Federal Aviation Administration

Research, Engineering, and Development Advisory Committee (REDAC) Subcommittee on Aircraft Safety (SAS)

FY2021 Aviation Safety Research Portfolio Output Report

Contents

FY2021 AVS Portfolio Funding Profile

Program Area Funding ($K unless noted) FAA Research - FY2021 Report (Program Areas grouped by Domain)	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aircraft Safety Assurance									
Fire Research and Safety (A11A)	$7,200	$2,787	$7,491	$2,879	$7,136	$2,449	$7,576	$2,862	$2,504
Propulsion and Fuel Systems (A11B)*	$2,100	$1,091	$2,256	$156	$4,215	$3,481	$3,121	$880	$3,275
Advanced Material/Structural Safety (A11C)	$14,720	$13,203	$13,693	$9,657	$14,720	$13,477	$1,678	$600	$1,745
Continued Airworthiness - Systems (A11E.SYS)	$11,269	$4,055	$11,269	$4,167	$11,269	$4,683	$8,829	$3,156	$5,154
Continued Airworthiness - Structures (A11E.STR)		$3,368		$3,376		$2,439		$1,780	$3,205
Aircraft Catastrophic Failure Prevention Research (A11F)*	$1,570	$1,433	$1,409	$1,282	$1,565	$1,444	N/A	N/A	N/A
Domain subtotal =	**$36,859**	**$25,937**	**$36,118**	**$21,517**	**$38,905**	**$27,973**	**$21,204**	**$9,278**	**$15,883**
Digital Systems and Technology									
Digital System Safety (A11D.SDS)	$4,767	$2,902	$4,500	$2,806	$3,137	$1,773	$3,689	$2,450	$3,336
Domain subtotal =	**$4,767**	**$2,902**	**$4,500**	**$2,806**	**$3,137**	**$1,773**	**$3,689**	**$2,450**	**$3,336**
Environment & Weather Impact Mitigation									
Aircrft Icing (A11D.AI)	$4,486	$3,171	$4,209	$2,625	$2,154	$1,500	$2,472	$820	$2,075
Alternate Fuels for General Aviation (A11M)	$1,900	$758	$1,900	$726	$2,524	$2,332	$4,986	$4,800	$2,011
Domain subtotal =	**$6,386**	**$3,929**	**$6,109**	**$3,351**	**$4,678**	**$3,832**	**$7,458**	**$5,620**	**$4,086**
Human Performance & Aeromedical Factors									
Flight Deck/Maintenance/System Integratio Human Factors (A11G)	$7,305	$2,710	$7,300	$2,587	$7,469	$2,588	$14,301	$9,422	$9,150
Aeromedical Research (A11J)	$9,080	$2,178	$7,919	$3,299	$10,235	$5,365	$13,257	$7,409	$3,807
Domain subtotal =	**$16,385**	**$4,888**	**$15,219**	**$5,886**	**$17,704**	**$7,953**	**$27,558**	**$16,831**	**$12,957**
Aviation Performance & Planning									
System Safety Management/Terminal Area Safety (A11H)	$5,500	$2,581	$4,500	$1,842	$5,485	$2,631	$7,898	$4,816	$6,958
Unmanned Aircraft Systems Research (A11L)	$24,035	$21,503	$24,035	$21,740	$24,035	$21,710	$22,077	$18,686	$11,797
Domain subtotal =	**$29,535**	**$24,084**	**$28,535**	**$23,582**	**$29,520**	**$24,341**	**$29,975**	**$23,502**	**$18,755**
Total Aviation Safety RE&D Portfolio =	**$93,932**	**$61,740**	**$90,481**	**$57,142**	**$93,944**	**$65,872**	**$89,884**	**$57,681**	**$55,017**
% of total FAA RE&D Appropriation/Request	49.2%		46.9%		47.4%		34.8%		
Total FAA RE&D Appropriation/Request	$191M		$193M		$198M		$258.5M		

**NOTE: Aircraft Castrophic Failure Prevention Research was incorporated into Propulsion and Fuel Systems Budget Narratives starting in FY19.*

***NOTE: These numbers represent the initial FAA budgeting and are subject to change.*

Domain: Aircraft Safety Assurance

Program Area: Fire Research and Safety (A11A)

BLI Scope: Fire Research and Safety

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)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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	AIR/ANG-E2	FY15	FY30

Project Outputs: Aircraft Fire Safety (A11A.FCS.1) outputs delivered in FY21

- Journal Article: Saraf, C., Stubbs, E., Hu, W., Emrick, T., Lesser, A. J., Combining Mechanical Fortification and Ultralow Flammability in Epoxy Networks. Macromol. Mater. Eng. 2020, 2000567
- Journal Article: Karp, M., Ochs, R.I. Methods for Characterizing Artificial Smoke Generators for Standardizing Inflight Smoke Detection Certification. Fire Technol (2020)
- Website: Publication of cargo risk mitigation website to assimilate information relevant to the hazards, risks, and mitigation strategies in the transportation of hazardous goods in an aircraft. https://www.fire.tc.faa.gov/cargosafety
- Presentation: Preliminary Results of Dry Ice Tests to Support Safe Shipment of COVID-19 Vaccines, https://www.fire.tc.faa.gov/pdf/FAA_CO2_Tests_01122021_FINAL_FOR_PUBLIC_RELEASE.pdf
- FAA Report: Summer, Steven M, Fuel Tank Flammability Assessment Method User's Manual – Updated for Version 11, DOT/FAA/TC-21/3, January 2021
- Journal Article: Richard E. Lyon, Natallia Safronava, Sean Crowley, Richard N. Walters, A molecular-level fire growth parameter, Polymer Degradation and Stability, Volume 186, 2021, 109478, ISSN 0141-3910

- FAA Report: Guo, Haiqing, et al. A Study on Experimental Tests and Numerical Simulations of Boeing 747 Overhead Inaccessible-Area Fires, DOT/FAA/TC-21/8, March 2021
- Int'l Aircraft Systems Fire Protection Forum Meeting: Total of 17 presentations of various topical areas related to systems fire protection, April 2021
- Int'l Aircraft Material Fire Test Forum Meeting: Total of 17 presentations of various topical areas related to material fire tests, April 2021
- Pending FAA Report: Gas Analysis in Support of the UN Informal Working Group on Lithium-Ion Battery Classification
- Pending FAA Report: Thermal Runaway Propagation in Support of the UN Informal Working Group on Lithium-Ion Battery Classification
- Pending Training Video: Insulation Burnthrough Test Training Video

BLI Funding Profile: Fire Research and Safety (A11A)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aircraft Safety Assurance									
Fire Research and Safety (A11A)	$7,200	$2,787	$7,491	$2,879	$7,136	$2,449	$7,576	$2,862	$2,504

Collaboration: Fire Research and Safety (A11A)

Collaboration/Partnerships	FAA Office of Hazardous Materials (AXH), FAA Civil Aeromedical Institute (CAMI), Interagency Advanced Power Group (IAPG), NIST, ICAO, SAE, EASA, ICCAIA, Boeing, Airbus, University of Cincinnati, Drexel University, University of Maryland, University of Massachusetts, Rutgers University, UN Dangerous Good Panel
Full Time Employees (FTE)	22 GOV FTEs and 16 CTR FTEs in various technical disciplines including engineering, analytics, material science, chemistry, lab testing, etc.
Facilities	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

Program Area: Propulsion and Fuel Systems (A11B)

BLI Scope: Propulsion and Fuel Systems

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.

Project: Damage Tolerance and Durability Issues: Engine Life-Limited Parts (A11B.PS.1)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11B.PS.1	Develop advanced damage tolerance and risk assessment methods, data, and tools that can be used to reduce the risk of uncontained rotor failures and other life-limited engine components. This research supports the development of a series of Advisory Circulars to assist with compliance to rule 33.70. Current efforts will address effects of melt related anomalies on nickel rotor materials and cold dwell fatigue on titanium rotor materials.	AIR/ANG-E2	FY12	FY25

Project Outputs: Damage Tolerance and Durability Issues: Engine Life-Limited Parts (A11B.PS.1)

- Developed a new capability in the DARWIN engine design code to account for residual stresses in curved surfaces of 2D finite element models. Accounting for these stresses will increase the accuracy of the DARWIN life prediction code used to analyze safety critical engine parts.
- Released DARWIN 10.1 Alpha version in August 2021 which includes the advanced residual stress capability for curved surfaces and the ability to quickly run DARWIN analysis using a developed Python module.

Project: Advanced Analysis Methods for Impact of Aircraft Materials from Rotor Burst and Blade Release (A11B.PS.2)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11B.PS.2	Develop predictive analysis methods for assessing engine fragment impact into engine and fuselage materials to determine the containment and shielding capabilities of each for safety assessments and certification by analysis. This research supports ANE Policy 33.94, ANM 25.903 (d).1 and AC 20-128A related to the B767, A380 and B777 uncontained events, EASA/FAA rule making efforts for Open rotor Engine concepts and electric propulsion systems. The policies, AC's, rules, and new rule making relevant to this research address engine containment and uncontained engine fragment threats, and they have to be updated as new technologies, such as open rotor, are developed. Furthermore, this research is building a knowledge base with industry on what might be required in future rulemaking to address certification by analysis of engine and propeller components and aircraft configurations.	AIR/ANG-E2	FY13	FY24

Project Outputs: Advanced Analysis Methods for Impact of Aircraft Materials from Rotor Burst and Blade Release (A11B.PS.2) outputs delivered in FY21

- Annual LS-DYNA Aerospace Working Group for Engine Related Impact and Failure (AWG ERIF) meeting held on June 8-10 with FAA, NASA, ANSYS, and industry. Updated QA test cases, user guidelines, and impact models
- LS-DYNA Modeling Guidelines Document V21-1 delivered in June and published to LS-DYNA AWG website.
- FAA Report DOT/FAA/TCTT-20/40 Full-Field Measurement of the Taylor-Quinney Coefficient in Tension Tests of Ti-6Al-4V, Aluminum 2024-T351, and Inconel 718 at Various Strain Rates published in October 2020
- Draft FAA Report DOT/FAA/TC-19/41, P2 Aluminum 2024-T351 Input Parameters for *MAT_224 in LS-DYNA Supplemental Report: Additional tests to determine plastic heating and ductile fracture behavior under combined loading
- Draft FAA Report DOT/FAA/TC-19/41, P4 Aluminum 2024-T351 Input Parameters for *MAT_224 in LS-DYNA Ballistic Impact Simulations of a Titanium 6Al-4V Generic Fan Blade Fragment on an Aluminum 2024 Panel Using *MAT_224 in LS-DYNA
- High strain rate and thermal test data for T800/F3900 composite delivered to modelers
- A two-part MAT_213 workshop was held with industry and LS-DYNA users on June 22 and July 13

- MAT_213 manual, user guide, and QA test cases delivered. MAT_213 integrated into LS-DYNA by ANSYS and available in the next full software release R13.
- Draft FAA Report DOT/FAA/TC-21/24 Certification Analysis Using the Uncontained Engine Debris Damage Assessment Model (UEDDAM) necessary to Supported draft revision of Advisory Circular 20-128A
- UEDDAM v6 software training was held with FAA AIR and industry representative participation on March 22-25

BLI Funding Profile: Propulsion and Fuel Systems (A11B)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aircraft Safety Assurance									
Propulsion and Fuel Systems (A11B)*	$2,100	$1,091	$2,256	$156	$4,215	$3,481	$3,121	$880	$3,275
**NOTE: Aircraft Catastrophic Failure Prevention Research was incorporated into Propulsion and Fuel Systems Budget Narratives starting in FY19.*									

Collaboration: Propulsion and Fuel Systems (A11B)

Collaboration/Partnerships	AIA-Rotor Integrity Subcommittee (RISC); Rotor Manufacturing (RoMan) Sub-team; Jet Engine Titanium Quality Committee (JETQC); Jet Engine Nickel Quality Committee (JENQC); AIA Inspection Team; USAF-AFRL, NASA. LS-DYNA Aerospace Working Group (AWG) – include Boeing, GE, P&W, RR and other industry OEMs NASA, Naval Air Warfare Center, ANSYS Inc.
Full Time Employees (FTE)	2 FTE
Facilities	FAA High Performance Computer (HPC)

Program Area: Advanced Material/Structural Safety (A11C)

BLI Scope: Advanced Material/Structural Safety

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

Project: Damage Tolerance of Composite Structures (A11C.SIC.1)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11C.SIC.1	Develop detailed background on composite structure fatigue & damage tolerance, including hybrid design combinations with metallic parts, while benchmarking best industry practice to meet existing or updated regulations. Broaden awareness of the related critical safety and certification issues. Standardize the certification approach across the Certification Service, with some emphasis on Transport Airplane needs in the timeframe from FY14 through FY21	AIR/ANG-E2	FY12	FY23

Project Outputs: Damage Tolerance of Composite Structures (A11C.SIC.1) outputs delivered in FY21

- FAA Final Technical Report on progressive damage growth of composites under variable-amplitude fatigue testing. This report documents the effect of load sequencing using variable-amplitude block spectrum.
- Draft ASTM test guide on Mode I dominant face sheet-to-core fracture toughness of sandwich constructions submitted for balloting
- Draft ASTM test guide to obtain fatigue fracture toughness values and corresponding growth rates under cyclic loading. The test guide is based on the ASTM standard for static fracture toughness testing (WK56166)
- Draft new ASTM test standard for sandwich composite structures. The test standard is based on the existing ASTM Mixed Mode-Bending (MMB) standard for monolithic laminates.
- T Based on research results, new and updated composite damage tolerance content was developed for the upcoming revision of the Composite Mater CMH-17 (Revision H) covering high-priority topics including updated certification requirements and guidance, design criteria, structural damage capability, damage threat assessments, composite aging, and industry cases studies. A select list of the developed technical content for CHM-17 is provided below:
    - Interlaminar Fracture toughness (Vol. 1 chapter 6.8.6)
    - Mechanics of delamination onset and propagation (Vol. 3 chapter 8.7.3.2)
    - Simulation of delamination failure using cohesive zone models (Vol. 3 chapter 8.7.6)

- Verification and Validation Process for Progressive Damage and Failure Analysis Methods (Vol. 3 chapter 8.9)
- New sections on testing and analysis including case studies related to sandwich face sheet/core separation are under development (Vol. 6 chapters 2, 4 and 8)

Project: Continued Operational Safety (COS) and Certification Efficiency (CE) for Emerging Composite Technologies (A11C.SIC.12)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11C.SIC.12	Provide technical report on the effects of fire on composite failure analysis procedures and methods. Determine the survivability of critical failure analysis evidence, as well as effective analysis methods that can bypass the fire damage. Provide Literature review into documented sensitivity of composite materials to new fuels and adequacy of current screening test. Provide technical report documenting effects of exposing composite materials to new fuels and use of new screening methods, if necessary. Generate data to support a review and update of the existing standard for photographic test methods that address lightning strike on composite structures. Provide technical report about the effects of disinfecting materials (e.g., cleaning fluids) and methods (e.g., UV, electrostatic fogging, ionization) on aircraft performance.	AIR/ANG-E2	FY17	FY22

Project Outputs: Continued Operational Safety (COS) and Certification Efficiency (CE) for Emerging Composite Technologies (A11C.SIC.12) outputs delivered in FY21

- FAA technical report on effects of new jet fuel exposure on aerospace composites. This research investigated the extent of initial fuel absorption in various composites and the effect of such absorption on the glass transition temperature and degradation of material properties of composites. This report documents the results of the following jet fuel blends 50/50 Gevo Alcohol-to-Jet (ATJ)/Jet A fuel, 50/50 Synthetic Paraffinic Kerosene (SPK)/Jet A, Amyris 20/80 Farnesane/Jet A fuel, and 50/50 S8/Jet A.
- FAA technical report titled “Effect of Jet Fuels Exposure on Aerospace Composites – Literature Review”. This document provides a survey of different types of aeronautical fluids that composites may encounter during their service life, with an emphasis on conventional jet fuels and alternative jet fuels. The diffusion process of solvents into polymeric composites is explained kinetically and

thermodynamically. Additionally, fundamental interaction mechanisms between the aeronautical fluids and aerospace composites, reinforcing fibers, and polymer matrices are investigated.

- FAA Technical Report titled "Post-Crash Fire Forensic Analysis on Aerospace Composites". This report examines the effects of direct fire exposure and efficacy of char removal techniques on fire-exposed surfaces of the pristine carbon/epoxy and mechanically failed graphite/epoxy composite specimens.
- FAA technical report titled "Post-Crash Fire Forensic Analysis on Aerospace Composites – A Literature Review". This review summarizes the current state of experimental testing on composite materials with applications to commercial aircraft and ships. Additionally, the review includes fire damage mechanisms (i.e., matrix decomposition/pyrolysis, fibers ablation/sublimation, outgassing, delamination, and char formation) that occur when exposing a composite material to controlled open flame or heat fluxes. Non-destructive inspection (NDI) and destructive inspection techniques for assessing the severity and extent of fire damage were incorporated along with modeling techniques used to predict progressive degradation in composite thermal and mechanical properties as a function of increasing temperature, heat flux, and exposure time.
- FAA final technical report on lightning strike on composite structures. This report provides a description of a new ignition detection methodology entitled "digital color emission spectrometry" and validated by round robin testing. Integration of obtained test data and developed methods documented in this report will be used to propose supplementing or superseding the existing standard (for photographic test method).
- Update to the Lightning Protection of Aircraft Handbook (DOT-FAA-CT-89-22)
- FAA technical report titled "Effect of Disinfectants on Aircraft Seating Materials", which document the results from testing seating materials with liquid disinfectants.

Project: Advanced Materials Standardization Development (A11C.SIC.13)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11C.SIC.13 (pop-up)	Promote standardization in use and certification of composite materials and non-metallic additively manufactured materials, thereby improving safety	AIR/ANG-E2	FY16	TBD

Project Outputs: Advanced Materials Standardization Development (A11C.SIC.13) outputs delivered in FY21

- Research on Additive Manufacturing (AM):
  - FAA technical report on additive manufacturing guidance for aircraft design and certification.
  - Draft material and process specifications for two polymer additive manufacturing programs (Markforged and HexPEKK).
  - Draft ASTM standard on test method guidance for polymer additively manufactured materials.
  - Tutorial on polymer AM testing conducted as part of ASTM additive manufacturing training series that leveraged lessons learned on FAA funded AM research.
- FAA technical report on advanced fiber reinforced polymer composite materials guidance for aircraft design certification process and control.
- FAA technical report on ceramic matrix composite materials guidance for aircraft design and certification
- FAA technical report on composite core materials qualification guidelines for aircraft design and certification
- FAA technical report on resin infused fiber reinforced materials guidelines for aircraft design and certification
- FAA technical report on guidelines for qualification and characterization of structural adhesives, and material and process specification development for aircraft design and certification
- FAA technical report on atmospheric plasma treatment parameter determination and wettability assessment
- FAA technical report on the development of higher-level building block testing standards for composites, which documents findings of failure modes and test results of interface characterization performed using seven point bending test methodology on Hat & T-stringers.
- FAA technical report on thermoplastic structural joining materials guidance for aircraft design and certification, which documented surface characterization findings from various surface treatment techniques used in preparing thermoplastic composite substrates for adhesive bonding.
- Hosted the polymer matrix composites (March 2021), ceramic matrix composites (January 2021) and additive manufacturing (November 2020 & April 2021) Composite Material Handbook – 17 (CMH-17) coordination meetings (virtual).

BLI Funding Profile: Advanced Material/Structural Safety (A11C)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aircraft Safety Assurance									
Advanced Material/Structural Safety (A11C)	$14,720	$13,203	$13,693	$9,657	$14,720	$13,477	$1,678	$600	$1,745

Collaboration: Advanced Material/Structural Safety (A11C)

Collaboration/Partnerships	Academia (FAA Joint Centers of Excellence for Advance Materials, COE JAMS): Wichita State University, University of California San Diego, University of Washington, Washington State University, Oregon State University, Florida International University, University of Utah, Mississippi State University, Auburn University. Industry: Boeing, Hexcel, Toray, Cytec, Airbus, Spirit Aero systems, Bombardier, SAE International, ASTM, CMH-17, America Makes, TenCate-US, Bell Helicopters, Sikorsky, Leonardo 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
Full Time Employees (FTE)	6 FTEs in various technical disciplines including engineering, analytics, material science, non-destructive evaluation, etc.
Facilities	FAA Aircraft Structural Test Evaluation and Research Lab (FASTER), FAA Structures and Materials Lab (SML)

Program Area: Continued Airworthiness – Structures/Systems (A11E-STR/SYS)

BLI Scope: Continued Airworthiness - Structures

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)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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. 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, fulfill commitments to manage and develop metallic material and joint design standards on which aerospace industry depends. This requirement supports the introduction of new metallic materials and joining processes. For these emerging materials, research is being conducted under the Damage Tolerance and Durability Issues for Emerging Technologies requirement to better define specification controls and key material properties needed for design. Once identified and agreed to, the material properties will be maintained under this requirement, MMPDS	AIR/ANG-E2	FY10	FY30

Project Outputs MMPDS Support and Design Values for Emerging Materials (A11E.SIM.4) outputs delivered in FY21

- Held the spring and fall MMPDS General Coordination Committee Meetings to approve agenda items for inclusion in the handbook and database.
- Output from this research is annual update of MMPDS Handbook and Derivative Products, MMPDS-16, released July 2021.

Project: Reliability of Structural Health Monitoring (SHM) systems (A11E.SIM.14)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11E.SIM.14	Accepted Industry standard that can be used by the FAA to develop guidance on SHM validation when used on transport category aircraft that are DT compliant.	AIR/ANG-E2	FY21	FY24

Project Outputs: Reliability of Structural Health Monitoring (SHM) systems (A11E.SIM.14) outputs delivered in FY21

- Established an Industry Consortium through the SAE AISC for SHM to develop and validate PoD methodologies
- Report on in-house (Structures and Materials Lab) capabilities assessment and PoD analysis of four SHM systems

Project: Damage Tolerance and Durability Issues (Area 1-A11E.SIM.5-Emerging Technologies) (Area 2-A11E.SIM.12-Fleet Risk Management for Small Airplanes) (A11E.SIM.16))

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11E.SIM.16	Area 1: Emerging Technologies: This requirement would provide the directorates data on new technologies in order to develop policy and regulatory guidance materials that will support their application on new products and potential use on legacy aircraft. The requirement will also ensure the safe and efficient implementation of new technologies in aircraft products by providing data on the basic characteristics of these new technologies. The sponsor plans to use the outputs from this research for the development of rulemaking, policy, regulatory guidance, and industry standards. This requirement allows the FAA to Partner with manufacturers to ensure the fatigue, durability, damage tolerance and residual strength performance of new material systems is well understood prior to introduction into service through fracture mechanics test and analysis. Obtain material/material system data, analytical tool validation data, etc. necessary to assess if new regulatory material is required, and Support certification of new products and maintenance of legacy aircraft where new technologies are being implemented. Research in Area 1 is broken down into 4 tasks: Task 1 Bonded Repair Technology: Data obtained will be used to develop regulatory guidance, associated policy and support certification compliance (explore good bond and weak bond) Task 2 Advanced Metallic Fuselage Structure: Data obtained will be used to develop regulatory guidance and associated policy. Task 3 Assessment of Aluminum Lithium for Primary Structure: Data being used to support the certification current and future certification projects. (Next generation and tailor-made alloys and functional materials). Data will also be used to develop policy as needed to standardize certification of airplanes utilizing Al-Li materials. Task 4 Thermal Residual Stresses in Metal-Composite Hybrid Structure, Data will be used to develop Advisory Circular and associated policy Area 2: Probabilistic Risk Assessment Methods: Research from all phases will result in: Data, methods, and tools to provide more robust fatigue evaluations and risk analysis and risk management for in-service findings. Software available to all FAA engineers and DERs. Data to help rewrite part 23 requirements, develop industry consensus standards for both fatigue evaluation and risk analysis, and revise existing and develop new policy and guidance material. Earlier FAA recognition of age-related safety concerns and more efficient resolution of those concerns resulting in increased prevention and mitigation of age-related accidents and incidents. Improved general aviation community understanding of risk due to fatigue issues"	AIR/ANG-E2	FY12	FY25

Project Outputs: Damage Tolerance and Durability Issues (A11E.SIM.16) outputs delivered in FY21

Area 1 under this requirement addresses certification and continued airworthiness issues arising from the introduction of emerging materials and construction methods used for aircraft structures in new fatigue critical applications. During FY21, the following activities and output were achieved:

- Task 1:
  - Issued report on baseline study of to determine strength and fatigue of undamaged test specimens.
  - Issued report on strength and fatigue of partial depth and full depth scarfed repairs.
- Task 2: issued report on baseline study of strength and fatigue of traditional fuselage design and materials as well as tradition repair.
- Task 4: Issued report on industry survey of current practices for analyzing thermal loads in composite-aluminum hybrid structures that are residual from the manufacturing process.

Area 2 under this requirement is using probabilistic methods to develop and improve tools required to assess and manage the structural fatigue risk to general aviation. During FY21, the following activities and output were achieved:

- A graphic user interface (GUI) is developed.
- The GUI is outlined to multiple algorithms and tools, for example, internal crack growth solver and adaptive sampling algorithm,
- An adaptive importance sampling algorithm is being developed to improve the computational time, and statistical information about the damage tolerance parameter are gathered.

Program Area: Continued Airworthiness - Systems (A11E-SYS)

BLI Scope: Continued Airworthiness - Systems

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

Project: Novel and Unusual Electric Aircraft Systems (A11E.ES.7)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11E.ES.7	New and modified airplanes utilizing More Electric Airplane (MEA) concepts and technologies are efficiently and safely certified.	AIR/ANG-E2	FY19	FY21

Project Outputs: Novel and Unusual Electric Aircraft Systems (A11E.ES.7) outputs delivered in FY21

- Developed a test plan for nearfield, radiated, and reflected wave EMI emission in HVDC power modules.
- Developed a test plan for partial discharge testing and modeling of insulation materials, power distribution components, and motor windings.
- Developed a preliminary model of a single converter module's EMI emission.
- Generated a preliminary analysis report for EMI filter design trade-offs in electric propulsion and distribution systems.
- Developed a throttle control test plan for turboelectric passive and active control schemes.
- Developed multi-rotor and fixed wing turboelectric integration plans.
- Generated a multi-roto and fixed wing turboelectric integration test report.
- Developed a vehicle system test plan for flight control and payload shift testing in eVTOL.
- Generated the eVTOL flight control payload shift models and analysis report.
- Generated the vehicle system test report.
- Developed a vehicle certification plan for eVTOL.
- Developed a test design and plan for structurally distributed batteries.
- Generated a test setup report documenting critical features of a structurally distributed battery test stand.
- Generated a test report for safety report for an all-solid-state lithium-ion battery (ASLIB) prototype.

Project: Integrated Flight Path Control to Address GAJSC/FAA GA Safety Interventions (A11E.FCMS.8)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11E.FCMS .8	The outcome will be design and certification requirements for a flight path control autopilots for light GA purposes. The resulting papers, reports, and technical guidance can be used by the FAA and industry to design systems, create industry standards, and field new designs similar to those already fielded in complex UAVs that refuse to crash, and in fly-by-wire aircraft but at lower cost. Ultimately, the outcome will be a significant reduction of CFIT and Loss of Control accidents in GA.	AIR/ANG-E2	FY17	FY22

Project Outputs: Integrated Flight Path Control to Address GAJSC/FAA GA Safety Interventions (A11E.FCMS.8) outputs delivered in FY21

- Conducted Initial Flight Tests to advance the maturity of NASA's Expandable Variable-Autonomy Architecture (EVAA) with imbedded Ground Collision Avoidance Systems (GCAS). Delivered the technical data.
- Conducted Guest Pilot Workshop to demonstrate flight control concepts for Simplified Vehicle Operations on eVTOL aircraft.

Project: Transfer of New Technologies for Enhancement of GA Safety (A11E.FCMS.13)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11E.FCMS .13	1. Demonstrate device integration on manned aircraft. 2. Validate the intended safety function is met. 3. Develop streamlined certification compliance requirements. 4. Publish advisory circular or share results with ASTM/other industry group for incorporation into industry standard."	AIR/ANG-E2	FY18	FY23

Project Outputs: Transfer of New Technologies for Enhancement of GA Safety (A11E.FCMS.13) outputs delivered in FY21

- Conduct flight simulation tests to assess Means of Compliance (MOC) for vertical takeoff and landing vehicle (VTOL) concepts with automated flight control systems. Delivered the technical data.

Project: Integrated Flight and Propulsion Control (A11E.RS.8)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11E.RS.8	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.	AIR/ANG-E2	FY21	FY23

Project Outputs: Integrated Flight and Propulsion Control (A11E.RS.8) outputs delivered in FY21

- Investigated sensors and algorithms scalable to different vehicle sizes that compute control power margins for Distributed Electric Propulsion (DEP) VTOL aircraft. Completed simulation modeling and constructed two prototypes to verify the models.

BLI Funding Profile: Continued Airworthiness – Systems/Structures (A11E)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aircraft Safety Assurance									
Continued Airworthiness - Systems (A11E.SYS)	$11,269	$4,055	$11,269	$4,167	$11,269	$4,683	$8,829	$3,156	$5,154
Continued Airworthiness - Structures (A11E.STR)		$3,368		$3,376		$2,439		$1,780	$3,205
Domain subtotal =	**$11,269**	**$7,423**	**$11,269**	**$7,543**	**$11,269**	**$7,122**	**$8,829**	**$4,936**	**$8,359**

Collaboration: Continued Airworthiness – Systems/Structures

Collaboration/Partnerships	Aviation Specialties Unlimited (ASU), PEGASAS Center of Excellence for General Aviation, Georgia Institute of Technology, NASA Ames, NASA Armstrong, NASA Langley, Battelle, Boeing, Arconic, Embraer, Bombardier, Constellium, Wichita State University, Southwest Research Institute, NASA, University of Texas at San Antonio, Textron Aviation, Rutgers University, University of Washington, Politecnico de Milano, Wichita State University MagniX, DENSO, Boeing, Airbus, Dassault, Joby, Acme Aero, EaglePicher, Teledyne, EP Systems, S&T Systems, University of Dayton Research Institute, SAE, NASA (Johnson and Glenn), EASA, Propulsion Power Systems Alliance
Full Time Employees (FTE)	8 FTEs in various technical disciplines including engineering, mathematics, material science, sensor technology, etc.
Facilities	FAA Full-scale Aircraft Structural Test Evaluation and Research (FASTER) Lab, FAA Structures and Materials Lab (SML), Aircraft Beam Structural Test (ABST) Fixture, FAA Arc Fault Evaluation Lab/More Electric Aircraft Lab, POWER Lab, Electric Flight Controls Test Capabilities, FAA's Sikorsky S76-D Helicopter Simulator at the William J. Hughes Technical Center's Cockpit Simulation Facility

Domain: Digital Systems & Technology

Program Area: Digital System Safety (A11D.SDS)

BLI Scope: Digital System Safety

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

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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.	AIR/ANG-E2	FY20	FY24

Project Outputs: Complex Digital Systems (A11D.SDS.6) outputs delivered in FY21

- Model-Based Systems Engineering and Model-Based Safety Analysis: Final Report.
- Understanding of the Overarching Properties: Interim report on the alternate means of assurance methods.

BLI Funding Profile: Digital System Safety (A11D.SDS)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Digital Systems and Technology									
Digital System Safety (A11D.SDS)	$4,767	$2,902	$4,500	$2,806	$3,137	$1,773	$3,689	$2,450	$3,336

Collaboration: Digital System Safety (A11D.SDS)

Collaboration/Partnerships	NASA Langley, Aerospace Vehicles Systems Institute (AVSI), FAA ATO Navigation Programs, GPS Program, U.S. Space Force, Air Force Research Laboratory (AFRL), Integrated Mission & Avionics Test & Evaluation Division, Naval Air Warfare Center, Patuxent River Naval Air Station
Full Time Employees (FTE)	SDS- 2 GOV FTE, 1 vacancy and partnerships from other organizations and contractors in Systems Engineering, Computer Engineering, and Computer Science disciplines
Facilities	N/A

Domain: Environment and Weather Mitigation

Program Area: Aircraft Icing (A11D.AI)

BLI Scope Aircraft Icing

The FAA's Aircraft Icing research program focuses on ground icing and inflight icing effects on all types of aircraft. Ground icing focuses on aircraft deicing and anti-icing methods prior to takeoff. Inflight icing focuses on aerodynamic and operational effects of icing on all types of aircraft, rotorcraft, and engines.

Project: Research on Ice Crystal Icing Conditions to Support New Icing Regulations and Guidance (A11D.AI.1)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11D.AI.1	Mitigate the hazardous impact of ice accretions on engine operation and core components, such as compressors, due to ice crystal ingestion.	AIR/ANG-E2	FY13	FY23

Project Research on Ice Crystal Icing Conditions to Support New Icing Regulations and Guidance (A11D.AI.1) outputs delivered in FY21

- Conducted simulated compressor icing studies utilizing the small-scale model-rotating rig in May 2021. The raw technical data was delivered.
- Completed climatology study for upcoming HIWC JAPAN Flight Campaign.
- SAE Journal of Aerospace article on "Comparisons of Cloud In Situ Microphysical Properties of Deep Convective Clouds to Appendix D/P Using Data from the High-Altitude Ice Crystals-High Ice Water Content and High Ice Water Content-RADAR I Flight Campaigns". Published April 2021

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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".	AFS/ANG-E2	FY10	FY21

Project Safe Operations and Take-off in Aircraft Ground Icing Conditions (A11D.AI.2) outputs delivered in FY21

- Constructed new and improved snow generation system ("snow machine") to simulate specified outdoor conditions.
- Completed cold soaked fuel frost (CSFF) aluminum skin testing. The raw technical data was delivered.
- Completed initial aerodynamic contamination testing on a GA aircraft vertical tail. The raw technical data was delivered.
- Multiple PowerPoint presentations were given at the SAE G-12 Hold Over Time Committee in May 2021. These Included:
  - Wind tunnel research on contaminated aircraft wing model to develop Ice pellet allowance times
  - The design and construction of the new and improved snow machine
  - Mixed phase icing
  - Mist deposition rates

BLI Funding Profile: Aircraft Icing (A11D.AI)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Environment & Weather Impact Mitigation									
Aircrft Icing (A11D.AI)	$4,486	$3,171	$4,209	$2,625	$2,154	$1,500	$2,472	$820	$2,075

Collaboration: Aircraft Icing (A11D.AI)

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

Program Area: Alternate Fuels for General Aviation (A11M)

BLI Scope Alternate Fuels for General Aviation

The alternative fuels for general aviation program perform research supporting the Piston Aviation Fuels Initiative (PAFI) to resolve the number one issue facing general aviation today. That is to identify and qualify (through testing) alternative replacement fuel(s) that will maintain the safety of the GA fleet before regulatory and/or market forces eliminate the availability of current leaded aviation gasoline.

Project: Unleaded Fuels Research for General Aviation (A11M.PS.5)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11M.PS.5	The primary outcome is introducing alternative fuels into the general aviation fleet that operate safely and maintain the original certification requirements of aircraft, aircraft engines, and components. This research supports the development of fuel authorization using other than traditional means of certification, in accordance with the FAA 2018 Reauthorization Act, as well as related policy, guidance, and advisory materials. These fuels will eliminate the largest single source of airborne lead emissions in the United States. The US EPA defines avgas as contributing approximately 70% of total airborne lead emissions.	AIR/ANG-E2	FY14	FY29

Project Unleaded Fuels Research for General Aviation (A11M.PS.5) outputs delivered in FY21

- Provided technical data from pre-screening detonation testing to AIR-600 for evaluation. Generated a test report for PAFI pre-screening tests conducted on a Lycoming TIO-540-J2BD.

BLI Funding Profile: Alternate Fuels for General Aviation (A11M)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Environment & Weather Impact Mitigation									
Alternate Fuels for General Aviation (A11M)	$1,900	$758	$1,900	$726	$2,524	$2,332	$4,986	$4,800	$2,011

Collaboration: Alternate Fuels for General Aviation (A11M)

Collaboration/Partnerships	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 Chemical, Phillips 66, Exxon/Mobil, Total, Chevron, Ethyl Corp., Swift Fuels LLC, Calumet Specialty Products, Lyondell Chemical Company, Lycoming Engines, Continental Motors Group, BRP-Rotax GmbH & Co KG, Textron Aviation, Robinson Helicopter Company, Cirrus Aircraft, Cape Air, Mooney Aircraft, Piper Aircraft, McCauley Propeller Systems, Hartzell Propeller, Meggitt Polymers & Composites, Innospec, Dixie Services, Haltermann Solutions, Everts Air, Enstrom Helicopter, Precision Airmotive, Precision Engines, Radial Engines Ltd, , Commemorative Air Force, ACADEMIA: Purdue University-PEGASAS Center of Excellence GOVERNMENT: Environmental Protection Agency, National Research Council Canada, Transport Canada
Full Time Employees (FTE)	5 GOV FTEs and 10 CTR FTEs in various technical disciplines including engineering, analytics, material science, chemistry, lab testing, etc.
Facilities	FAA Aviation Fuel Research Lab (AFRL), FAA Propulsion & airpOWer Engineering Research (POWER) Lab

Domain: Human and Aeromedical Factors

BLI Scope: Flightdeck/Maintenance/System Integration Human Factors

This research will use human factors principles to focus on the impact of systems, procedures, training, advanced technologies, and new/novel concepts of operations on human performance. This human-centered approach will address the issues associated with regulatory aspects of design, training, operations, and maintenance, including complex systems and human-system integration, and it will provide strategic solutions to improve aviation safety.

Project: Advanced Vision Systems (EFVS, EVS, SVS, CVS), Head-Up Displays (HUD), and Head Mounted Displays (HMD): Operational Standards & Approval Criteria (A11G.HF.4)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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.	AFS/ANG-C1	FY15	FY23

Project Advanced Vision Systems (EFVS, EVS, SVS, CVS), Head-Up Displays (HUD), and Head Mounted Displays (HMD): Operational Standards & Approval Criteria (A11G.HF.4) outputs delivered in FY21

- Experiment Research Plan for the study: Evaluation of human factors and crew coordination aspects of dual HUD CAT III operations compared to single HUD CAT III operations
- Experiment Research Plan for the study: Quantifying the contribution of HUD to pilot performance on approaches where HUD is used, but not required, to transition landing
- Human Computer Interaction International (HCII) 2021 3D Workload Profile Paper for the study: Evaluating human factors considerations for using HUD with localizer guidance in lieu of required infrastructure for takeoff
- Experiment Research Plan for the study: Pilot Performance using Flight Director, HUD, and SVGS in the Instrument Segment to inform lowering standard CAT I minima

- Task Analysis for the study: Evaluate pilot performance and human factors considerations associated with using HUD and conducting CAT II and CAT III approaches using other than ALSF I or ALSF II approach lighting systems

Project: Fatigue Mitigation in Flight Operations (A11G.HF.8)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11G.HF.8	Reduced accident rate with pilot fatigue in flight operations as a causal or contributing factor. Flight Standards Service will be able to evaluate the effectiveness of fatigue risk management approaches utilized by certificate holders under CFR parts 121 and 117 to mitigate fatigue and improve flight crew member alertness. Possible revisions to various Advisory Circulars (e.g., AC 120-103 A) associated with the flight crew member duty and rest regulations will be made as determined by the continuous monitoring and analysis of the FRMS database and research study results.	AFS/ANG-C1	FY2015	FYXX

Project Outputs: Fatigue Mitigation in Flight Operations (A11G.HF.8) outputs delivered in FY21

- Summary report of modifications and enhancements made to the Fatigue Risk Management System (FRMS) Database.
- Initial Research Plan for human factors/pilot performance considerations in flight operations involving short haul multiple segment workload and cumulative sleep loss across trip pairings.

BLI Funding Profile: Flight deck/Maintenance/System Integration Human Factors (A11G)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Human Performance & Aeromedical Factors									
Flight Deck/Maintenance/System Integratio Human Factors (A11G)	$7,305	$2,710	$7,300	$2,587	$7,469	$2,588	$14,301	$9,422	$9,150

Collaboration: Flight deck/Maintenance/System Integration Human Factors (A11G)

Collaboration/Partnerships	Industry, NASA, Volpe, Radio Technical Commission for Aeronautics (RTCA), Universities
Full Time Employees (FTE)	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
Facilities	Civil Aerospace Medical Institute (CAMI), William J Hughes Technical Center (WJHTC), Private Industry

Program Area: Aeromedical Research (A11J)

BLI Scope: Aeromedical Research (A11J)

The aerospace medicine research program is executed at the FAA's Civil Aerospace Medical Institute (CAMI) in support of the agency's aviation safety mission. The research program focuses on safety sensitive personnel, airline passenger, and commercial space flight participant health, safety, and performance in current and forecasted future civilian aerospace operations. CAMI researchers conduct aerospace-relevant applied research in the biomedical, biodynamics and survivability/cabin safety sciences. A unique portfolio of capabilities allows CAMI to transition validated knowledge and effective technologies to enable innovation in aerospace operations and mitigate and prevent aeromedical hazards associated with aerospace mishaps.

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11J.AM.1	The principal contributions of aerospace medical research to the enhancement of NAS operations are: (a) CONTINUED OPERATIONAL SAFETY – by maximizing the strengths of the human link in the NAS and minimizing inherent human weakness to prevent accidents and improve safety through evidence-based medicine, (b) RISK MANAGEMENT – by identifying hazards and investigating injury and death patterns in civilian flight accidents towards an aeromedical safety management system, and (c) CERTIFICATION STANDARDS AND POLICY – by formulating criteria that will lead to improved knowledge management and decision-making processes in aerospace medicine, aircraft certification, flight standards, and accident investigation & prevention programs. The specific sponsor outcomes expected from the highlighted FY21 research studies listed for this requirement are: #10168 – INFLIGHT. The findings from this study will offer improvements for airline and public policies regarding issues that are based on inflight event data such as crew protocols and use of medical kits. It will characterize the most common medical problems, the type of on-board assistance rendered, and the incidence of and factors associated with unscheduled aircraft diversion.	AAM/AAM-600	FY19	FY21

Project Outputs: CAMI Aerospace Medical Systems Analyses (A11J.AM.1) outputs delivered in FY21

- Determine the State of Knowledge on Inflight Disease Transmission Based on a Review of Historical Occurrences Report (anticipated FY21 delivery)

- COVID-19 Literature Review: Face Masks and Blocked Middle Seats for Preventing In-Flight Transmission Report (anticipated FY21 delivery)
- Determine the State of Knowledge on the Efficacy of COVID-19 Testing in the Aviation Environment (anticipated FY21 delivery)
- Aeromedical Significance of Post-COVID-19 Syndrome for Patients Treated in the Intensive Care Unit: A Narrative Review (anticipated FY21 delivery)
- Estimated Accident Risk for BasicMed vs. Medically Certified U.S. Pilots Report (DOT/FAA/AM-21/18)
- Comparison of Autopsy Results for Third-Class Medically Certified Pilots Vs BasicMed and Sport Pilots Report (anticipated FY21 delivery)
- Vaccination and its Effect on SARS-CoV2 Onward Transmission: A Narrative Review CAPSCA Report
- CARI-7 Documentation: Geomagnetic Cutoff Rigidity Calculations and Tables for 1965-2010 (DOT/FAA/AM-19/04; published in FY21)
- CARI-7 Documentation: Radiation Transport in the Atmosphere Report (DOT/FAA/AM-21/05)
- CARI-7 Documentation: Particle Spectra Report (DOT/FAA/AM-21/04)
- Ionizing Radiation and Radiation Safety in Aerospace Environments (DOT/FAA/AM-21/08)
- CARI-7 Users Guide (DOT/FAA/AM-21/06)
- CGEM User's Guide
- CGEM: A Cerebral Blood Flow Based Computer Model of Gz-Induced Effects
- EMS Helicopter Accident Review: Causes and Contributing Factors (DOT/FAA/AM-21/19)
- Drug Name Correction of Medical Records from Aeromedical Certification Exams Report (DOT/FAA/AM-21/23)
- Contemporary Evidence on Risk Stratification of Anticoagulated Non-valvular Atrial Fibrillation Patients Grouped by CHA2D2-VASc Score Levels Presentation

Project: CAMI Aerospace Medical Accident Investigation & Prevention (A11J.AM.2)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11J.AM.2	The principal contributions of aerospace medical research to the enhancement of NAS operations are: (a) CONTINUED OPERATIONAL SAFETY – by maximizing the strengths of the human link in the NAS and minimizing inherent human weakness to prevent accidents and improve safety through evidence-based medicine, (b) RISK MANAGEMENT – by identifying hazards and investigating injury and death patterns in civilian flight accidents towards an aeromedical safety management system, and (c) CERTIFICATION STANDARDS AND POLICY – by formulating criteria that will lead to improved knowledge management and decision-making processes in aerospace medicine, aircraft certification, flight standards, and accident investigation & prevention programs. The specific sponsor outcomes expected from the highlighted FY21 research studies listed for this requirement are: #10025. A fourth study, COMPARISON ACROSS MULTIPLE TYPES OF SLEEP DEPRIVATION continues its execution from the approved FY18 & FY19 AM-2 TCRGs. Its outcome has been previously addressed.	AAM/AAM-600	FY18	FY22

Project Outputs: CAMI Aerospace Medical Accident Investigation & Prevention (A11J.AM.2) outputs delivered in FY21

- Comparison Study of Microarray and RNAseq for Differential Expression Report (DOT/FAA/AM-20/09; published in FY21)
- The Utility of Genetic Risk Scores in Predicting the Onset of Stroke Report (anticipated FY21 delivery) (DOT/FAA/AM-21/24)
- Transcriptional Responses to Altitude-Induced Hypoxia in Bronchial Epithelium, Broncho-alveolar Cells, and Blood Differ Between Smokers and Nonsmokers Report (anticipated FY21 delivery) (DOT/FAA/AM-21/25)
- Human Bronchial Epithelial Cells Display Alterations in Chromatin Accessibility and Gene Expression According to Oxygen Availability Report (anticipated FY21 delivery) (DOT/FAA/AM-21/26)
- NCBI data sets released: Gene Expression Omnibus Bioproject PRJNA492492
- Fatigue biomarkers for accident investigation and prevention briefing presented to an inter-agency federal Fatigue Management & Research work group
- Fatigue Mitigation in Flight Operations to Aerospace Medical Research Advisory Council Winter Meeting 2021 (AMRAC)

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11J.AM.3	The principal contributions of aerospace medical research to the enhancement of NAS operations are: (a) CONTINUED OPERATIONAL SAFETY – by maximizing the strengths of the human link in the NAS and minimizing inherent human weakness to prevent accidents and improve safety through evidence-based medicine, (b) RISK MANAGEMENT – by identifying hazards and investigating injury and death patterns in civilian flight accidents towards an aeromedical safety management system, and (c) CERTIFICATION STANDARDS AND POLICY – by formulating criteria that will lead to improved knowledge management and decision-making processes in aerospace medicine, aircraft certification, flight standards, and accident investigation & prevention programs. The specific sponsor outcomes expected from the highlighted FY21 research studies listed for this requirement are: #10128 – MEDICATIONS. Understanding of the effects of certain substances on human performance in the flight environment. Enhancement of medical certification strategies with a standardized aerospace medical testing protocol(s) that addresses disqualifying conditions such as diabetes, decongestants, antihistamines, and the functionality at altitude of certain medical devices (monitors and pumps). #10156 – EVACUATION. Provide consolidated background information for future studies focused on aircraft evacuation slides and provide empirical data on technique and injury trends, as observed in training and certification events, for the development of recommendations to mitigate future injuries in aircraft egress events using evacuation slides. #10160 – IMPACT. Improved transfer of knowledge to stakeholders with updated, new, and streamlined didactic material for the Dynamic Impact Test Procedures Class.	AAM/AAM-600	FY19	FY23

Project Outputs: CAMI Human Protection & Survival (A11J.AM.3) outputs delivered in FY21

- Passenger Oxygen Mask Design Study (DOT/FAA/AM-21/11)
- Altitude Physiology Research Laboratory: Equipment and Set-Up (DOT/FAA/AM-21/12)
- Simulation of Oblique Loading Configurations using an FAA Hybrid III Virtual ATD Report (DOT/FAA/AM-21/07)
- List of Occupant Injury Criteria Report (DOT/FAA/AM-21/02)
- Evaluation of Serious Games for Passenger Education I: Aircraft Safety Information Retention across Media Types Report (anticipated FY21 delivery) (DOT/FAA/AM-21/22)
- Lumbar Load Variability in Dynamic Testing of Transport Category Aircraft Seat Cushions Report (DOT/FAA/AM-21/09)
- Tensile Injuries of the Isolated Lumbar Spine in Oblique Bending Conference Paper
- Crashworthiness - Surviving the Accident Conference Presentation

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11J.FCS.7	Utilize the data presented in the report to issue guidance concerning the ramifications of different seating configurations on evacuation.	AIR/AAM-600	FY18	FY22

Project Outputs Effects of cabin seat pitch and alternative seat configurations on evacuation (A11J.FCS.7) outputs delivered in FY21

- Effects of Airplane Cabin Interiors on Egress I: Assessment of Anthropometrics, Seat Pitch, and Seat Width on Egress Report (anticipated FY21 delivery) (DOT/FAA/AM-21/01)

BLI Funding Profile: Aeromedical Research (A11J)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Human Performance & Aeromedical Factors									
Aeromedical Research (A11J)	$9,080	$2,178	$7,919	$3,299	$10,235	$5,365	$13,257	$7,409	$3,807

Collaboration: Aeromedical Research (A11J)

Collaboration/Partnerships	Aerospace Medical Association, American Society of Mechanical Engineers, Baylor College of Medicine, Brigham and Women's Hospital, Canadian Royal Air Force, Center for Child Injury Prevention Studies, Customs and Border Protection, Department of Homeland Security, General Aviation Joint Steering Committee, International Cabin Safety Research Technical Group, International Civil Aviation Organization, Medical College of Wisconsin, MedAire, National Air and Space Administration (NASA), National Highway Traffic Safety Administration, National Institute for Occupational Safety and Health, National Oceanic and Atmospheric Administration, National Transportation Safety Board, Naval Medical Research Unit-D, Oklahoma Medical Research Foundation, SAE International, SAFE Association, Southwest Research Institute, Transportation Safety Institute, United States Helicopter Safety Team, United States Marshals, United States Navy, Wichita State University.
Full Time Employees (FTE)	37 In-House at the Civil Aerospace Medical Institute (CAMI): 31 GOV FTE; 6 CTR FTE Disciplines: Medicine, Human Factors, Cabin Safety, Genomics, Bioinformatics, Biodynamics, Radiobiology, Physiology, Physics, Mathematics, and Computer Science
Facilities	> 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), Functional Genomics Research Laboratory, Friedberg Numerical Sciences Laboratory

Domain: Aviation Performance & Planning

Program Area: System Safety Management (A11H.SSM)

BLI Scope: System Safety Management

Lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the nation's transportation system. Improve airport and heliport operations, air traffic and airspace management capabilities and deliver air navigation services oversight decision support tools. Additionally, advance safety data collection, risk analysis, and prototype risk-based decision-making capabilities by improving modeling capabilities and enhanced analysis capabilities.

The System Safety Management program is designed to improve safety by developing data collection methods, advancing data and risk analysis techniques, and creating prototypes for risk-based decision-making capabilities to identify and analyze emerging safety issues in a collaborative nature with aviation stakeholders.

Project: Runway Operations Safety Monitoring and Surveillance Tool (A11H.SSM.26)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11H.SSM .26	"AOV will be able to identify and assess current causal and contributing risk factors for runway operations safety occurrences and monitor safety performance trends. 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."	AOV/ANG-E2	FY21	FY23

Project Outputs Runway Operations Safety Monitoring and Surveillance Tool (A11H.SSM.26) outputs delivered in FY21

- Research survey results documenting runway safety and operations data from various data sources.
- SRPT Concept of Operations (ConOps) document detailing the system concept and models.

Project: Improving Go Around Safety (A11H.TAS.7)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11H.TAS.7	Reduce "potentially hazardous outcome reports" from go-arounds by a factor of 5. Presently, the rate is 1 in 10.	AFS/ANG-E2	FY18	FY21

Project Outputs: Improving Go Around Safety (A11H.TAS.7) outputs delivered in FY21

- Briefing on a proposed go-around procedure redesign that improves the workload balance between the pilot flying and the pilot monitoring and drives explicit attention to the flight path
- Briefing on the execution and outcomes of a human-in-the-loop simulation using Level D full-flight simulators evaluating the proposed go-around procedure redesign
- Go-around safety procedure redesign recommendations and validation report (estimated completion date of July 30, 2021)

Project: Wet Runway Wheel Braking Testing (A11H.TAS.9)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11H.TAS.9	Reduced runway excursions on wet runways	AFS/ANG-E2	FY19	FY21

Project Outputs: Wet Runway Wheel Braking Testing (A11H.TAS.9) outputs delivered in FY21

- Detailed flight test plan for wet runway wheel braking flight testing using a leased Boeing 737 at NASA Wallops Flight Facility. The flight test plan involves constructing a water pond on a runway at NASA Wallops and having the aircraft run through the water pond while applying maximum braking. The amount of water in the pond as well as the entry ground speed of the aircraft would be varied to determine the effects on wheel braking.

Project: Improved Helicopter Simulation Models (A11H.TAS.10)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11H.TAS.10	Higher-fidelity mathematical and performance models of helicopter flight dynamics during various mission segments and phases of flight. Increased safety resulting from increased use of simulators/flight training devices/advanced aviation training devices to better prepare pilots on how to avoid and recover from outside the envelope flight conditions (i.e., Autorotation's, VRS, LTE, etc.). Successful research, incorporation of Helicopter Simulator Models with regulatory/guidance/policy updates for these technologies will support the USHST goal of a 20% reduction of the helicopter fatal accident rate by 2020 and the long-term vision of zero accidents by the USHST. These targets are dependent on industry adoption of these technologies and business case/commitment to retrofit existing simulators/flight training devices/advanced aviation training devices with these newer high-fidelity flight dynamics models.	AFS/ANG-E2	FY20	FY24

Project Outputs: Improved Helicopter Simulation Models (A11H.TAS.10) outputs delivered in FY21

- Summary literature review report documenting current helicopter simulator/flight training device models' fidelity, performance gaps, and candidate flight conditions/maneuvers
- Assessment of the feasibility of motion capture technologies and weather sensors for helicopter simulation/flight data collection
- Data collected from S76-D rotorcraft simulation platform for candidate flight conditions/maneuvers (i.e., Vortex Ring State, Loss of Tail Rotor Effectiveness, Autorotation, UIMC encounters, etc.) representing key mission segments: personal/private, air tour, commercial/VIP transport, helicopter air ambulance, law enforcement, offshore, search and rescue, and others

BLI Funding Profile: System Safety Management (A11H.SSM)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aviation Performance & Planning									
System Safety Management/Terminal Area Safety (A11H)	$5,500	$2,581	$4,500	$1,842	$5,485	$2,631	$7,898	$4,816	$6,958

Collaboration: System Safety Management (A11H.SSM)

Collaboration/Partnerships	NASA, United States Helicopter Safety Team (USHST), Vertical Flight Society (VFS), Helicopter Association International (HAI), Vertical Aviation Safety Team (VAST), PEGASAS COE for General Aviation, Georgia Institute of Technology, Rowan University, Sikorsky, Airbus Helicopters, Leonardo, United States Coast Guard, Five-Alpha, LZ Control, TruthData, HeliOffshore, Helicopter Safety Advisory Committee (HSAC), RTCA SC-213/EUROCAE WG79, Universal Avionics/Elbit Systems, Astronics/MaxViz, Iowa University Operator Performance Laboratory (OPL), Dept. of Defense (multiple segments), L3/Harris, VRM Simulations, Flight Safety, CAE, Saab, University of Liverpool,
Full Time Employees (FTE)	23.5 GOV FTE; 98.25 CTR FTEs in various technical disciplines including engineering, computer science, statistics, safety, and risk management
Facilities	FAA's Computing and Analytics Shared Services Environment (CASSIE), FAA's Sikorsky S76-D Helicopter Simulator at the William J. Hughes Technical Center's Cockpit Simulation Facility, Rowan University's CAVE Virtual/Augmented Reality Laboratory

Program Area: Unmanned Aircraft Systems Research (A11L)

BLI Scope: Unmanned Aircraft Systems Research

The FAA's annual five-year UAS Integration Research Plan is supported by this RED BLI and other appropriations. This BLI supports a one FAA and one AVS approach to safe and efficient integration of UAS into the NAS. UAS research is the foundation of FAA/AVS UAS integration activities, and is phased by operational capabilities, providing a streamlined pathway to safe UAS integration. UAS research informs the development of rules, policies, procedures, standards, decisions, and other outcomes needed to safely integrate UAS into the NAS.

Project: DAA Multi Sensor Surveillance Data Fusion Strategies (A11L.UAS.2)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.2	Meet or better the collision risk in the NAS against manned traffic operations. DAA systems with only well-clear avoidance strategy have at least a collision risk rate of .107 and DAA systems with collision avoidance strategies have at least a risk rate of .088.	AIR/ANG-C2	FY14	FY21

Project Outputs: DAA Multi Sensor Surveillance Data Fusion Strategies (A11L.UAS.2) outputs delivered in FY21

- Interim Report on Sensor and Tracker Model Development

Project: Safety Case Methodology (A11L.UAS.7)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.7	The output of this research will be used to inform possible regulations and guidelines for UAS to be utilized over people. It will help inform different governmental agencies on how they can streamline their use of UAS over people to ensure overall transportation safety.	AUS/ANG-C2	FY19	FY19

Project Outputs: Safety Case Methodology (A11L.UAS.7) outputs delivered in FY21

- Research Task Plan
- Draft Test Plan

Project: sUAS Detect and Avoid Requirements Necessary for Beyond Visual Line of Sight (BVLOS) Operations (A11L.UAS.22)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.22	The sponsor intends to use the results of the research to help support any FAA position on industry standards for sUAS DAA systems.	AUS/ANG-C2	FY17	FY21

Project Outputs: sUAS Detect and Avoid Requirements Necessary for Beyond Visual Line of Sight (BVLOS) Operations (A11L.UAS.22) outputs delivered in FY21

- Coordination with Standards Agencies to Establish Framework
- sUAS DAA Solutions Inventory Update

Project: UAS Command and Control Link Compatibility (A11L.UAS.23)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.23	The results of this effort are expected to inform DO-377A/B. In addition, closeout work for MASPS safety analysis is to support applicants for UAS certification.	AUS/ANG-C2	FY20	FY21

Project Outputs: UAS Command and Control Link Compatibility (A11L.UAS.23) outputs delivered in FY21

- Part 4/5 Link Compatibility and Interworking: Test Procedures

Project: High Visual Contrast for UAS (A11L.UAS.31)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.31	Research will provide input to FAA standards and advisory circular material to support the safe, efficient, and timely integration of UAS into the NAS. Performing sound research will lead to preventative measures in reducing incident and accident rates due to mid-air collisions between UAS and other aircraft and collisions with people on the ground.	AIR/ANG-C2	FY19	FY19

Project Outputs: High Visual Contrast for UAS (A11L.UAS.31) outputs delivered in FY21

- UAS High Visual Contrast Annotated Bibliography

Project: ASIAS with Unmanned Data (A11L.UAS.43)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.43	Maintain a reduced risk of collision between manned and unmanned aircraft, in spite of the exponential increase in quantities of unmanned systems, unmanned operations, and interactions between manned and unmanned aircraft.	AIR/ANG-C2	FY18	FY22

Project Outputs: ASIAS with Unmanned Data (A11L.UAS.43) outputs delivered in FY21

- Project Kick-off Meeting and Research Task Plan

Project: Air Carrier Operational Considerations for Unmanned Aircraft Systems (A11L.UAS.44)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.44	The results of this research will provide input to help develop FAA regulations, standards, and guidance for the design and operational approval of Unmanned Aircraft Systems (UAS) air carrier operations in the National Airspace System (NAS) to support the safe, efficient, and timely integration of UAS into the NAS. Performing sound research will lead to preventative measures in reducing incident and accident rates due to human factors in UAS air carrier operations.	AVP/ANG-C2	FY19	FY21

Project Outputs: Air Carrier Operational Considerations for Unmanned Aircraft Systems (A11L.UAS.44) outputs delivered in FY21

- Nesthus, T.E., Fercho, K.A., Durham, J.D., Mofle, T.C., Nesmith, B.L., and Hu, P. (2021). Summary Final Report for Unmanned Aircraft Systems in Air Carrier Operations: UAS Operator Fatigue. DOT/FAA/AM-21/16, Office of Aerospace Medicine, Washington, DC 20591.
- Justin D. Durham, J.D., Mofle, T.C., Nesmith, B.L., Hu, P., Fercho, K.A., and Nesthus, T.E. (2021). Literature Review and Annotated Bibliography (1990 – 2019): Duty Time, Shift Work, and Operator Fatigue for Consideration of Unmanned Aircraft Systems in Air Carrier Operations. DOT/FAA/AM-21/21, Office of Aerospace Medicine, Washington, DC 20591.
- Torrence, B., Nelson, B., Thomas, G.F., Nesmith, B.L., and Williams, K.W. (2021). Annotated Bibliography (1990 – 2019): Knowledge, Skills, and Tests for Unmanned Aircraft Systems (UAS) Air Carrier Operations. DOT/FAA/AM-21/14, Office of Aerospace Medicine, Washington, DC 20591.
- Draft survey instrument for assessment of crew, duty time, knowledge, skills, abilities, and testing requirements for UAS crew performing air carrier-like operations in the NAS.

Project: UAS Safety Case Development, Process Improvement, and Data Collection (A11L.UAS.50)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.50	The outcome of this fully functioning comprehensive system for collecting, storing, analyzing, and mining UAS flight test data in support of UAS integration objectives will be better informed rulemaking and standards, and better-informed decisions based on existing data and data still needed, ultimately leading to the safe integration of UAS in the NAS. The data collection and analysis it enables will allow for safety case(s) for UAS operations leading to repeatable UAS operational approvals.	AFS/ANG-C2	FY18	FY22

Project Outputs: UAS Safety Case Development, Process Improvement, and Data Collection (A11L.UAS.50) outputs delivered in FY21

- Development of Initial Analysis Products

Project: Minority Outreach -- UAS as a STEM Minority Outreach Learning Platform for K-12 (A11L.UAS.53)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.53	The long-term goal of the project is to ignite an interest in UAS/STEM and, therefore, nurture part of the possible future UAS workforce.	AUS/ANG-C2	FY16	FY25

Project Outputs: Minority Outreach -- UAS as a STEM Minority Outreach Learning Platform for K-12 (A11L.UAS.53) outputs delivered in FY21

- Sinclair – Simulation Experience reached 5,043 individuals

Project: Low Altitude Detect and Avoid (DAA) Validation (A11L.UAS.55)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.55	Specific, tailored RDT&E capability to accomplish FAA goals for UAS Integration research.	AUS/ANG-C2	FY19	FY19

Project Outputs: Low Altitude Detect and Avoid (DAA) Validation (A11L.UAS.55) outputs delivered in FY21

- Literature Review
- Flight Test Plan

Project: Remote Identification Validation (A11L.UAS.55)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.55	Specific, tailored RDT&E capability to accomplish FAA goals for UAS Integration research.	AUS/ANG-C2	FY19	FY19

Project Outputs: Low Altitude Detect and Avoid (DAA) Validation (A11L.UAS.55) outputs delivered in FY21

- Draft Preliminary Flight Test Report

Project: Airborne Collision Engine Ingestion Hazard Severity Evaluation (A11L.UAS.58)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.58	Create a verifiable and measurable risk assessment of a UAS ingestion. This is a repeatable and reliable model of a UAS ingestion into an operating large bypass turbine engine.	AUS/ANG-C2	FY17	FY17

Project Outputs: Airborne Collision Engine Ingestion Hazard Severity Evaluation (A11L.UAS.58) outputs delivered in FY21

- Experimental Validation of Components
  - Test Matrix for Component Level Tests
  - Build Fixtures for Component Level Tests
  - Component Level Testing

Project: Airborne Collision: Structural Impact Hazard Severity Evaluation (A11L.UAS.60)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.60	Create a verifiable and measurable risk assessment of a sUAS collision with a manned aircraft.	AUS/ANG-C2	FY17	FY17

Project Outputs: Airborne Collision: Structural Impact Hazard Severity Evaluation (A11L.UAS.60)

outputs delivered in FY21

- Component Level Testing

Project: UAS Automation and Autonomy (A11L.UAS.61)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.61	This research requirement will identify the core technology capabilities for the safe integration of automation for command and control of the UA, navigation of the UA through the airspace, and pilot compliance with clearances and instructions issued to the UAS pilot from ATC.	AUS/ANG-C2	FY19	FY20

Project Outputs: UAS Automation and Autonomy (A11L.UAS.61) outputs delivered in FY21

- Study 1 Technical Report

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.68	The sponsor intends to use the results of this research to support UAS involved in disaster and emergency management preparedness in the NAS. The results, findings, and recommendations from this research will inform requirements, technical standards, regulations, policies, and procedures for emergency responders operating UAS in the NAS to respond to disasters and emergencies.	AUS/ANG-C2	FY19	FY23

Project Outputs: Disaster Preparedness and Response (A11L.UAS.68) outputs delivered in FY21

- Initial Peer Review Meeting
- Survey results of Government experts for use cases
- Survey results of Government experts of coordination

Project: Integrating Expanded and Non-Segregated UAS Operations into the NAS: Impact on Traffic Trends and Safety (A11L.UAS.69)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.69	Phase 1: Evaluation of data and establish quantitative impact of expanded operations: Will provide summaries of all available data and establish quantitative relationships between existing trends and explain shifts due to different aspects of integration activities such as waivers, LAANC, IPP, and other regulatory relaxations.	AUS/ANG-C2	FY21	FY22

Project Outputs: Integrating Expanded and Non-Segregated UAS Operations into the NAS: Impact on Traffic Trends and Safety (A11L.UAS.69) outputs delivered in FY21

- Phase 1 Technical Report

Project: SARP Co-Chair (A11L.UAS.70)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.70	Recommendations for collision avoidance/well clear for UA-to-UA operations supporting safe UAS Integration.	AUS/ANG-C2	FY18	FY18

Project Outputs: SARP Co-Chair (A11L.UAS.70) outputs delivered in FY21

- Bi-Monthly Reports

Project: Establish Risk-Based Thresholds for Approval Needed to Certify UAS for Safe Operations (A11L.UAS.71)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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.	AUS/ANG-C2	FY18	FY18

Project Outputs: Establish Risk-Based Thresholds for Approval Needed to Certify UAS for Safe Operations (A11L.UAS.71) outputs delivered in FY21

- UAS Pilot: Operational Training Requirements Report

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.72	Validated concepts for operating on the airport surface to include methods for delivery of clearances and instructions, waypoints, routes and procedures, aircraft equipage requirements.	AUS/ANG-C2	FY18	FY18

Project Outputs: Safety Risks and Mitigations for UAS Operations On and Around Airports (A11L.UAS.72) outputs delivered in FY21

- Literature Review
- Research Task Plan

Project: Propose Risk-Based Standards for Scalable Compliance Review for sUAS (A11L.UAS.73)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.73	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 provide guidance on Part 107 waivers. The research will also assist the FAA in evaluating UAS type certification applications for UAS designed for beyond part 107 operations.	AUS/ANG-C2	FY18	FY18

Project Propose Risk-Based Standards for Scalable Compliance Review for sUAS (A11L.UAS.73) outputs delivered in FY21

- Literature Review
- Draft Roadmap for Low Altitude Risk Analysis

Project: Multi-UAS Pilot Proficiency (A11L.UAS.74)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.74	Report(s) describing recommended UAS crewmember training and certification requirements, and recommended UAS crewmember procedures and operational requirements during normal and non-normal events. Additionally, identifying the one pilot to many UAS fatigue factors and the impact of autonomy is expected. The goal of this research is to standardize UAS pilot training/certification, and procedures to facilitate UAS pilots' transition from one UAS to another	AUS/ANG-C2	FY18	FY18

Project Multi-UAS Pilot Proficiency (A11L.UAS.74) outputs delivered in FY21

- Literature Review
- Research Task Plan
- Loosely Coupled Task Use Case

Project: Wake Turbulence for UAS (A11L.UAS.75)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
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 information necessary to provide guidance and make safety determination for UAS operations.	AUS/ANG-C2	FY20	FY21

Project Wake Turbulence for UAS (A11L.UAS.75) outputs delivered in FY21

- Literature Review
- Case Studies based on Literature Review
- Research Task Plan

Project: Track Standards to Analyze and Improve Research Efforts (A11L.UAS.77)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.77 (pop-up)	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.	AUS/ANG-C2	FY20	FY21

Project Track Standards to Analyze and Improve Research Efforts (A11L.UAS.77) outputs delivered in FY21

- Literature Review
- Research Task Plan

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

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.78	To inform follow-on cyber-security research.	AUS/ANG-C2	FY20	FY22

Project Cyber Security and Safety Literature Review (A11L.UAS.78) outputs delivered in FY21

- Research Task Plan

Project: FY21 Airport Detection (Section 383) (WJHTC) (A11L.UAS.79)

CA#	Outcome	Project (Sponsor/ Performer)	First FY Funded	Last FY Funding
A11L.UAS.79 (pop-up)	Develop performance standards for UAS detection and mitigation technologies by end of FY23.	AUS/ANG-C2	FY20	FY22

Project Outputs: FY21 Airport Detection (Section 383) (WJHTC) (A11L.UAS.79) outputs delivered in FY21

- Research Plan
- Draft Advisory Circular Framework
- Technical Screen

BLI Funding Profile: Unmanned Aircraft Systems Research (A11L)

Program Area Funding ($K unless noted) FAA Aviation Safety Research FY2021 REDAC Output Report	FY19 Total Actuals	FY19 Contract Actuals	FY20 Total Actuals	FY20 Contract Actuals	FY21 Total Actuals	FY21 Contract Actuals	FY22 Total Request	FY22 Contract Request	FY23 Contract Target **
Aviation Performance & Planning									
Unmanned Aircraft Systems Research (A11L)	$24,035	$21,503	$24,035	$21,740	$24,035	$21,710	$22,077	$18,686	$11,797

Collaboration: Unmanned Aircraft Systems Research (A11L)

Collaboration/Partnerships	FAA William J, Hughes Technical Center, FAA Civil Aerospace Medical Institute, MITRE Center for Advanced Aviation System Development, DoT Volpe, Alliance for System Safety of UAS through Research Excellence: Center of Excellence, National Aeronautics and Space Administration, Interagency Partnerships (e.g., UAS Executive Committee), Industry Partnerships, International Partnerships, UAS Test Sites, Standards Organizations.
Full Time Employees (FTE)	10 Federal FTEs as Subject matter experts in UAS detect and avoid capability, air carrier operations, human factors, and safety data collection
Facilities	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)