals, etc.… • 40 International: Airbus; Bahamas CAA; European Aviation Safety Agency; German Aerospace Center; Intl. Cabin Safety Res. Tech. Gp.; ICAO; Natl. U. of Colombia; Republic of Korea Radio Research Agency; Royal Canadian AF; SAE International; Czech Technical U.; Università degli Studi di Udine, Italy.

Domain: Aviation Performance & Planning

Program Area: System Safety Management – SSM (A11H)

Anticipation of system-wide operational risks, Additional data-driven approaches, Lower accident rate due to loss-of-control, Fewer runway excursions and Improved helicopter safety, Support Risk-Based Decision Making for oversight of the Air Traffic Organization.

Project: Helicopter Flight Data Monitoring and Analysis (A11H.SSM.9)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11H.SSM.9	Reduction in the fatal accident rates for specific rotorcraft mission segments and increased safety through more voluntary reporting and analytical measures with a reduction in overall accidents/incidents for the vertical lift community, especially considering interaction with unmanned and other novel aircraft/rotorcraft (i.e. tiltrotors, urban air mobility platforms).	Helicopter Flight Data Monitoring and Analysis (AVP/ANG-E2)	Yes	2022	2025	$590

Project Output: Helicopter Flight Data Monitoring and Analysis anticipated research outputs in FY22 (A11H.SSM.9)

Ongoing research in these areas for helicopters will help identify new safety data sources, develop new analysis, tools, techniques, and metrics, simulation tools and replay capabilities, and perform accuracy analysis of various flight data recorders and directed studies for those conditions/causal factors identified by the Helicopter Issue Analysis Team (IAT) within the ASIAS program.

Phase 1: Investigate New Helicopter Safety Data Sources - Research and examine new state-of-the art HFDM recorders and data capture devices, especially devices that incorporate mobile wireless technology like phone, tablet, portable GPS tracking devices, and extracting FDM information from audio/video devices (i.e. video cameras and microphones). Explore collecting additional safety data beyond FDM to include ASAP, LOSA, and event data (self-reporting and incident/event reports) from various sources. This will include developing corresponding taxonomies for the vertical flight community to enable analyses of these unique datasets. Further develop HADRAS and Digital Copilot applications and begin data collection/outreach program in accordance with USHST H-SE #81: Helicopter Flight Data Monitoring goals and objectives. Investigate FDM data parameters and telemetry data from other vertical lift platforms (i.e. tiltrotors, eVTOL/UAM, etc.).
Phase 1 Outputs: Additional data sources representing the vertical lift community provisioned for use by ASIAS, the USHST, and other safety-based teams. Revised HADRAS and Digital Copilot Applications and begin initial data collection from helicopter communities. (2021-2025)

Phase 2: Develop new Analysis Techniques, Tools, and Metrics – Using Helicopter Flight Data Monitoring (HFDM) data and FAA surveillance data, develop new analysis tools, techniques and capabilities. Develop additional rotorcraft-specific FDM safety metrics for diverse mission segments (i.e. high/low rate of descent, VFR/IFR Cruising altitudes, proximity to UAS/Birds, etc.) and enhance current safety metrics for additional mission segments/helicopter platforms (i.e. un-stabilized approach, loss of tail rotor effectiveness, vortex ring state). This will involve working with participating operators and associations for each identified mission segment to develop FDM analysis tools unique to these operations. Create metrics and measures specific to low-level infrastructure entailing FAA surveillance data (i.e. SBS/ADS-B/Radar), helipad/heliport/vertiport data, and other data sources (i.e. weather, procedures, etc.). Similar to Airport Daily Overview and other tools within ASIAS, these metrics will capture information on the # of takeoffs and landings, unstable approaches, helipad overruns, noise profiles and other quantifiable risk areas from rotorcraft operations. Often this information is missing or incomplete in the FAA's systems, so this effort will entail research into not only collecting and calculating these safety metrics to be used by the USHST/ASIAS but also to identify new data sources capable of providing this information. Examine artificial intelligence, pattern recognition, and machine learning algorithms to identify, transcribe, and visualize HFDM data in simulated/real-world operational environments (i.e. augmented/virtual reality). Develop new events, exceedances, and metrics for additional vertical lift platforms to include eVTOL/UAM and tiltrotor vehicles (i.e. AW609).
Phase 2 Outputs: Additional data analysis techniques, tools, and metrics representing the vertical lift community provisioned for use by ASIAS via the Helicopter IAT, USHST JHSAT, and others as required/appropriate. (2021-2026)

Phase 3: Develop new Helicopter Flight Data Simulation Analysis Tools/Replay Capabilities - Research the capability to replay a flight or series of flights in simulation or virtual reality using a standard data format so in the case of an accident/incident/event, an operator can port their FDR data into a simulator and replay a condition for training, investigation, or analysis purposes. Collect data from maneuvers and profiles conducted in simulation and flight testing in order to create standard maneuver profiles and recreate events. Develop a data repository of known simulator and flight data recorder formats which can then be merged into an authoritative source to populate simulation devices for replay/analysis purposes. Utilize existing AR/VR and helicopter simulator devices at the FAA WJHTC to prototype the event replay concept based on a select set of incidents/accidents from NTSB/USHST/FAA.
Phase 3 Outputs: Prototype event replay for rotorcraft along with standardized data format for replay across different simulation or playback devices. (2021-2023)

Phase 4: Perform Accuracy Analysis of Various Recorders - Research the overall performance of various flight data recorder types including their capabilities, limitations, precision, and accuracy values. This information is even more critical given the initial findings of the HFDM Research Program and discussions with various operators that identified shortcomings and errors/inaccuracies in the collected flight data which are a major issue towards safety analysis leading to both false positives and additional erroneous events which are incorrectly classified. Collect data from maneuvers and profiles conducted in simulation and flight testing in order to create standard maneuver profiles and recreate events. Analyze helicopter flight data recorder parameters for accuracy/precision using statistical analysis tools.
Phase 4 Outputs: Technical report detailing the accuracies, precision, capabilities, and limitations of various flight data recorders based upon flight test and ground test efforts. Data collected and analysis results will support possible revisions to policy/guidance implementation stemming from the minimum HFDM parameters identified in the 2018 HAA rule, potential Advisory Circulars on vertical Lift FDR requirements, and H-SE #82: Helicopter Flight Data Monitoring. (2023-2025)

Phase 5: Develop a framework for conducting helicopter directed studies - Develop a framework for conducting helicopter directed studies and supporting the ASIAS Helicopter Issue Analysis Team (IAT) which is composed of government and industry representatives who examine safety risks in helicopter operations similar to the IAT from the CAST or GA-JSC. Examine existing CAST/GA-JSC constructs and develop a framework and risk-based methodology for safety data research analysis support to the USHST via the Rotorcraft/Vertical Lift IAT in ASIAS. Engage industry associations/working groups such as AMOA, ASPA, Heli Offshore, HSAC, HTOC, NEMSPA, TOPS, and others by analyzing the data with members of the working groups to conduct directed studies for the helicopter community. Develop standard parameter data sets for supporting the USHST JHSAT working groups (i.e. safety analysis team/issue analysis team) while also directly tying to outputs in the associated helicopter safety enhancements such as H-SE #82:

Helicopter Flight Data Monitoring. This work would support the USHST's future direction by providing analytical expertise and knowledge to allow the group to further cement and improve on their current data-driven approach.
Phase 5 Outputs: Directed studies and analytical expertise to the USHST, Helicopter IAT, and other government-industry associations to advance ASIAS Goals and Capabilities and meet USHST H-SE milestones. (2021-2026)

Project: ANSP Sector Risk Profile Tool - Surface Safety (A11H.SSM.26)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11H.SSM.26	As an integral part of the implementation of the FAA Integrated Oversight Philosophy, AOV will be able to determine the appropriate surveillance, in terms of frequency and scope. The risk profile may be used to plan other safety oversight activities. It is commonly used to adjust the frequency and scope of surveillance, as well as to focus on specific areas requiring attention. AOV will be able to find patterns in airport operating environments, procedures, and system performance that predict the potential for negative safety occurrences. Using forecasting functions in the tool, AOV can apply proactive or predictive surveillance actions and allocate oversight resource more efficiently to ensure the safe delivery of air traffic services. The model and machine learning algorithms developed for runway operations can be easily adapted to support AOV's monitoring and surveillance on other NAS operations, which will significantly improve NAS safety performance.	ANSP Sector Risk Profile Tool - Surface Safety SRPT-Surface (AOV/ANG-E2)		FY21	FY24	$853

Project Output: ANSP Sector Risk Profile Tool - Surface Safety anticipated research outputs in FY22 (A11H.SSM.26)

This research will develop a runway operations safety monitoring and surveillance tool and establish a sector risk profile for airport surface safety to support AOV's oversight mission. CHANGES: The plan was changed from a three-year research plan in FY21 requirement to a four-year research plan to permit the proper development and integration of artificial intelligence and machine learning capabilities into the tool.

Phase I: Develop Concept of Operations (ConOps) and Initial Data Model (Oct. 2020 – Sep. 2021). This phase includes literature survey, data collection, preliminary data analysis and modeling, and ConOps development.
Milestone 1: Identify and review previous research efforts on runway safety and operations to utilize available information for this research. (12/20)

Milestone 2: Collect runway safety and operations data from various data sources and develop Concept of Operations for the tool (3/21)
Milestone 3: Conduct preliminary data analysis to identify the gaps and establish an initial data model (6/21)
Milestone 4: Conduct a user focus group on system concept and models and update the Concept of Operations for the tool (9/21)

Phase II: Develop Descriptive Analytics and Proof of Concept for Safety Performance Indicators (Oct. 2021 – Sep. 2022). This phase includes comprehensive data analysis and development of runway operations safety analytics model, performance indicators, and AI and machine learning algorithms for detecting and classifying safety event factors and anomalies.
Milestone 1: Conduct comprehensive data analysis to identify and prioritize causal and contributing factors that influence hazardous occurrences during runway area operations. (12/21)
Milestone 2: Develop descriptive safety analytic models for airport surface, takeoff, approach, and landing operations, initially focused on wrong runway landings and departures, runway excursions, and traffic conflicts between arrivals and takeoffs. (3/22)
Milestone 3: Develop AI and machine learning algorithms and train the safety analytic models to detect contributing factors and anomalous patterns based on historical, known safety incidents. Implement a proof of concept to demonstrate results. (6/22)
Milestone 4: Develop Safety Performance Indicators (SPIs) to monitor runway operations safety performance trends as part of an initial prototype proof of concept. (9/22)

Phase III: Develop Predictive Analytics and Proof of Concept for Safety Risk Indicators (Oct. 2022 – Sep. 2023) Using Phase II results, Phase III introduces predictive analytics to identify NAS risk exposure for future runway operations safety incidents. This phase extends and applies AI and machine learning algorithms to predict runway operations safety issues and vulnerabilities given planned NAS changes.
Milestone 1: Collect and analyze data for planned NAS changes (e.g., runway construction activities, NAS equipment changes, air traffic facility changes, etc.) based on contributing factors that influence hazardous occurrences during runway area operations. (12/22)
Milestone 2: Develop predictive safety analytic models for airport surface, takeoff, approach, and landing operations, initially focused on wrong runway landings and departures, runway excursions, and traffic conflicts between arrivals and takeoffs. (3/23)
Milestone 3: Develop and apply AI and machine learning algorithms to predict risk exposure for runway operations safety issues. Implement a proof of concept to demonstrate results. (6/23)
Milestone 4: Develop Safety Risk Indicators (SRIs) to forecast the emerging NAS and regional risk vulnerabilities and exposure for runway safety issues as part of a prototype proof of concept. (9/23)

Phase IV: Develop Runway Operations Safety Monitoring and Surveillance Tool and Sector Risk Profile for Airport Surface Safety (Oct. 2023 – Sep. 2024) This phase focuses on developing the prototype Runway Operations Safety Monitoring Tool and establishing a sector risk profile for airport surface safety. The prototype tool and sector risk profile provides an integrated set of safety performance and predictive risk indicators and analytics.
Milestone 1: Develop a sector risk profile for surface safety that integrates the SPIs and SRIs established in prior phases. Conduct a focus group to validate the profile and steer prototyping. (12/23)
Milestone 2: Develop an integrated prototype runway operations safety monitoring and surveillance tool to analyze and support runway operations safety performance monitoring and safety risk forecasting (3/24)
Milestone 3: Implement a prototype capability for AOV to track safety directives, letters of correction, and other documentation to address ATO compliance with safety standards associated with runway safety SPIs and SRIs and ameliorate risk factors before hazardous effects occur. (6/24)
Milestone 4: Develop user guide for the prototype tool and conduct technology transfer to AOV. (9/24)

Project: ANSP Sector Risk Profile Tool – Aeronautical Information Services (A11H.SSM.30)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11H.SSM.30	As an integral part of the implementation of the FAA Integrated Oversight Philosophy, AOV will have tools and a methodology to identify existing safety risks and emerging safety risks for the ATO and to incorporate this information into the ATO safety risk profile. The ATO safety risk profile will provide the necessary data for AOV to conduct risk-based safety oversight of all relevant activities of the US Air Navigation Services Provider (the ATO). This will provide the required means to comply with the FAA Integrated Oversight Philosophy and for risk-based decision making.	ANSP Sector Risk Profile Tool – Aeronautical Information Services (ANSP-SRPT-AIS) (AOV/ANG-E2)		FY22	FY24	$592

Project Output: ANSP Sector Risk Profile Tool – Aeronautical Information Services anticipated research outputs in FY22 (A11H.SSM.30)

This research will provide a tool for AOV to use to identify emerging aeronautical information services risks in the NAS related to the ATO and will help integrate these emerging risks into the overall safety risk profile for the ATO.

Phase 1 – Develop Concept and Model for Sector Risk Profile Tool for Aeronautical Information Services (ANSP-SRPT-AIS) (Oct. 21 – Sep. 22)

This task includes data collection, preliminary data analysis, ConOps development, identification of initial safety performance and safety risk indicators concepts, and definition of high-level development plan.

Milestone 1: Conduct research review, analyze AIS policy and requirements, and identify specific aeronautical information services safety topics to apply in this research (12/21)

Milestone 2: Identify aeronautical information services data sources, collect sample data and develop the ANSP-SRPT-AIS Concept of Operations (4/22)

Milestone 3: Establish an initial data model and define concepts for safety performance and safety risk indicators (7/22)

Milestone 4: Identify ANSP-SRPT-AIS tool user stories, organize stories into a high-level development plan and conduct user focus group on concept, model and indicators for the tool (9/22)

Phase 2 – Develop Analytics Methodology, Prototype Early Indicators, and Proof-of-Concept Capability (Oct. 22 – Sep. 23)

This task includes comprehensive data analysis, development of safety analytics model and machine learning algorithms (with a focus on safety performance), implementation of early prototype indicators, and development of proof-of-concept capability.

Milestone 1: Conduct thorough data analysis to identify and prioritize causes and contributing aeronautical information service factors for ATM safety events (11/22)

Milestone 2: Identify initial safety performance indicators to address a focused set of AIS causal and contributing risk factors. Collect data and develop machine learning

algorithms and train the safety analytic model to detect causal factors and patterns based on historical, known safety incidents and support calculation of performance indicators. (2/23)
Milestone 3: Identify initial safety risk indicator concepts to address a focused set of AIS causal and contributing risk factors. Initiate the data collection and develop and apply AI and machine learning algorithms to identify and predict risk exposure for AIS risk factors. (6/23)
Milestone 4: Integrate initial Safety Performance Indicators (SPIs) into a proof-of-concept capability to support AOV identification and evaluation of AIS safety vulnerabilities. (9/23)

Phase 3 – Develop Aeronautical information Services Sector Risk Profile and Safety and Surveillance Tool (Oct. 23 – Sep. 24)
this phase refines and expands AIS safety indicators and establishes a sector risk profile for aeronautical information services. It includes integration of performance and predictive indicators and analytics into a prototype tool that supports AOV risk-based oversight decisions.
Milestone 1: Detail prototype delivery user stories and define and prioritize specific development tasks. Develop prototype development plan. (11/23)
Milestone 2: Refine predictive safety analytics model and application of AI and machine learning algorithms to predict risk exposure for AIS risk factors. Define and integrate Safety Risk Indicators (SRIs) into the tool capability. (1/24)
Milestone 3: Develop a sector risk profile for AIS that integrates all developed SPIs and SRIs. Conduce a focus group to validate the profile and steer prototype design. (3/24)
Milestone 4: Implement a prototype capability that enables AOV to track ATO compliance to aeronautical information services safety standards associated with AIS SPIs and SRIs. Conduct a tool demonstration to review the AIS sector risk profile and examine potential oversight actions for AIS risk factors. (7/24)
Milestone 5: Develop user guidance and supporting documentation for the tool and conduct a technology transfer to AOV (9/24)

Program Resources ($K): System Safety Management – SSM (A11H)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aviation Performance & Planning									
System Safety Management (A11H.SSM)	$3,520	$2,217	$2,710	$1,251	$1,201	$0	$2,323	$792	$2,035

People	Facilities	Partnerships
• 23.5 GOV FTE; 98.25 CTR FTEs in various technical disciplines including engineering, computer science, statistics, safety and risk management	• Computing and Analytics Shared Services Environment (CASSIE) • FAA Flight Program's helicopter located at WJHTC	• NASA • United States Helicopter Safety Team (USHST) • HAI • Bell • Five-Alpha • LZ Control • TruthData • Skytrac • Appareo • Outerlink

Program Area: Unmanned Aircraft Systems Research (A11L)

Develop certification standards, policy, and guidance needed to safely integrate UAS into the NAS.

Project: Disaster Preparedness and Response (A11L.UAS.68)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.68	The sponsor intends to use the results of this research to support UAS involved in emergency management preparedness in the NAS.	Disaster Preparedness and Response (AUS/ANG-C2)	Yes	FY19	FY23	$1950

Project Output: Disaster Preparedness and Response anticipated research outputs in FY22 (A11L.UAS.68)

Task 6: Demonstrate through flight testing the coordination through all agencies needed and walk through the steps needed for each interaction with the agency representatives.
Exit Criteria: Flight test conducted through UAS Test Sites. (T + 27)

Task 7: Document the lessons learned through the demonstrations of how coordination should work with each of the partner agencies to ensure smooth UAS operations for disaster response.
Exit Criteria: Report detailing the lessons learned through the demonstrations and how any previous reports would be changed from the lessons learned. (T + 30)

Task 8: Document UAS procedures and guidelines to follow for emergency response that can be cross cutting across the NAS to ensure proper coordination. Document the category of vehicles needed for each mission type and how the UAS chosen can change the procedures.
Exit Criteria: Report detailing UAS procedures and guidelines for emergency response in the NAS. (T + 33)

Task 9: Peer Review. Plan for a peer review to ensure public availability of the research within 30 days of final report delivery. (T + 35)

Task 10: Program Management. ASSURE program management of the research project and performers. Initial Criteria: Project Management Plan (PMP). (T+3). The PMP can use a satisfactory Research Task Plan to fulfill this requirement. Additionally, it will include an initial one page document (one pager) describing the research and status with monthly updates.
Exit Criteria: Completed final report, completed peer review, finalized financial reporting, final one pager, and all documentation to close out the research project. (T+36)

Project: Establish risk-based thresholds for approvals needed to certify UAS for safe operation (A11L.UAS.71)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.71	The sponsor intends to use the results of this research to support the expansion of UAS integration into the NAS. The research will provide the information necessary to make "equivalent level of safety" determinations and respond to petitions for exemption to 14 CFR, Part 107 from the sUAS community prior to formal rulemaking for UAS operations. The research will also assist the FAA in evaluating UAS type certification applications for UAS designed for beyond part 107 operations. In order to properly proceed, the research starts with an assessment of potential uses and identifying the FAA's immediate needs. This allows for the rapid technological advances that are occurring in the UAS community. Following that initial step, the research necessary research will be prioritized. At the time of this writing, enabling BVLOS operations represent the most urgent need. Based on funding and updated needs as the research is executed, the prioritized tasks will be complete.	Establish risk-based thresholds for approvals needed to certify UAS for safe operation (UAS/ANG-C2)	Yes	FY19	FY23	$750

Project Output: Establish risk-based thresholds for approvals needed to certify UAS for safe operation anticipated research outputs in FY22 (A11L.UAS.71)

Task 1: Conduct literature reviews for each of the research areas described above and determine Use Cases for the research. Tie in industry consensus standards.
Exit Criteria: Literature review and use cases for the execution of this research with monthly Technical Interchange Meetings. T+1.5M

Task 2: Propose other potential areas of research beyond what is outlined in the tasks below. Coordinate and prioritize the research to be conducted. Develop a Research Task Plan with potential increased/decreased scoping based on findings. Hold a scoping peer review with the FAA and other parties determined by the FAA to discuss the Research Task Plan and determine the appropriate scope level. The sponsor, based on other areas identified, will select research that meets the FAA immediate needs based on the cost estimate.
Exit Criteria: A sponsor approved Research Task Plan (RTP) for the execution of this research with monthly Technical Interchange Meetings. T+3M

Task 3: Peer Scope Review.
Exit Criteria: An approved Research Task Plan. (T+4M)

Task 4: Perform research and testing as required to identify develop recommended crewmember training and certification requirements, to include pilots and other crewmembers. What are the requirements?
Exit Criteria: Provide a report detailing the crewmember training and certification requirements and the applicability to current regulations, policies and directives. T+6M

Task 5: Develop a methodology the evaluate injury risk curves for the unique collision characteristics of a UAS colliding with a non-participant. In addition to other research, build on the work of the ASSURE ground collision research (A14).
Exit Criteria: A report detailing the strengths and weaknesses of proposed well-clear guidance. T+10M

Task 6: Based on a literature review and prior ASSURE research, develop a methodology by which a special airworthiness certificate could be issued for medium or low risk UAS. Develop and propose industry consensus standards.
Exit Criteria: A report detailing the strengths and weaknesses on the methodology. T+10M

Task 7: Evaluate how new automated features of UAS should be tested, certified, and integrated.
Exit Criteria: A report detailing the testing, certification, and integration of automated systems. This should include discussion on the pedigree of software. T+15M

Task 8: Case Study. Based on current policy and if feasible, obtain a waiver, exemption, or type certification based on the proposed industry standards or explain the current shortfalls.
Exit Criteria: An approved operation with supporting documentation and a report outlining the process conducted by the FAA or a report detailing the shortcomings of the waiver process. T+18M

Task 9: Final Report.
Exit Criteria: Summarize the findings of the research. This should include recommendations for future research based on the gaps identified during the execution of this research. The future recommendations should take the form of a Research Task Plan and include research questions. T+20M.

Task 10: Peer Review. Plan and budget for a peer review to ensure public availability of the research within 30 days of final report delivery. T+21M

Task 11: Program Management. ASSURE program management of the research project and performers.
Initial Criteria: Project Management Plan (PMP). (T+3). The PMP can use a satisfactory preproposal or Research Task Plan to fulfill this requirement. Additionally, it will include an initial one page document (one pager) describing the research and status with monthly updates.
Exit Criteria: Completed final report, completed peer review, finalized financial reporting, final one pager, and all documentation to close out the research project. (T+24)

Project: Safety Risks and Mitigations for UAS Operations on and Around Airports A11L.UAS.72)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.72	Verified the potential risks with regards to UAS operations on and around airports to include potential changes to FAA regulations (such as 7110.65) and industrial standards	Safety Risks and Mitigations for UAS Operations On and Around Airports FY22 (AUS/ANG-C2)	Yes	FY20	FY23	$750

Project Output: Safety Risks and Mitigations for UAS Operations On and Around Airports anticipated research outputs in FY22 (A11L.UAS.72)

Task 1: Literature review
Identify relevant research and documentation in the areas of unmanned aircraft systems performance in and around airports including Urban Air Mobility (UAM) and UAS Traffic Management (UTM) implications. This review should include to the following areas: UAS physical / aerodynamic response to upsets and perturbations, including those caused by encounters with wake vortices for numerous different types of UAS (i.e. rotorcraft, fixed wing, sUAS, etc.)Consider loss of link, drop link, fly-away, and Remote Pilot in Command (RPIC) loss of situational awareness. Publicly available SMS studies .Publicly available Level of upset to the UAS aircraft that will cause loss of link or drop link with the remote pilot. Automated response considerations in the event of off-nominal events. Consult with the FAA to incorporate Science and Research Panel (SARP) considerations. Consider prior research on SMS including research conducted by ASSURE.
Exit Criteria 1: A report outlining relevant research and documentation. T+4M

Task 2: Propose other potential areas of research beyond what is outlined in the tasks below. Coordinate and prioritize the research to be conducted. Develop a Research Task Plan with potential increased/decreased scoping based on findings. Hold a scoping peer review with the FAA and other parties determined by the FAA to discuss the Research Task Plan and determine the appropriate scope level. The sponsor, based on other areas identified, will select research that meets the FAA immediate needs based on the cost estimate.
Exit Criteria 2: A sponsor approved Research Task Plan (RTP) for the execution of this research with monthly Technical Interchange Meetings. T+4M

Task 3: Determine research shortfalls identified from the literature review and develop case studies to address shortfall areas. Case study methods may include, but are not limited to modeling and simulation, and flight tests to address research shortfalls. Define the overall concept and specific use cases for conducting operations on the airport surface. This includes, but is not limited to UAS airport inspections Perimeter Security Foreign Object Debris (FOD) inspections Runway Inspections Emergency response Wake Turbulence Separation Consider the airspace class (B,C,D,E,G), towered/non-towered, etc. for each use case.
Exit Criteria 3: A detailed set of use cases broken down by class of airspace. T+11M

Task 4: Using the FAA's ATO Safety Management System (SMS) process, identify the hazards and mitigations of the use cases. Consider publicly available hazards and mitigations from prior FAA waivers, exemptions, federal register notices, IPP results, and the FAA's report to the white house on the IPPs.
Exit Criteria 4: A set of FAA SMS based list of unmitigated hazards and mitigations. Describe the mitigation strategy. T+14M
Task 5: Evaluate at least three use cases by conducting a research team SMS panel using FAA SMS policies.

Exit Criteria 5: An SMS panel report in a format similar to FAA SMS for each use case. T+16M

Task 6: Flight Testing – Propose flight testing and analysis with exit criteria for three use cases to validate the proposed mitigations. For clarity, this task can be completed in parallel with other tasks.
Exit Criteria: Report summarizing the flight tests. T+22M

Task 7: Final Report
E**xit Criteria 7**: A consolidated report of all the research activities.

Task 8: Program Management. ASSURE program management of the research project and performers.
Initial Criteria: Project Management Plan (PMP). (T+3). The PMP can use a satisfactory preproposal or Research Task Plan to fulfill this requirement. Additionally, it will include an initial one page document (one pager) describing the research and status with monthly updates.
Exit Criteria 8: Completed final report, completed peer review, finalized financial reporting, final one pager, and all documentation to close out the research project.

Project: Establish Pilot Proficiency Requirements (A11L.UAS.74)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.74	Report(s) describing recommended UAS crewmember training and certification requirements, and recommended UAS crewmember.	Establish pilot proficiency requirements (AUS/ANG-C2)	Yes	FY20	FY23	$750

Project Output: Establish Pilot Proficiency Requirements anticipated research outputs in FY22 (A11L.UAS.74)

This research will address gaps in knowledge that are currently a barrier to the safe, efficient, and timely integration of unmanned aircraft systems (UAS) into the National Airspace System (NAS). If feasible, design the research to Part 135 operations and/or passenger operations. Separate, but highly interdependent, research areas need to be addressed:
Task 1: Literature Review.

Exit Criteria: A report outlining relevant research. T+3M

Task 2: Propose other potential areas of research beyond what is outlined in the tasks below. Coordinate and prioritize the research to be conducted. Develop a Research Task Plan with potential increased/decreased scoping based on findings. Hold a scoping peer review with the FAA and other parties determined by the FAA to discuss the Research Task Plan and determine the appropriate scope level. The sponsor, based on other areas identified, will select research that meets the FAA immediate needs based on the cost estimate.
Exit Criteria: A sponsor approved Research Task Plan (RTP) for the execution of this research with monthly Technical Interchange Meetings. T+3M

Task 3: Perform research and testing as required to identify develop recommended crewmember training and certification requirements, to include pilots and other crewmembers. What are the requirements?
Exit Criteria: Provide a report detailing the crewmember training and certification requirements and the applicability to current regulations, policies and directives. T+6M

Task 4: What are the human factors limitations to operating beyond visual line of sight (BVLOS)?
Exit Criteria: A report that outlines the human factors limitations to operating BVLOS to include the identification of potential hazards, mitigations, and controls for the mitigations. T+12M

Task 5: What are the required aptitude and expected fatigue differences for a pilot manipulating controls of a UA vs. technician monitoring automated UA(s)?
Exit Criteria: A report with the required aptitude and expected fatigue differences for a pilot manipulating controls of a UA vs. technician monitoring automated UA(s) to include the identification of potential hazards, mitigations, and controls for the mitigations. T+12M

Task 6: Conduct a Human in the Loop (HITL) simulation exploring human factor considerations of BVLOS operations.
Exit Criteria: Produce a reporting the results of human interactions with multiple UAS. Propose industry standards. T+21M

Task 7: Final Report. Produce a report outlining proposed UAS training and certification requirements related to all these questions, to include the visual observer(s).
Exit Criteria: Summarize the findings of the research. This should include recommendations for future research based on the gaps identified during the execution of this research. The future recommendations should take the form of a Research Task Plan and include research questions. Propose industry standards. T+24M.

Task 8: Peer Review. Plan and budget for a peer review to facilitate public availability of the research within 30 days of final report delivery. T+25M

Task 9: Program Management. ASSURE program management of the research project and performers.
Initial Criteria: Project Management Plan (PMP). (T+3). The PMP can use a satisfactory preproposal or Research Task Plan to fulfill this requirement. Additionally, it will include an initial one page document (one pager) describing the research and status with monthly updates.
Exit Criteria: Completed final report, completed peer review, finalized financial reporting, final one pager, and all documentation to close out the research project.

Project: UAS Wake Research (A11L.UAS.75)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.75	The sponsor intends to use the results of this research to support the expansion of UAS integration into the NAS. The research will provide the information necessary to provide guidance and make safety determinations for UAS operations. . In order to properly proceed, the research starts with an assessment of potential uses and identifying the FAA's immediate needs. This allows for the rapid technological advances that are occurring in the UAS community. Following that initial step, the research necessary research will be prioritized. Based on funding and updated needs as the research is executed, the prioritized tasks will be complete.	UAS Wake Research (AUS/ANG-C2)	Yes	FY20	FY22	$795

Project Output: UAS Wake Research anticipated research outputs in FY22 (A11L.UAS.75)

Task 1: Literature review

- Identify relevant research and documentation in the areas of unmanned aircraft systems performance and wake turbulence, including UAM implications. This review should include to the following areas:
- UAS physical / aerodynamic response to upsets and perturbations, including those caused by encounters with wake vortices for numerous different types of UAS (i.e. rotorcraft, fixed wing, sUAS, etc.)
- Causes and thresholds for upsets to cause loss of link, ground collision or other off-nominal event requiring risk mitigation
- Level of upset to the UAS aircraft that will cause loss of link or drop link with the remote pilot
- Response of the UAS aircraft to off-nominal condition such as lost link. To be conducted for preprogrammed or automated response, in all phases of the UAS aircraft flight, as well as during the performance of various assigned or intended tasks
- Vehicle flutter
- Physical harm caused by turbulence to passengers aboard an autonomous vehicle

Exit Criteria 1: A report outlining relevant research and documentation. T+2M

Task 2: Determine research shortfalls identified from the literature review and develop case studies to address shortfall areas. Case study methods may include, but are not limited to modeling and simulation, computational fluid dynamics studies, flight tests, wind tunnel tests, ground tests, transmission tests, etc. to address research shortfalls in the following areas:

- UAS physical / aerodynamic response to upsets and perturbations, including those caused by encounters with wake vortices for numerous different types of UAS (i.e. rotorcraft, fixed wing, sUAS, etc.)
- Causes and thresholds for upsets to cause loss of link, ground collision or other off-nominal event requiring risk mitigation
- Level of upset to the UAS aircraft that will cause loss of link or drop link with the remote pilot
- Response of the UAS aircraft to off-nominal condition such as lost link. To be conducted for preprogrammed or automated response, in all phases of the UAS aircraft flight, as well as during the performance of various assigned or intended tasks

Exit Criteria 2: A report including case study research recommendations to address research shortfalls. T+6

Task 3: Propose other potential areas of research beyond what is outlined in the tasks below. Coordinate and prioritize the research to be conducted. Develop a Research Task Plan with potential increased/decreased scoping based on findings. Hold a scoping peer review with the FAA and other parties determined by the FAA to discuss the Research Task Plan and determine the appropriate scope level. The sponsor, based on other areas identified, will select research that meets the FAA immediate needs based on the cost estimate.

Exit Criteria 3: A sponsor approved Research Task Plan (RTP) for the execution of this research with monthly Technical Interchange Meetings. T+3M

Task 4: Analyze and assess UAS response to encountering various strengths of wake vortices.

- Conduct severity analyses and assessments of the UAS response to various strengths of wake vortices.
- Conduct likelihood analyses and assessments of the UAS response to various strengths of wake vortices.
- Based upon the analyses and assessments provide operational limitations, restrictions and / or mitigations for the evaluated operations

Exit Criteria 4: A report including results and recommendations of analysis of UAS response to wake vortex encounters. T+12

Task 5: Conduct assessments and provide safety analysis considerations for FAA policy, guidance, and procedures for wake turbulence mitigation for UAS.
Conduct a risk assessment of several UAS aircraft and wake vortex encounters. Perform this assessment for generic operations in the airport environment and selected (to be identified later) operations. Based upon risk assessments provide operational limitations, restrictions and / or mitigations for generic operations in the airport environment. Develop and recommend processes and procedures to be used in the evaluation of sUAS operations associated with potential wake vortex encounters
Exit Criteria 5: A report providing results and recommendations for safety analysis consideration to inform FAA policy, guidance, and procedures. T+18

Task 6: Peer Review. Plan and budget for a peer review to ensure public availability of the research within 30 days of final report delivery. T+20M

Task 7: Program Management. ASSURE program management of the research project and performers.
Initial Criteria: Project Management Plan (PMP). (T+3). The PMP can use a satisfactory preproposal or Research Task Plan to fulfill this requirement. Additionally, it will include an initial one page document (one pager) describing the research and status with monthly updates.
Exit Criteria: Completed final report, completed peer review, finalized financial reporting, final one pager, and all documentation to close out the research project.

Project: UAS Standards Tracking, Mapping, and Analysis (A11L.UAS.77)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.77	The sponsor intends to use the results of this research to identify, prioritize and develop research requirements that directly support the development of the UAS integration enabling industry standards in the most optimized way, while leveraging all available resources.	UAS Standards Tracking, Mapping, and Analysis (AUS/ANG-C2)	Yes	FY20	FY23	$750

Project Output: UAS Standards Tracking, Mapping, and Analysis anticipated research outputs in FY22 (A11L.UAS.77)

Task 1: Literature Review on completed standards mapping describing work completed. Identify industry standards that are needed to support UAS integration.
Exit Criteria 1: Report accompanied by a presentation and briefing on tracking to the sponsor. (Award + 1month)

Task 2: Propose other potential areas of research beyond what is outlined in the tasks. Coordinate and prioritize the research to be conducted. Develop a Research Task Plan with potential increased/decreased scoping based on findings. Hold a scoping peer review with the FAA and other parties determined by the FAA to discuss the Research Task Plan and determine the appropriate scope level. The sponsor, based on other areas identified, will select research that meets the FAA immediate needs based on the cost estimate.
Exit Criteria 2: A sponsor approved Research Task Plan (RTP) for the execution of this research with monthly Technical Interchange Meetings. (Award + 2)

Task 3: Map ANSI's UAS standards roadmap to the FAA critical path defined in the (UIRP) 2018-2023. Identify research gaps. FAA will provide, to the maximum extent possible, their current standards tracking information.
Exit Criteria: Report, detailing the correlation of the ANSI standards roadmap to the capability enabling technologies along the critical path phases as defined in the UIRP 2018-2023. (Award + 5 months); Include monthly written progress reports.

Task 4: Based on the prior tasks, align the standards and gaps with UIRP and ANSI UAS Roadmap, then prioritize the requirements list. Address the following, specifically:

- Identify the immediate standards needed for the FAA to enable operations
- Tie in current, past, and future standards development.
- Analyze the standards roadmap developed by ANSI
- Analysis must include International UAS standards

Exit Criteria: Written draft report and a presentation providing a clear connection between the identified standards – including international - that need to be developed to define research that will support the development of such standards. From the multitude of potentially useful research, extract:

- The highest priority standards
- Identify the standards most feasible to develop

- Identify research priorities in support of standards and rank them in the order that correlates with most feasible to implement.

Final report and a presentation (Award + 12 months)

Project: UAS Cyber Security and Safety (A11L.UAS.78)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.78	Identify and reduce cybersecurity risks agency wide and establish a UAS Cybersecurity Management process that will be practical and effective per area of responsibility aid in identifying, assessing and mitigating UAS cybersecurity and safety gaps.	UAS Cyber Security and Safety (AUS/ANG-C2)	Yes	FY22	FY22	$800

Project Output: UAS Cyber Security and Safety anticipated research outputs in FY22 (A11L.UAS.78)

Task 1: Literature Review: Collect, review and organize applicable U.S. government Department and Agency (such as NIST, DOD and FAA) guidelines, programs and directives that can be applicable to the creation of an FAA UAS Cybersecurity Risk Management process.
Utilizing the National Institute of Standards (NIST) Cybersecurity Framework (Five Functions, and other applicable guidance) and other established frameworks, assess and outline the best practice or approach to manage UAS cybersecurity risk in the different FAA areas of responsibility such as Operations, Certification, Airports, and Commercial Space.
Establish a ranking process for evaluating cybersecurity risks and contrast UAS and UAS operations in the NAS that are most vulnerable.
Exit Criteria: Create a guide or tool that will assist in delineating a practical process (utilizing the information specified in the Task 1 Literature Review above) to effectively manage UAS Cybersecurity and Safety holistically. The information in this guide or tool can be divided into operations, certification and other subjects. Completion date of NLT 4 months from start date.

Task 2: UAS Test Cases:
Determine how many UAS Test Cases can serve as best examples (by highest risk) and rank to serve as best test cases.
Select the best UAS types (such as the DoD UAS Groups [1-5]) and UAS operations that can serve as test cases to study and identify cybersecurity vulnerabilities as used in the NAS to the maximum extent possible.
Utilize the guide or tool specified in Task 1 Exit Criteria and contrast each UAS and operation test cases to determine UAS Cybersecurity and Safety vulnerabilities.
Exit Criteria: Generate reports on findings per each UAS Test Cases as applicable to each FAA area of responsibility. The report should contain the highest ranked cybersecurity vulnerabilities and recommended mitigations utilizing the guide or tool specified in Exit Criteria 1. Completion date of NLT 8 months from start date.

Task 3: Roadmap: Considering the information learned in Task 1 and Task 2, create a UAS Cybersecurity and Safety Roadmap that will list as many vulnerabilities that need to be

addressed and rank highest risk accordingly. These can be categorized in areas related to such as FAA Cyber Infrastructure, UAS types or models, UAS supporting equipment like ground control stations and other devices utilizing plain language format. Completion date of NLT 11.5 months from start date.

Project: Section 383 UAS Detection and Mitigation (A11L.UAS.79)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.79	Develop performance standards for UAS detection and mitigation technologies by end of FY23.	Section 383 UAS Detection and Mitigation (AUS/ANG-C2)	Yes	FY20	FY22	$2,180

Project Output: Section 383 UAS Detection and Mitigation anticipated research outputs in FY22 (A11L.UAS.79)

Note: it is planned that this work will begin in FY20 as an unbudgeted requirement. This effort will be a multi-year program that will include evaluation of least 10 technologies at the Atlantic City International Airport, followed by deployments of a subset of those 10 technologies at five airports across the country. There will be a significant amount of work associated with evaluating each technology in a thorough, complete process that will enable us to yield the necessary data to support the development of specifications. Furthermore, the deployments at the five airports will provide in-service operational data that has not yet been collected by any government agency. While efforts conducted to support Section 2206 did provide valuable lessons learned, it did not allow researchers the necessary time to properly evaluate the detection technologies. We are confident that we are on the right path now to capture everything that is needed to properly meet the requirements of Section 383. The Office of Airports (ARP) Airport Technology Research and Development Program (ATR), tasked to complete this effort has a detailed 3-year research plan, scheduled to start in FY20. FY22 activities would include the field testing of 5 vendor technologies at 5 airports, post testing activities including the recommendation of performance specifications to include in the AC.

Task 1: In House Contract Support
Output - Advisory circular framework delivered and coordination with other government agencies
Start: (07/2022); total months: 12

Task 2: Equipment Lease for ACY (FY20 task)

Task 3: Site Preparation
Output - Flight testing conducted at various locations with flight test reports.
Start: (07/2022); total months: 12

Task 4: UAS Pilot Services

Output - Recommendation of performance specifications for UAS Detection Technologies at Airports
Start: (07/2022); total months: 7

Task 5: Equipment Lease for other test locations
Output - Flight testing conducted at various locations with flight test reports on the detection technologies.
Start: (07/2022); total months: 8

Task 6: Update Technical Screen
Output - Updated report with final testing technologies added in.
Start: (07/2022); total months: 12

Task 7: Travel to support locations
Output - Tech requirements assessed with equipment and operational requirements and needs documented with appropriate out briefs.
Start: (07/2022); total months: 12

Project: Investigate and Identify the Key Differences between Commercial Air Carrier Operations and Unmanned Transport Operations (A11L.UAS.83)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.83	This research will identify weaknesses and develop a framework to make the standards more robust, and increase the safety of large UAS operations in the NAS. This will support the expanded use of UAS to safely transport commercial cargo and passengers.	Investigate and Identify the Key Differences Between Commercial Air Carrier Operations and Unmanned Transport Operations (AUS/ANG-C2)	Yes	FY22	FY23	$790

Project Output: Investigate and Identify the Key Differences between Commercial Air Carrier Operations and Unmanned Transport Operations anticipated research outputs in FY22 (A11L.UAS.83)

The requirement is intended to address gaps in knowledge that are currently a barrier to the safe, efficient, and timely integration of unmanned aircraft systems (UAS) into the National Airspace System (NAS). This includes those operating large UAS likely to be transporting air passengers. This research will develop a framework for understanding and evaluating UAS commercial feasibility together with projected locational demand. Furthermore, an analytical framework detailing large UAS certification and explore the impact

of autonomy on UAS with an emphasis on passenger transportation environment will be offered as well. This research will answer the following research questions: What is the potential for large UAS in carrying passengers in the US? Starting from road transportation and existing air transportation, it is expected that a potential market scope will be laid out. What is the likely locations of large UAS to meet demand and growth of air transportation over a period of 10 years? What interface characteristics are necessary for UAS passenger (e.g., UAM) to maintain awareness of aircraft system state with automated aircraft system and subsystem control? What is the envisioned characteristics of transition from piloted UAS to fully autonomous UAS in carrying passengers? What interface characteristics are necessary for the UAS pilot to manage the aircraft's flight path with automated navigation? How can the autonomous systems be evaluated or certified such that safe integration of UAS in the existing ATM environment or emerging UTM is enabled? How will the UTM paradigm integrate with the large UAS environment? Or will a separate paradigm be needed? How these paradigms will be integrated with the NAS ATM that is already in place? How will strategic scheduling of large UAS occur? How will the non-scheduled large UAS be handled? What other resources and NAS investment may be necessary to facilitate growth of UAS in air passengers? What will be the aggregated economic benefits, i.e., direct, indirect and induced, of integrating large UAS in transporting passengers on the overall economy?

Task 1: Literature and Market Analysis: Completion of literature review, market analysis and related recommendations for this study based upon lessons learned from prior research including NASA-sponsored studies and grand challenges;
Exit Criteria: A detailed report outlining relevant research related to large UAS as well as identifying research related to transition (i.e., piloted to autonomous) and autonomous systems and operations. T+3M

Task 2: Determine Use Cases for the research including determining the commercial feasibility and projections of demand over time (the use cases will examine substitution estimates and new demand).
Exit Criteria: Use cases for the execution of this research. T+6M

Task 3: Define a plan to conduct designed experiments and related analysis to expand, refine, and/or validate results of prior work in the autonomous environment that is accepted by the sponsor and addresses the research questions.
Exit Criteria: Sponsor approved experiments and documentation of validated results; T+6M

Task 4: Conduct designed experiments and related analysis as defined and agreed between the sponsor and the performer that answers the critical research questions.
Exit Criteria: A sponsor approved Research Task Plan (RTP) for the execution of this research. T+14M

Task 5: Conduct economic assessments of integration. Provide a methodology and supporting data taking into account direct, indirect and induced benefits.
Exit criteria: A sponsor approved work-plan outlining all aspects of benefit. T+16M
Task 6: Final Report.
Exit Criteria: Summarize the findings of the research. This should include recommendations for future research based on the gaps identified during the execution of this research. T+18M.

Task 7: Peer Review. Plan and budget for a peer review to ensure public availability of the research within 30 days of final report delivery. T+20M

Project: From Manned Cargo to UAS Cargo Operations: Future Trends, Performance, Reliability, and Safety Characteristics towards Integration into the NAS (A11L.UAS.84)

Control Account Number	Outcome	Project (Sponsor/ Performer)	Congressional Direction	First FY Funded	Last FY Funding	Contract Target ($K)
A11L.UAS.84	This research will develop a framework for understanding and evaluating UAS commercial feasibility together with projected locational demand. Furthermore, an analytical framework detailing large UAS certification and explore the impact of autonomy on UAS with an emphasis on the cargo environment will be offered as well.	From Manned Cargo to UAS Cargo Operations: Future Trends, Performance, Reliability, and Safety Characteristics Towards Integration into the NAS (AUS/ANG-C2)	Yes	FY22	FY23	$790

Project Output: From Manned Cargo to UAS Cargo Operations: Future Trends, Performance, Reliability, and Safety Characteristics towards Integration into the NAS anticipated research outputs in FY22 (A11L.UAS.84)

This research will identify weaknesses and develop a framework to make the standards more robust, and increase the safety of large UAS operations in the NAS.
Projected Benefit of Research Comprehensive analysis of market, feasibility and projections of future demand together with their locations and likely network; Findings, recommendations, and lessons learned will enhance the FAA understanding of Large UAS certification requirements beyond what is available; and This research will also explore the role of autonomy in UAS vehicles beginning with less risky areas (e.g., rural to exurbs) and then onto more populated areas of suburban and metro areas. The requirement is intended to address gaps in knowledge that are currently a barrier to the safe, efficient, and timely integration of unmanned aircraft systems (UAS) into the National Airspace System (NAS). This includes those operating large UAS likely to be transporting cargo by air. This research will develop a framework for understanding and evaluating UAS commercial feasibility together with projected locational demand. Furthermore, an analytical framework detailing large UAS certification and explore the impact of autonomy on UAS with an emphasis on the cargo environment will be offered as well.
This research will answer the following research questions: What is the potential for large UAS in carrying air cargo in the US? Starting from road transportation and existing air cargo, it is expected that a potential market scope will be laid out. What is the likely location and distribution of large UAS to meet demand and growth of air cargo over a period of 5 years? What interface characteristics are necessary for the UAS pilot (IPP), existing and emerging businesses (e.g., package delivery under Part 135 and/or waiver trends) or UAS passenger (e.g., UAM) to maintain awareness of aircraft system state with automated aircraft system and subsystem control? What interface characteristics are necessary for the UAS pilot to manage the aircraft's flight path with automated navigation? How can the autonomous systems be evaluated or certified such that safe integration of UAS in the existing ATM environment or emerging UTM is enabled? How will the UTM paradigm integrate into the large UAS environment? Or will a separate paradigm be required? How these traffic management paradigms be integrated with the NAS ATM that is already operational? How will strategic scheduling of large UAS occur? How will the non-scheduled large UAS be handled? What other resources and NAS investment may be necessary to facilitate growth of UAS in air cargo? What will be the aggregated economic benefits, i.e., direct, indirect and induced, of integrating large UAS in transporting air cargo on the overall economy?

Task 1: Literature and Market Analysis: Completion of literature review, market analysis and related recommendations for this study based upon lessons learned from prior research.
Exit Criteria: A detailed report outlining relevant research related to large UAS as well as identifying research related to autonomous systems and operations. T+3M

Task 2: Determine Use Cases for the research including determining the commercial feasibility and projections of demand time
Exit Criteria: Use cases for the execution of this research. T+6M

Task 3: Define a plan to conduct designed experiments and related analysis to expand, refine, and/or validate results of prior work in the autonomous environment that is accepted by the sponsor and addresses the research questions.
Exit Criteria: Sponsor approved experiments and documentation of validated results; T+6M

Task 4: Conduct designed experiments and related analysis as defined and agreed between the sponsor and the performer that answers the critical research questions.
Exit Criteria: A sponsor approved Research Task Plan (RTP) for the execution of this research. T+14M

Task 5: Conduct economic assessments of integration. Provide a methodology and supporting data taking into account direct, indirect and induced benefits.
Exit criteria: A sponsor approved work-plan outlining all aspects of benefit. T+16M

Task 6: Final Report.
Exit Criteria: Summarize the findings of the research. This should include recommendations for future research based on the gaps identified during the execution of this research. The future research recommendations should take the form of a Research Task Plan and include research questions. T+18M.

Task 7: Peer Review. Plan and budget for a peer review to ensure public availability of the research within 30 days of final report delivery. T+20M

Program Resources ($K): Unmanned Aircraft Systems Research (A11L)

FAA Research - FY2020 Report (Program Areas grouped by Domain)	FY18 Total Actuals	FY18 Contract Actuals	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Request	FY21 Contract Request	FY22 Contract Target
Aviation Performance & Planning									
Unmanned Aircraft Systems Research (A11L)	$24,035	$20,931	$24,035	$21,503	$24,035	$20,774	$24,035	$22,436	$10,305

People	Facilities	Partnerships
• FAA Center of Excellence (COE) for UAS • FAA Aviation Safety including: UAS Integration Office (AUS), Aviation Safety (AVS), Aircraft Certification (AIR), Small Airplane Directorate (ACE) , Flight Standards (AFS) • 8 Federal FTEs as Subject matter experts in UAS detect and avoid capability, air carrier operations, human factors, and safety data collection	• FAA William J. Hughes Technical Center • FAA Civil Aerospace Medical Institute (CAMI) • FAA UAS Test Sites: North Dakota DOC, State of Nevada, New Mexico State University, University of Alaska Fairbanks, Texas A&M University Corpus Christi, Virginia Polytechnic Institute & State University, Griffiss International Airport (NY)	• NASA • United States Helicopter Safety Team (USHST) • UAS Center of Excellence • Alliance for System Safety of UAS through Research Excellence (ASSURE): 23 leading research institutions and a hundred leading industry, academic, and government partners.