NASA Update for FAA REDAC

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ULTRA-EFFICIENT TRANSPORT

FUTURE AIRSPACE AND SAFET



HIGH-SPEED COMMERCIAL FLIGHT



Four Transformations for Sustainability, Greater Mobility, and Economic Growth

Aeronautics FY 2024 Budget Request



\$ Millions	FY 2023 Enacted	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028
Aeronautics	\$935.0	\$995.8	\$1,015.7	\$1,036.0	\$1,056.7	\$1,077.8
Airspace Operations and Safety		158.7	164.4	179.4	198.2	202.8
Advanced Air Vehicles		295.2	311.6	305.0	273.6	257.5
Integrated Aviation Systems		264.9	260.5	263.5	279.7	305.5
Transformative Aeronautics Concepts		160.0	161.8	170.3	184.5	188.5
Aerosciences Evaluation and Test Capabilities		117.0	117.4	117.7	120.7	123.5

- Supports a robust Sustainable Flight National Partnership to enable highly efficient next generation aircraft and ensure U.S. leadership in aviation
 - Demonstrate the first-ever high-power hybrid electric propulsion for large transport aircraft
 - Develop a full-scale sustainable flight demonstrator X-plane to validate integrated systems and their benefits
 - Advance small turbine cores that will increase engine thermal efficiency and reduce fuel burn
 - Improve the rate of composite manufacturing by 4 to 6 times faster than current production rates
 - Develop technologies needed to increase use of sustainable aviation fuels
 - Develop a robust model-based systems analysis and engineering framework at the aircraft system level
 - Develop the next evolution of air traffic management to safely increase operational efficiency which reduces fuel burn and emissions

- Conducts the first flight of the X-59 Low Boom Flight Demonstrator and envelope expansion flights to prove airworthiness. These flight tests will provide data to the global aviation community to reassess the ban on supersonic flight over land and implement noise regulations acceptable to local communities
- Enables the FAA adopted Extensible Traffic Management (XTM) concept to create safe airspace access for emerging aviation systems
- Supports Advanced Air Mobility to ensure U.S. leadership in an emerging aviation market that studies have projected to generate an annual market value of \$115 billion by 2035
- Increases funding to develop revolutionary, beyond next-generation zeroemissions aircraft concepts and technologies through the highly successful University Leadership Initiative and industry led studies
- Funds an effort to improve aerial responses to wildfires by leveraging NASA UAS traffic management technologies, in partnership with NASA's Science and Space Technology Mission Directorates

FY 2024 Budget Request – Changes vs FY 2023 Request



ARMD's FY 2024 budget request reflects five major changes relative to the FY 2023 request

- Decreased the Sustainable Flight Demonstrator (SFD) and Electrified Powertrain Flight Demonstrations (EPFD) projects to better reflect current planning estimates. SFD is in pre-formulation phase and EPFD is in formulation. Both projects will deliver results to industry in time to meet their needs for critical technologies for the next generation single-aisle aircraft (introduction in early 2030s).
- Increase to zero-emissions aviation activities including studies of beyond next generation aircraft designs, modeling of aviation's climate impact, and characterization of sustainable aviation fuels.
- Increase to the Low Boom Flight Demonstrator project to reflect the latest contractor costs and schedule adjustment. The project is currently in the final assembly phase before flight.
- Increase to the Hypersonic Technology project to \$45M to support government and industry partnerships in key technology areas.
- Increase to the High Rate Composite Aircraft Manufacturing project to better support technology development for both fuselage and wing structures. The investment could support two demonstrations.

Sustainable Flight National Partnership

Accelerating Toward Net-Zero Greenhouse Gas Emissions and Reduced Non-CO₂ Climate Impact in the 2030s



Advance engine efficiency and emissions reductions

Enable integrated trajectory optimization

Advance airframe efficiency and manufacturing rate

Enable use of 100% sustainable aviation fuels

Next-generation transports using up to 30% less fuel, current and future fleets flying optimal trajectories, engines burning www.masa.gov 1 5 sustainable aviation fuels for greater than 50% reduction in lifecycle greenhouse gas emissions

Sustainable Flight Demonstrator (SFD) Project



- Awarded a Funded Space Act Agreement (FSAA) to Boeing in January 2023 to design, build, test and fly an advanced airframe configuration demonstrator aircraft and related technologies to dramatically reduce fuel burn and CO₂ emissions.
 - \$425M direct NASA investment + requested NASA facilities/labor support.
 - \$725M funding from Boeing and industry partners
- Boeing's Transonic Truss-Braced Wing (TTBW) configuration utilizes a high aspect ratio, thin, truss-braced wing design to reduce drag and optimize fuel efficiency.



SFD modification includes addition of Transonic Truss-Braced Wing and subsystems, modern turbofan engines, and instrumentation.

- Demonstrator aircraft will be a MD-90 aircraft modified with a truss-braced wing and shortened fuselage.
 - First flight planned for 2028.
- Completing the flight tests in the 2020s to enable the industry to evaluate the utilization of the related technologies for the 2030s market.



NASA-led SFNP Operations Demonstrations





Collaborative Digital Departure Reroute (SFNP-Ops-1, FY22-25) Sustainable Oceanic Airborne Re-Routing (SFNP-Ops-2, FY26) Irregular Ops Recovery/Disruption Management (SFNP-Ops-3, FY27)

4D Trajectory Optimization (SFNP-Ops-4, FY28)

SFNP-Ops = Sustainable Flight National Partnerships - Operations

Sustainability Goals: Deliver reduction in emissions, fuel, and noise of aviation operations through digital services technology

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FY 2022 Realized Benefits





Collaborative Digital Departure Re-Route

Joint partner flight demonstration of re-routing Technology via Trajectory Option Set (TOS) by re-routing flights and departures at Dallas Fort Worth (DFW) and Dallas Love Field (DAL) International Airports with FAA, American Airlines, Southwest Airlines, and Envoy Air.



System-wide aggregated savings (individually re-routed + other flights) at **D10 North Texas Metroplex** (01 Jan 2022 – 16 Sep 2022)

High-Speed Commercial Flight

Sustainable transformation of the speed of air travel



Addressing the unique barriers to sustainable, environmentally responsible high-speed flight

The Quesst Mission generates key data to support development of en route certification standards based on acceptable sound levels

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X-59 Construction and Testing





Complete X-59 Build and Ground Tests in Early 2023 Achieve First Flight in Late 2023

National Campaign 1 (NC-1) Accomplishments



Joby Accomplishments:

- Instrument flight procedure (IFP) simulation build up completed that will serve as a pathfinder for NC-2 activity.
- IFP simulation completed with FAA onsite support September 2022.



Wisk Accomplishments:

- Wisk / NASA /Airspace-Partner planning. Information gathered fed recently published Wisk ConOps.
- Wisk tabletop exercises: 3 completed

Reliable Robotics Accomplishments:

- Flight tests completed in March 2023 to measure the benefits of primary radar to RR's DAA business case
- NASA submitted data request to FAA National Defense Program (NDP) for radar data support. MOA with FAA for the release of Primary Surveillance Radar (PSR) signed,

AURA Accomplishments:

- Wisk tabletops which included vehicle, airspace and infrastructure (AURA) partners. 3 completed
- Planning and coordination to integrate AURA into NTX. Bell descoped AURA from the live flight test due to limited budget
- Initial evaluation of industry communication, navigation and surveillance information (CNSI) as part of an NC-2 "System of Systems" approach

NTX Accomplishments:

- Sprint 1 Weather integration simulation completed
- Sprint 2 Demand/Capacity balancing simulation completed

NASA Advanced Air Mobility (AAM) Noise Research Highlight



Held toolchain workshop for 107 participants, with 69 from non-Govt organizations

Develop and Distribute Noise Prediction Tools

> Included broadband noise and multi-rotor capability in acoustic analysis tools.

Accurately Model and Predict AAM Noise Sources





Best practices for modeling AAM vehicle noise and operations published and conveyed to FAA and Volpe

Methods for Assessing

AAM Acoustic Impact in Operations



First psychoacoustic test conducted for multiple AAM flyover events



Obtain Flight and Wind Tunnel Data to Characterize Noise

Psychoacoustic

Research for Human Response to AAM Noise

Collected flight acoustic data in hover for Moog SureFly

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NASA developed V&V Capabilities Span the Engineering Lifecycle





Benefits from the application of NASA developed V&V Tools





Use Cases Selected by Industry

- VHDL Geofencing Monitors— GE Aviation
- Automated Flight Plan Generation—GE Aviation
- Autothrottle on a regional jet— Collins Aerospace
- Engine Full Authority Digital Electronic Control (FADEC)— Collins Aerospace



Cost Savings

- Person-hour savings on 4 cases spanned 21-60%
- Aggregate time-savings
 of 48%

Quality Improvements Mistakes were caught by formal/ automated analysis that were missed in the traditional analysis

- Vulnerable mode transition paths missed during traditional analysis and caught by automated analysis
- Inconsistent naming conventions applied to the faults (inconsistent naming conventions increases likelihood of an engineering mistake or misunderstanding)
- Captured inconsistent failure scenario



GOAL: Develop, demonstrate, and transition to operations, emerging aviation technologies to identify, monitor, and suppress wildland fires, as a means to enhance safety, improve efficiency, and prevent economic loss.

University Leadership Initiative (ULI) Engaging the University Community



6 rounds of solicitations \$178M of awards

Seeking and awarding proposals addressing all strategic thrusts and special topics

- 23 awards with 80 universities
- 11 HBCUs and 16 other MSIs
- 507 proposals submitted
- 377 different proposing Principal Investigators
- 4023 team members
- 20–50 students per team

ULI round 6 Awardees

- New Mexico State
- Boston University
- Tennessee Tech
- University of Notre Dame

In ULI, the universities take the lead, build their own teams, and set their own research path.





Back Up

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Electrified Powertrain Flight Demonstration

Demonstrate integrated electrified powertrains in flight using industry platforms





Scope

- Demonstrate practical vehicle-level integration of megawatt-class electrified aircraft propulsion systems, leveraging advanced airframe systems to reinvigorate the regional and emerging smaller aircraft markets and strengthen the single aisle aircraft market.
- Assess gaps in regulations/standards to support future Electrified Aircraft Propulsion (EAP) certification requirements.

Benefit

- Accelerate U.S. industry readiness to transition to EAP-based commercial transport aircraft.
- Enable new standards that are needed for EAP-based aircraft certification.

Approach

- Engage with U.S. industry to integrate and demonstrate megawatt-class EAP machines in flight.
- Engage with the FAA, SAE, ASTM, etc. to contribute data that inform EAP standards and regulations.

Flight demonstration contracts awarded in September 2021. Baseline unmodified flight testing began February 2023.

ACERO Use Cases





ACERO will focus on the identification, monitoring, and suppression of wildland fires by developing airspace management and aircraft capabilities for safely integrating remotely and optionally piloted aircraft into the wildland fire operations