



Federal Aviation Administration

Preparing for Advanced Air Mobility through Modeling & Simulation

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Advanced Air Mobility (AAM)













Administration





- First electric vertical takeoff and landing (eVTOL) aircraft expected to be FAA certified in 2025
- Predicted to be a \$115B market by 2035
- New venture capital funded "disruptive" manufacturers backed by traditional operators
- Initial business cases
 - Air taxi (airport to city pair)
 - Cargo (small market to hubs)
 - Medical transport
- Initial operations look like traditional helicopter/GA piloted aircraft, but plan rapid shift to autonomous
- Unique, yet-to-be-built "ecosystem" needs to support vertiports, charging, routes, & automation

Balancing the Pace of Innovation and Safe

Operations Advanced Air MOBILITY

Safety Focused Approach

- Whole of government approach needed to support integration of new class of aircraft, flying in constrained airspace, needing new support infrastructure, and accelerating to autonomous operations environment
- Updating a regulatory framework to address the unique aspects of new hybrid, non-traditional aircraft
- The FAA created a programmatic portfolio approach called Innovate28 that integrates all cross-agency efforts toward user initial entry into service goals
- DOT-led AAM interagency working group developing national strategy for AAM, identifying key national issues for implementation; security, power/energy, infrastructure, community impacts, spectrum, and supply chain





FAA's Role in Advanced Air Mobility

- Ensure this new generation of aircraft maintains the highest level of operational safety that defines commercial aviation today.
 - $_{\circ}~$ Certify AAM aircraft designs and production
 - $_{\odot}~$ Finalize the Operating Framework for pilots and companies
- Integrate these new aircraft into the existing aviation system safely.
- Develop safety standards for AAM infrastructure, i.e. "Vertiports".
- Engage with State, Local, and Tribal governments and communities.
- Environmental Review, depending on the type of project and whether FAA approval is required.
- International harmonization with our partners, to adopt common certification and integration standards.







FAA Integrated Team



Innovate28 Goals for Near-term Operations

- Define and complete agency actions needed to enable AAM operations in locations determined by industry in the near-term leading up to 2028
- Provide an FAA focal point on AAM issues, and provide programmatic support that coordinates efforts across the agency on behalf of specific key projects
- Develop a repeatable process to allow ease of implementation in other locations
- Plan for permanent and scalable processes, procedures, infrastructure, and mechanisms to support continued AAM operations





AAM Workstreams

Cross Cutting Major Risk Areas: Wake Separation, Vertiports, Power, Security, Noise, and Community Impacts

Near-term

- Engage with industry to determine operational needs and desired operations
- Research impacts to Air Traffic Services
- Tailor implementation plan to initial entries into service
- Perform research and engineering activities to support UAM ConOps maturity
- Establish workstreams for mid- and far-term, to include Autonomy
 Working Group



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Mid-term

- Explore operational efficiency through strategic employment of modeling and simulation to effectively manage large-scale operations
- Develop policies and standards based on learned performance
- Establish standards and requirements for enablers such as information exchanges, Communications / Navigation / Surveillance, etc.
- Support industry development of supplemental services

Mature Stage

- Perform research and engineering to validate technological and procedural enhancements to separation management
- Refine policies and standards based on advanced aircraft capabilities
- Derive requirements for infrastructure and automation capabilities
- Refining the mature state of UAM
 ConOps, and incorporate findings
 from Autonomy Working Group to
 integrate autonomous operations



AAM Anticipated Operations and Infrastructure



AAM Airspace Integration Assessments

- The majority of AAM operators are targeting use cases at major airports in complex operating environments
- The FAA is developing strategies to understand aircraft performance and how it will impact existing operations
- Complementary integration efforts support our overall process for getting to 'yes' safely as we develop an AAM ecosystem encompassing infrastructure, airspace considerations, energy management, etc.
 - Work with airport authority, operators, and Air Traffic Controllers to identify beneficial and safe use cases
 - $_{\odot}\,$ Modeling and simulation
 - Operational and flight testing





Modeling and Simulation Activities

- AAM will be introduced in places that already have a constrained environment
- Access must remain equitable and the impact to ongoing operations must be limited
- Perform modeling and simulation of potential takeoff/landing locations to determine impact to existing operations





Modeling and Simulation – Purpose and Process

Purpose: Assess airspace integration relative impacts of identified vertiport locations at (or near) identified major metropolitan airports

1. Initial fast time simulations

- Airspace integration and basic operations
- Airport transfer use cases
- Integrated with existing traffic flows

2. Refined fast time simulations focusing on AAM operations

- Fleet Operations & Vertiports
- eVTOL Flight Characteristics
- 3. Human in the loop (HITL) simulations in high fidelity labs at Technical Center
 - Safety & Operational Performance
 - Nominal / Off Nominal Scenarios

Repeat process as OEM data and other related information becomes available



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NAS-Based Modeling and Simulation Tools

Target Generation Facility (TGF) Fast Time Modeling & Simulation (M&S) Tools

Overview: Used by NextGen's RDT&E Organizations, to evaluate NAS Systems in fast-time and real-time.

- Flight Plan Development Environment: Creates scenarios from recorded NAS EnRoute, Terminal, & Surface data. Route overlays (e.g., UAM Airspace Structures).
- Java Planned View Display: Fast time play back, scenario play overlays.
- Data Reduction and Analysis Tool: Quick view of summary data and statistics.
- Weather: Winds aloft







AAM Modeling and Simulation Tools

Advanced Trajectory Services – Toolkit for Integrated Ground & Air Research (ATS-TIGAR)

Overview: NASA's tool utilized in the Operational Integration Assessment (OIA) for AAM scenario development, mission planning, vertiport management, fleet management, and other scenario parameters.

- **Mission Planning:** Origin, destination, number of passengers, desired trip start time. Supports pre-departure strategic deconfliction.
- Vertiport System: Location(s) and basic configuration(s).
- **Vehicle Fleet:** Type and quantity of each vehicle, performance characteristics, passenger capacity, etc..
- Other Scenario Parameters: 4D Trajectories, Weather/Winds, Charging Time







High Fidelity Human-In-The-Loop Simulations

High Fidelity Integrated AAM Simulation Environment

- Simulated ATC Tower
- Voice Communications
- Real ATC Automation Systems

- Simulated Aircraft Traditional & eVTOL
- Pseudo Pilots
- Cockpit Simulators







Simulated eVTOL (NASA Flyer)





