

A city skyline at dusk, with several skyscrapers illuminated. Overlaid on the scene are several glowing white arcs and dots, resembling a network or flight paths. The sky is a mix of purple and blue.

Roadmap of **Advanced Air Mobility** Operations

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HELICOPTER ASSOCIATION INTERNATIONAL

HAI is the professional trade association for the international helicopter industry and represents more than 1,100 companies and over 16,000 industry professionals in more than 65 countries. Each year, HAI members safely operate more than 3,700 helicopters and remotely piloted aircraft approximately 2.9 million hours. HAI is dedicated to the promotion of vertical aviation as a safe, effective method of commerce and to the advancement of the international vertical aviation community.

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No other organization is better positioned to assist the vertical aviation industry in its efforts to achieve these goals.

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Advanced air mobility (AAM) holds the promise of ushering in a **new era of aviation.**



Introduction

BACKGROUND

Advanced air mobility (AAM) holds the promise of ushering in a new era of aviation.

AAM harnesses and integrates several technological advances including:

- ➔ Distributed electric propulsion, in which several battery-powered rotors or jets are spread throughout the wing and/or airframe
- ➔ Enhanced automation
- ➔ Sensors, including those needed for detect-and-avoid navigation and surveillance
- ➔ Simplified electronic controls
- ➔ Cloud-based data collection, processing, and analysis, including artificial intelligence/machine learning
- ➔ Next-generation composites, structures, and materials

The air vehicles typically associated with AAM include electric vertical takeoff and landing (eVTOL), electric short takeoff and landing (eSTOL), and hybrid-electric aircraft. While the term “AAM” sometimes includes small uncrewed aircraft systems (sUAS, or drones), such aircraft operations are not the focus of this document.

AAM, including its submarkets of urban air mobility (UAM) and regional air mobility (RAM), will safely and efficiently move people and cargo between places currently not served or underserved by aviation and will

complement existing surface-based alternatives. Importantly, these aircraft have the potential to be quiet, safe, more sustainable, and more affordable (as the industry scales), providing societal, environmental, and economic benefits to our communities.

The potential benefits of AAM include:

- ➔ Low operating costs
- ➔ Reduced travel time from one city area to another as compared to surface transportation (e.g., cars or buses)
- ➔ Increased accessibility to and equity of aviation
- ➔ Revitalization of currently underutilized regional/local airports
- ➔ Increased sustainability through low sound profiles and operating emissions
- ➔ Expansion of the aviation industry to new users/operators
- ➔ Improved rural community connectivity
- ➔ Faster time-critical medical transports such as organs for transplant
- ➔ Creation of new jobs and training opportunities that develop a skilled workforce pipeline for the broader aviation industry
- ➔ Creation of new aviation missions across the industry by leveraging the unique characteristics of next-generation aircraft.

While many of these aircraft are indeed new, the rotorcraft and powered lift industry to which they belong has a long and storied legacy. The manufacturers, operators, vendors, suppliers, and enablers of such aircraft

are proudly represented by Helicopter Association International (HAI).

HAI is the leading international vertical aviation association, comprising over 1,100 companies and over 16,000 industry professionals in more than 65 countries. HAI's members operate the full scope of vertical aviation aircraft, both crewed and uncrewed, logging over 3 million flight hours annually.

HAI shares in the widespread excitement regarding the potential of AAM and is committed to helping the vertical aviation industry realize that promise. Given its broad vertical aviation industry member base, its 75 years of industry experience, and its established partnerships with global regulatory agencies and other key industry stakeholders, HAI is ideally positioned to lead and support the vertical aviation community as it embraces the next generation of technology and flight operations.

As reflected in the Acknowledgements section of this report, the leading AAM companies comprise HAI's AAM Industry Advisory Council (AAM-IAC), which was formed to identify issues, develop solutions, and advance initiatives to address industry's most pressing AAM challenges. The HAI AAM-IAC leverages the full scope of knowledge and experience of its membership to inform the way forward for HAI and to strengthen HAI's unique capabilities within the vertical aviation industry. The work of the HAI AAM-IAC fosters a proactive foundation of cooperative communications between all sectors of the vertical aviation industry.

PURPOSE AND INTENDED USE

AAM operations are poised to begin as soon as 2024, with new aircraft achieving certification under conventional pathways, being piloted traditionally, and operating within established air traffic management rules. To advance to a more mature scale, many disparate challenges involving multiple stakeholders must be addressed. Accordingly, we have titled this document a "roadmap" to acknowledge that it will take time for the AAM industry to scale and for operations to become more complex. Although we recognize that this is a journey, we need to start thinking about the future now.

We will refer to three high-level stages:



Near-term – This stage is characterized by the first public and commercial operations constituting an initial operating capability of AAM, in which existing infrastructure (e.g., underutilized general aviation airports and heliports) and air routes under known principles are leveraged (e.g., initially under Visual Flight Rules, or VFR) while new infrastructure is developed.



Mid-term – This stage reflects an overall maturation with more operators, increased operational tempo, initial introduction of degrees of autonomy, and more ambitious use cases, while still using mostly conventional air

traffic control (ATC) including Instrument Flight Rules (IFR) operations, and ramping up the use of new greenfield takeoff/landing sites, termed “vertiports.”



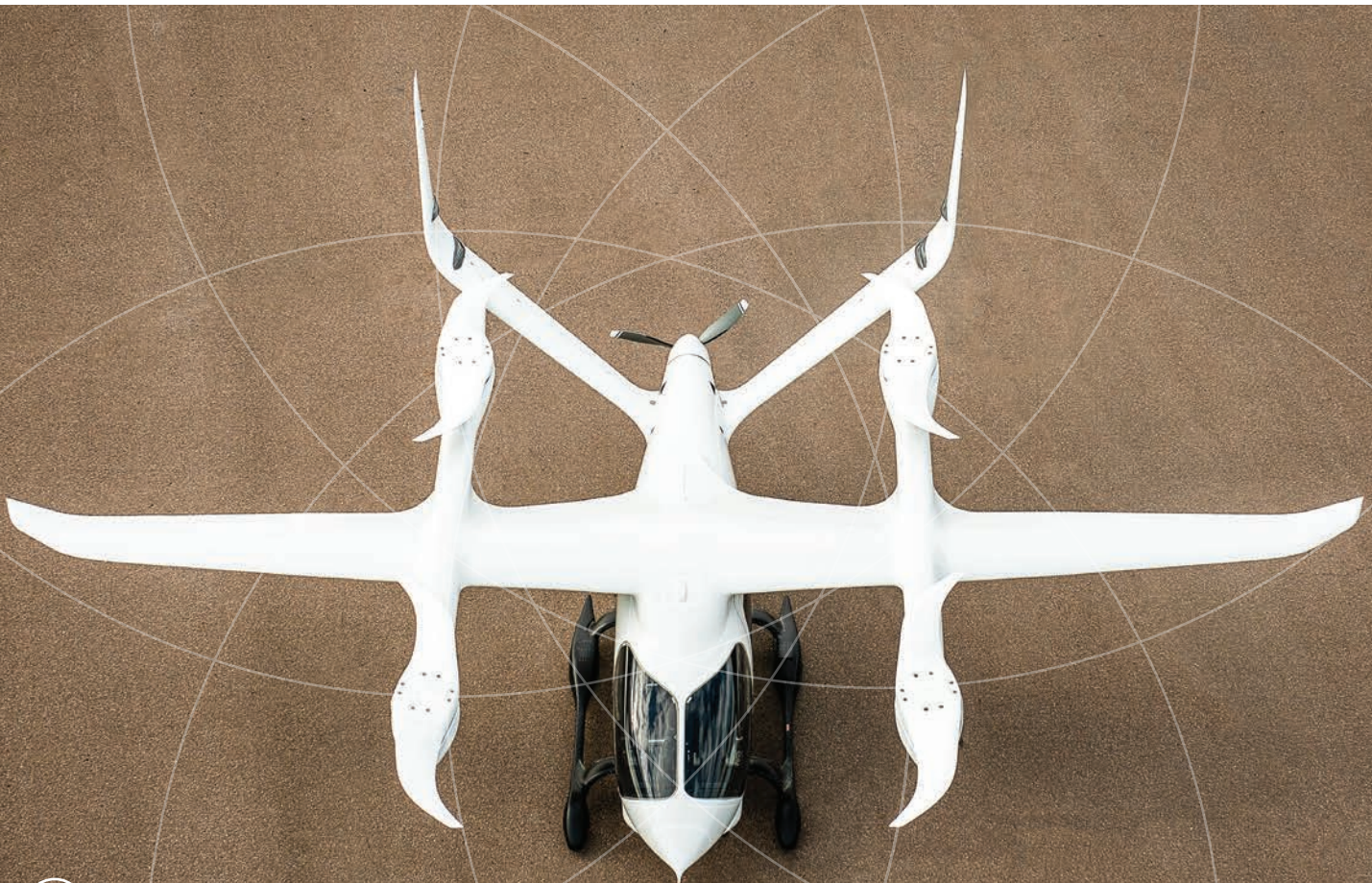
Far-term – This stage embodies a pervasive scale of operations, fully integrated with other transportation modalities and executing complex missions enabled by technological advancement such as increased autonomy and new airspace management concepts.

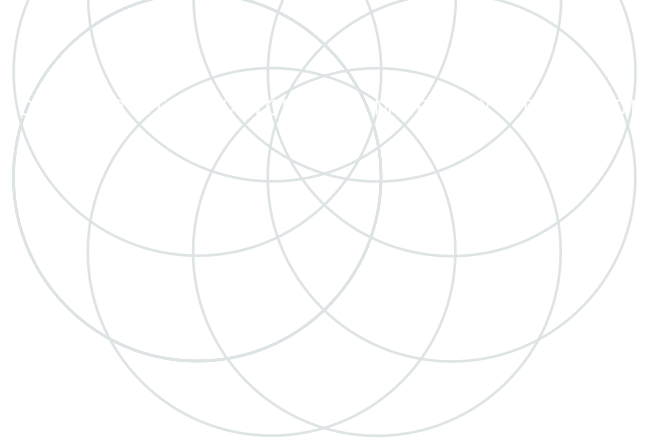
These stages are not firmly defined in terms of calendar time, but we must carefully coordinate

activities to ensure that AAM development is holistic—while the aircraft are being designed and certified, the ground infrastructure needs are being addressed, the airspace management planned, and local communities engaged.

This document is intended to be used by multiple audiences to:

- Coordinate and communicate the priorities of HAI AAM-IAC members.
- Inform regulators of the identified challenges and solutions.
- Aid in the development of harmonious global standards.
- Raise awareness among the general public of the exciting possibilities enabled by AAM.





Infrastructure

While a lot of attention is being paid to new AAM aircraft, there remains the essential question of where these aircraft will take off from and land. To enable the many use cases envisioned, we need to both avail existing infrastructure and develop new infrastructure, ensure that charging capacity is available and facilitated, and thoughtfully plan needed capabilities and partnerships.

USE OF EXISTING AVIATION INFRASTRUCTURE

Airports

AAM is expected to have a strong presence at existing heliports and airports as these facilities provide ideal locations for initial operations. For example, several AAM manufacturers/operators and their airline partners are planning for an airport shuttle use case for efficiently transporting passengers to and from airports where they would connect with the airlines' robust network of flights.

The existing system of airports has the capability to support AAM operations that should be fully leveraged. To do so will require engagement with airport managers, Federal Aviation Administration (FAA) flight standards district offices (FSDOs), FAA regional airports divisions and district offices (ADOs), airport associations, state departments of

transportation (DOTs), ATC, and others to allow for a seamless experience for both operators and passengers.



Heliports

Heliports will provide much needed takeoff and landing facilities while the construction of new infrastructure progresses. An entire system of heliports and helistops exists today that will be leveraged for AAM operations. Existing heliports are often in denser environments compared to airports and therefore are convenient in terms of passenger-carrying operations, albeit proactive efforts will be important to ensure community integration.

New heliports will also be established that accommodate many types of aircraft capable of vertical takeoff and landing. The use of heliports for AAM could entail challenges such as sizing, safeguarding airspace,



AAM is expected to have a strong presence at existing heliports and airports as these facilities provide **ideal locations for initial operations.**

weather, private ownership, and limited or restricted throughput. These challenges should encourage the FAA to move toward performance-based guidance for new AAM infrastructure, as discussed in the next section. Meanwhile, the industry should continue engaging with heliports and service providers to maximize the use of existing infrastructure when and where possible to enable AAM operations such as by adding charging capability. Finally, existing rotorcraft infrastructure should not be eliminated, as the successful introduction of AAM tomorrow requires a healthy rotorcraft industry today.

DEVELOPMENT OF NEW INFRASTRUCTURE: VERTIPOINTS

While the industry will continue to leverage existing airport and heliport facilities, new complementary infrastructure will support increased AAM operations. Further research and data on the viability, safety, and scalability are critical to enable AAM operations to be conducted from new vertiports. These purpose-built facilities are amenable to various locations (urban, suburban, rural, rooftop, and surface-level, etc.) to support AAM operations. Creating such infrastructure will require the combined efforts of industry and regulators to facilitate and enhance the AAM experience.



In many ways, vertiports will be indistinguishable from heliports in terms of physical infrastructure as both are designed to support aircraft that can take off and land vertically. HAI and its members are proponents of integrated vertical aviation infrastructure rather than a segregated model based on aircraft type or propulsion method.



In September 2022 the FAA published Engineering Brief (EB) No. 105, Vertiport Design. This document provides “key information for airport owners, operators and infrastructure developers to begin development of facilities that will support operations of AAM aircraft that are electrically powered and take-off and land vertically.” While HAI is proud to have participated in the FAA’s Industry Day and provided critical input in advance of the publication of this engineering brief, further progress is needed in areas, including the items described below.

INFRASTRUCTURE CONCERNS AND PRIORITIES

There exist both public and private infrastructure, both of which are important elements of an eventual AAM network of oper-

ations. The differences between them are in the definitions found in Code of Federal Regulations (CFR) Title 14 and the United States Code (USC) Title 49:

- **Public-Use Infrastructure:** Assets that are generally financed with public resources and serve all aircraft and operators.
 - FAA has authority to protect public-use airspace
 - Significant federal oversight/state oversight, standardized by FAA
 - Included in the FAA Airport Directory
 - Tall structure and obstruction protection at the state level
 - Must always remain open for operations for everyone
 - Published instrument procedures
 - Qualified to receive federal Airport Improvement Program grant funding

- **Private-Use Infrastructure:** Assets that are privately financed.
 - No federal oversight; 50 different variations of state oversight
 - Not included in the FAA Airport Directory
 - No protections for tall structure and obstruction at the state level (at the federal level, 14 CFR Part 77 is the regulations on obstructions)
 - Can close at any given time and may restrict some operations
 - Special, non-published instrument procedures
 - Not qualified to receive federal Airport Improvement Program grant funding

Many states throughout the United States have also introduced two additional use categories beyond public and private that should be noted and taken into consideration. These are “Personal” or “Restricted” Use and “Commercial Use.” These additional classifications provide for additional flexibility, as well as reduced or increased oversight as appropriate to the type of operation being conducted.

Collaboration with FAA is needed in the development of feasible and reasonable performance-based standards for future vertiports. A mature system will eventually be required by industry to solidify standards and define the rules of public and private-use infrastructure as well as any new categories introduced in the future.

EB 105 sets a foundation for the development of a future Vertiport Advisory Circular. However, an alternative path, one recommended by HAI, would be to expand the scope of the existing heliport design Advisory Circular (AC 150/5390-2) as a way to implement performance-based guidance for both helicopters and eVTOL aircraft alike, rather than establishing two different infrastructure design Advisory Circulars. This would require accounting for the aerodynamic capabilities, as well as deficiencies for each individual aircraft category and type, in developing the design criteria of the supporting infrastructure. For example, further analysis is needed to establish the impact of the downwash and outwash created by these new aircraft. Notably, EB 105 does not address/support IFR and will need to be amended in order to enable such operations. HAI understands and supports the

fact that our industry has the responsibility to share data to help the FAA promulgate the desired performance-based guidance.

There have been discussions of possibly requiring that all AAM vertiports be built to “Transport Heliport” standards as listed in FAA AC 150/5390-2 chapter 3 (or some similar requirement). However, this may be excessive and could hinder the growth of the industry. A formal risk analysis in conjunction with a cost-benefit analysis should be conducted prior to committing to these more burdensome standard criteria.

When achievable, developing multifunctional infrastructure that can accommodate both traditional rotorcraft and next-generation aircraft is a primary goal for HAI AAM-IAC members. This maximization of infrastructure where airports, heliports, vertiports, and droneports can be developed into a single footprint has the potential of saving hundreds of millions of dollars while reducing the overall aviation footprint in communities.

Regardless of whether AAM infrastructure is located at an airport, heliport, or vertiport, there are three primary physical components that are required at these sites to effectively support AAM operations and expected to require significant throughput and charging capabilities:

1. Clear unobstructed airspace to support safe approach/departure paths in varying environmental conditions that can be protected from future obstruction encroachment and will not have a negative impact on the surrounding community.

2. Adequate ground space capable of allowing the throughput necessary to support a profitable business model and that also provides ample room for safe aircraft movement, passenger movement, cargo movement, supporting equipment, and room for future expansion.
3. Access to adequate and dependable electrical grid connectivity and capacity capable of supporting the charging demands of AAM vehicles without negatively impacting the surrounding community.

While much of the existing U.S. infrastructure may meet one or two of the above criteria, few facilities currently meet all three and many never will. Thus, we recommend a plan of action that, when possible, provides a realistic approach toward retrofitting current infrastructure capable of supporting legacy and AAM flight operations in tandem with the development of new greenfield infrastructure when and where needed.

An area of concern in moving AAM forward is how best to coordinate future infrastructure needs and requirements within our health-care community. Currently there are over 7,000 hospitals listed in the United States, the majority of which have a heliport associated with them that is dedicated to the transport of critically ill and injured patients. Many health-care institutions have struggled over the years to allocate the necessary physical space and funding to support this critical type of infrastructure. Requiring the duplication of this type of infrastructure to accommodate a second category of aircraft would have a significant and negative impact on our health-care

industry as a whole. For this reason, HAI recommends that the FAA, in collaboration with industry, develop a strategy that provides a clear path forward for the adoption of AAM in health care that can account for both traditional aircraft and new entrants.

HAI's overarching vision is for the development of infrastructure capable of accommodating both traditional aircraft as well as future vertical aviation aircraft whenever possible.

INFRASTRUCTURE OVERSIGHT

Given that the FAA has no current federal regulatory oversight authority over private-use infrastructure, some form of oversight will be necessary to ensure that vertical flight infrastructure used for the purposes of providing public transportation meets and maintains compliance with certain safety critical elements and standards. This may be in the form of an accepted accreditation program similar to the International Standard for Business Aircraft Operations (IS-BAO) implemented by the International



HAI's overarching **vision** is for the development of infrastructure capable of accommodating both traditional aircraft as well as future vertical aviation aircraft whenever possible.

Business Aviation Council (IBAC). Achieving accreditation under an accepted standard may then be used to provide safety assurances to the general public as well as insurance underwriters.

CHARGING INFRASTRUCTURE

Among the worthwhile benefits of AAM is the potential to use energy originating from sustainable sources. To make this a practical reality, the industry must start developing, in concert with the power industry, the necessary grid structures to support scaled AAM operations so that the industry has adequate power without negatively impacting cities' electricity supplies.

All stakeholders would benefit from a better understanding of the charging requirements, supporting electrical infrastructure, and any potential limitations in supporting initial operations. As operations scale, charging stations should be expected to deliver multiple and consecutive charges with high-power fast charging. The goal is to enable all types of AAM vehicles to use the charging station, whether through a universal charging port, adapters, or other methods.

Equipment will be needed to construct and support charging stations such as transformers, switch gear, and even power substations. Supply chain inadequacies in conjunction with component availability will be a concern when planning for mass construction of multiple charging stations throughout multiple regions. Fortunately, despite early electric aircraft having a variety of charging systems, the “make-ready” con-

nections from the grid to service areas will aid interoperability as the same transformers, distribution conduit, and switchgear can serve a variety of aircraft-specific charging equipment.

..... Safety risks and mitigations will be critical considerations for AAM charging infrastructure.

Charging stations will require high-powered electrical systems, introducing risks at supporting infrastructure such as electrical shock hazards, electromagnetic fields and interference, and fire hazards. Appropriate safety measures will need to be put in place for charging stations that account for both normal and emergency operations. Due to the high power of the fast-charging stations (estimated in megawatts), the power cables of these stations will be highly heated, which implies the need for cooling; a detailed study of the solutions is suggested. The aircraft rescue and fire-fighting (ARFF) units at airports and local fire departments at vertiports will also need to be trained and



equipped in electrical fire-fighting requirements.

Standards for installing, operating, and maintaining charging infrastructure to support AAM must be recognized and planned for accordingly. This effort is expected to be primarily achieved through the development and implementation of building and fire code standards through such organizations as ASTM International, SAE, International Code Council and the National Fire Protection Association.

REQUIRED CAPABILITIES AND PARTNERSHIPS

To ensure that proper infrastructure is in place, all AAM partners—from governments to operators to industry—will need to be flexible and work together to ensure infrastructure planning is done effectively and meets both the near- and long-term needs of AAM. Efforts should prioritize achieving interoperability within the infrastructure system for most instances to increase resource efficiency for initial operations.

The ground infrastructure must reflect the capabilities and requirements of other aspects of the AAM ecosystem, including communications, security, and utility services. Communication capabilities such as vehicle-to-vehicle (V2V) and vehicle-to-ground (V2G) are additional far-term elements of AAM operations and will need substantial support and facilitation to scale for an eventual high-density AAM ecosystem. Utility and service reliability at vertiports and heliports will vary depending on the vehicle type or type of operation being conducted.

Although not crucial for initial operations, modifications to existing services should be expected.

Taking a global view, we recognize that the United States is not the only nation seeking to develop a robust AAM ecosystem. Accordingly, industry should communicate and engage with international manufacturers, regulators, and operators to prioritize harmonization, where appropriate, across the globe.

SUMMARY OF INFRASTRUCTURE PRIORITIES

Near-Term

- ➔ The existing system of airports and heliports should be leveraged to support initial operations when and where possible, while planning for and beginning to deploy new infrastructure. The industry should continue engaging with airport/heliport managers, FSDOs, ADOs, state DOTs, airport associations, ATC, local governments, metropolitan planning organizations, and others.
- ➔ Both public and private infrastructure should comprise the AAM network to enable the industry to begin initial operations quickly and to scale effectively.
- ➔ Charging stations will be required to support early operations. The industry would benefit from a better understanding of charging requirements, supporting electrical infrastructure, and any potential limitations that would affect initial AAM operations. Standards, guidance, and

policies for installing AAM charging infrastructure need to be developed.

Mid-Term

- ➔ The industry will need to start developing and understanding, in concert with the power industry, the necessary grid structures to support AAM. Standards, guidance, and policies for installing AAM charging infrastructure need to be developed and planned accordingly. We recommend an in-depth, joint (including aircraft manufacturers, operators, infrastructure companies, electric utility companies, electricity regulatory bodies, and localities) study on the electricity demand for each type of vertiport, including the number of stands and electric charging stations. Additionally, methods to ensure that all types of AAM vehicles will be able to utilize any charging station, such as universal charging ports, should continue to be developed.
- ➔ The industry should communicate and engage with international manufacturers, regulators, authorities, and operators to prioritize global

harmonization, where appropriate. While the United States is gearing toward AAM support and activities, other nations are equally seeking to materialize a robust AAM ecosystem.

- ➔ The industry can use digital twins of cities to support data-driven decision making related to infrastructure planning, zoning, route optimization, and asset management. These tools will be critical for cost avoidance, identification of second-order impacts, and enhanced productivity. Further, digital twins can help policymakers and the public visualize the impact of AAM on their communities.

Far-Term

- ➔ Communication capabilities such as vehicle-to-vehicle (V2V) and vehicle-to-ground (V2G) are vital elements of AAM operations and will need substantial support and facilitation to scale for a dense AAM ecosystem.
- ➔ New infrastructure such as vertiports will require the combined efforts of industry and regulators to facilitate the entry of new markets and operations (both VFR and IFR) into the AAM ecosystem.





Regulations and Airspace Use

REGULATORY SUPPORT FOR EXISTING INFRASTRUCTURE

Access to existing infrastructure such as heliports will be required for early AAM operations, and the regulatory environment should evolve from existing rules, with managed deviations from the existing frameworks, to allow AAM to blossom.

Therefore, engagement with regulatory bodies such as the FAA and the European Union Aviation Safety Agency (EASA) are of critical importance to enable initial AAM operations.

The industry should promote efforts to enable use of existing infrastructure and airspace to accelerate the path to initial AAM operations, while also pursuing new infrastructure. In turn, this means that the legacy infrastructure, to include the processes, forms, and databases that govern it, will need to be updated, improved, and streamlined. Hence, the industry will benefit from a path that requires minimum changes to regulatory processes and structures for early AAM operations.

As existing and new infrastructure are not mutually exclusive, regulations will need to support a smooth transition from existing infrastructure to new infrastructure or a combination of both. The focus should be on keeping and/or creating infrastructure

that meets the needs of wide variety of use cases, as one solution may not fit the needs of all.

ENERGY RESERVE REQUIREMENTS

The evolution of energy reserve requirements is a priority to support the AAM ecosystem of the future. HAI members and stakeholders can assist in the modification of energy regulations across the AAM landscape. There is a need for clear definitions related to electric power reserves of AAM aircraft. The energy reserve requirements should be performance based and as such, must capture the full scope of various concepts of operations (ConOps) across the various manufacturers.

These requirements should not focus solely on rotary-wing reserves, as some aircraft will operate as STOL, while others will have capabilities that reflect a hybrid of rotary wing and fixed-wing aircraft. The performance of some AAM aircraft may closely resemble characteristics of conventional takeoff and landing aircraft and current fuel reserve requirements may be appropriate. Destination intentions such as landing as a fixed-wing aircraft at an airport or as a rotary wing at a touchdown liftoff (TLOF) area may also play a role in determining specific energy requirements. The “state of function” of the battery will be key to determining battery parameters (temperature, usage, etc.) for preflight planning and in-flight determi-



The development of **flexible and performance-based rules** for airspace regulation is an integral part of AAM operations.

nations. The electrical storage system cannot be used to determine “fuel reserves” as in traditional aircraft; therefore, its state of function must be determined prior to any flight operation.

One potential avenue for consideration is in how the International Civil Aviation Organization (ICAO) defines “Operational Performance” through category and class as outlined in Annex 14 and Annex 6. Additionally, ICAO considers the physical geography over which an aircraft is being flown by defining it as “hostile” or “non-hostile, as well as “congested” or “non-congested.” Taking these criteria into account may provide a better barometer for establishing realistic energy reserve requirements. Further consideration of determining exact amounts of energy and planned use throughout phases of flight can provide information on specific energy requirements.

ROUTE DEVELOPMENT

Although not a primary concern for early operations, route development for AAM operations must be addressed for the mid- and far-term scenarios. Piloted AAM operations could exist today with conventional ATC interaction; however, the concern of scalability is still in question. Supportive AAM procedures should focus on enabling direct routing and the ability to use existing helicopter low-altitude routing where appropriate and to the extent it does not disrupt helicopter traffic.

By leveraging current helicopter operations, a proof-of-concept opportunity can be developed to support future AAM routing

procedures. Route development efforts should initially leverage existing routing structures where applicable, but these may not be adequate for long-term operations. Currently, helicopter routing charts are relatively limited and utilized in only a dozen U.S. cities and, in most cases, are designed to shepherd rotorcraft traffic around higher traffic areas. An expanded solution beyond helicopter routes will be needed to facilitate AAM across a wider area. Because existing routes are sometimes indirect and meandering, AAM operations will benefit from more direct routing, given the power limitations of some of these aircraft.

The creation of far-term routing solutions harmonized with various AAM capabilities is critical to achieving a mature-state AAM ecosystem. HAI will continue to advocate for regulations that are not unduly prohibitive and can assist in the elimination or modification of rules that are overly confusing or not suitable for AAM.

Routing procedures for all operational areas such as urban, rural, or a combination of both, must be addressed in the mid and far term. Instrument helicopter routes can be developed to enable an IFR route network for UAM, and this routing must account for future on/off ramps within low-altitude structures. Other restrictions to be considered include those related to aircraft sound, the environment, local zoning, and the FAA.

Route development should also consider procedures within high-density areas as compared to less-dense flight areas. Aircraft-generated sound considerations should also be accounted for during route

development, especially in populated areas such as an urban setting. Routing within close proximity to populated areas, such as operations within cities, should be a major concern for flight operators and regulators as it affects the impact on communities. Lower aircraft sound levels for AAM operations should foster greater public acceptance and enable more direct routing.

AIRSPACE DEVELOPMENT

The development of flexible and performance-based rules for airspace regulation is an integral part of AAM operations. An AAM aircraft should be equipped appropriately for the approved ConOps and the airspace in which it operates. The full scope of operations should be monitored, including low-altitude routing, enroute procedures, departures and arrivals, and various controlling agencies and methods to support AAM. This holds true for both nominal and off-nominal operations. The NASA Aeronautics Research Institute (NARI) has helpfully created a community integration working group that has undertaken an effort to help develop and integrate a functional ATC routing and communication system.

HAI's leadership experience in the industry positions the association to closely interact with civil aviation authorities and standards agencies to facilitate partnerships and collaborations beneficial for developing policies and rules regarding AAM and AAM players. Multiple aircraft type certification sources may be utilized to support AAM. For example, in the United States, the FAA's efforts include Part 23, Part 27, and Part 29. As such, the FAA has provided the clarity

industry needed for certification of aircraft through the powered-lift special class. Similar clarity is needed for the use of eVTOL in Part 135 operations.

Airspace regulations should also reflect all operational types, including VFR and IFR. A variety of rules may apply depending on the type of operation (e.g., those included in 14 CFR Chapter I, Subchapter E, Airspace, and Subchapter F, Air Traffic and General Operating Rules; separation standards; wake vortex separation; etc.) and should be supported. Current IFR operations may not fully meet the needs of AAM and should be further studied. A hybrid set of flight rules to accompany VFR and IFR operations, such as Digital Flight Rules (DFR), as proposed by NASA, may be more beneficial to the AAM environment.

Ground control stations or air traffic controllers will be leveraged to support early operations. However, with an increase in operational volumes, AAM will need more advanced air traffic management, perhaps by providers of services for UAM (PSUs). These services will be inspired by UAS traffic management but enable the fair and equitable access of all airspace users, not just drones, including traditional aircraft, piloted eVTOLs, autonomous eVTOLs, and drones.

⋮ The goal should be for airspace to be fully integrated rather than be segregated.

Segregation is inefficient use of airspace that blocks out some users and distorts traffic patterns. As we move to performance-based standards, segregation will prove to be

unnecessary. An eVTOL aircraft should not be treated differently than other aircraft so long as it can comply with the rules of the air and requirements of access to a volume of airspace.

Digital infrastructure and information exchange will be necessary to support safe and efficient traffic management and airspace integration for AAM. This is especially important for those operations in and near airports. Shared information about AAM flight plans and status, vertiport status, airspace status, and UAM airspace conditions will be critical to enabling safe airspace integration as well as intermodal passenger journeys.

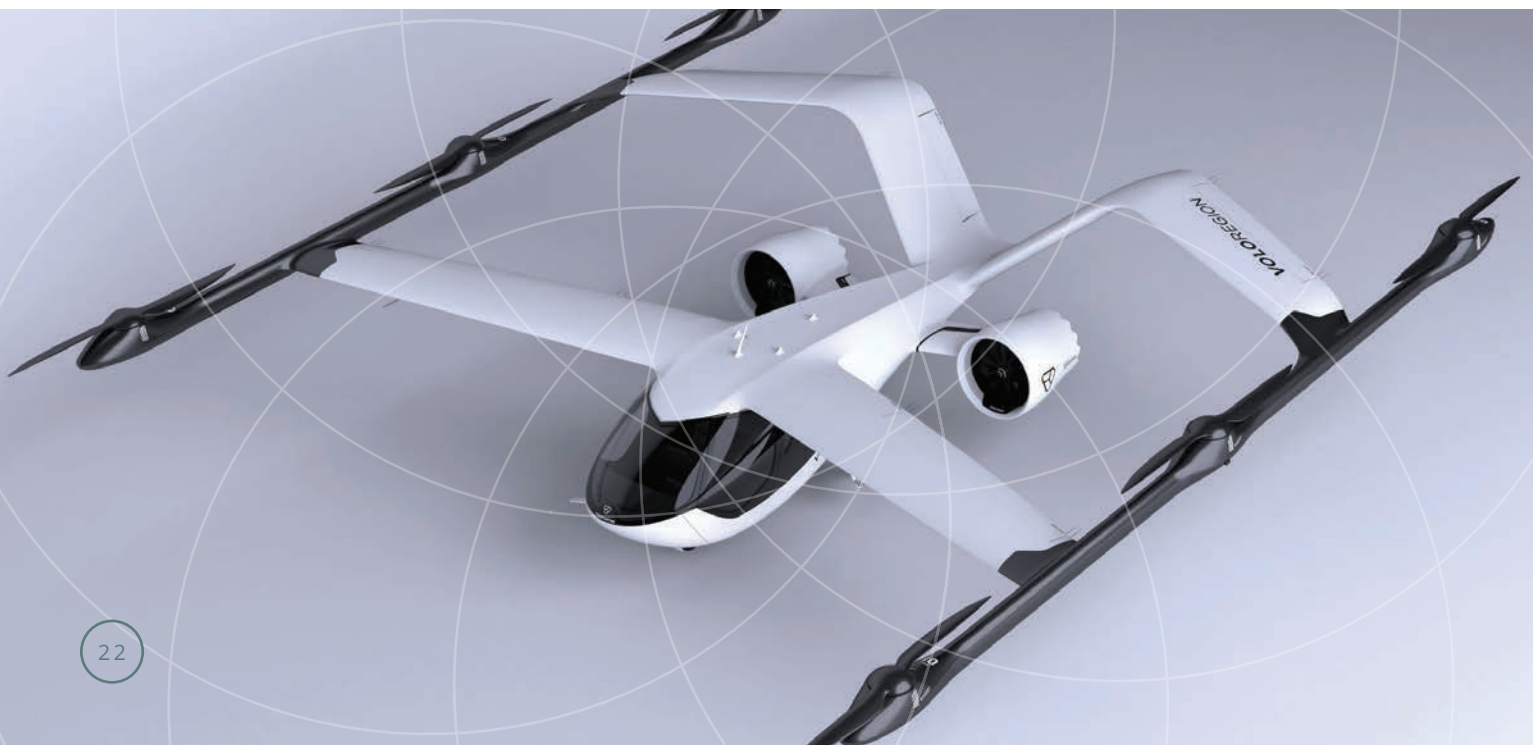
SUMMARY OF REGULATIONS AND AIRSPACE USE PRIORITIES

Near-Term

- ➔ The industry should continue to build partnerships with stakeholder authorities (e.g., EASA, ICAO, FAA, NASA)

and other interested parties for airspace development for AAM operations. The FAA airworthiness regulations 14 CFR Part 23, 27, and 29 can be utilized to support AAM aircraft certification activities. However, the use of eVTOL in Part 135 commercial operations requires additional clarity and adaptation due to the unique operational characteristics. The FAA's recent notice of proposed rule-making (NPRM) to incorporate powered-lift (eVTOL) aircraft into its regulatory definitions covering air carriers (Docket No. FAA-2022-1563; Notice No. 23-03) is a necessary first step, but the FAA must also define the aircrew and operating rules.

- ➔ Current regulations restrict existing infrastructure such as heliports due to the rigidity of the language. There is a considerable portion of existing infrastructure that is not covered by current regulations that could be leveraged for initial AAM operations.
- ➔ Regulations must facilitate a smooth transition from existing ground



infrastructure to new infrastructure or a combination of both.

- ➔ AAM operations will benefit greatly from direct routing due to power limitations. In a dense AAM ecosystem with numerous operations requiring specific routes, the industry will need to create far-term routing solutions harmonized with all AAM capabilities. Routing procedures should consider all operational areas (urban, rural, mixed) and differentiate between high-density and low-density flight areas. Integration of the airspace, rather than segregation of operations, should be the goal.

Mid-Term

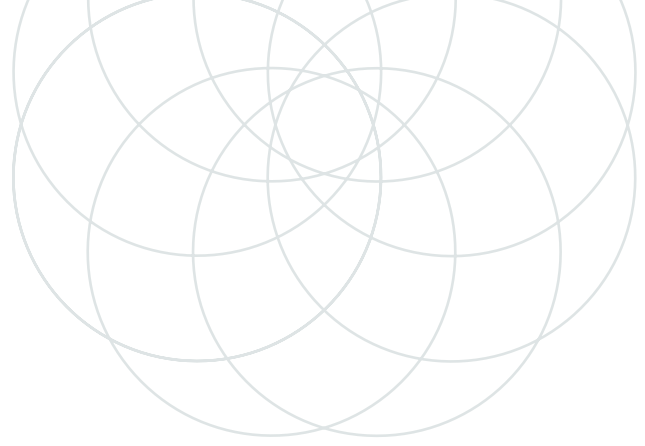
- ➔ Airspace regulations for AAM operations must be flexible and performance based. As current IFR rules may not be sufficient, a hybrid set of flight rules, i.e., Digital Flight Rules (DFR), to accompany VFR and IFR operations may be more beneficial to AAM.
- ➔ AAM could initially leverage existing routing procedures, such as low-altitude helicopter routing, but this may not be

adequate as operations scale. Aircraft-generated sound should be considered when developing routing, especially within populated areas such as cities, and attention will need to be placed on community equity.

Far-Term

- ➔ While legacy regulations related to reserve requirements may be adequate for some operators, energy reserve requirements must capture the scope of all operators and types of operations, whether fixed-wing, rotary-wing, or a hybrid of both. Destination intentions, weather considerations, unique airport operations, local geography, and population density will all play a role in determining energy reserve requirements (e.g., landing as a fixed wing at an airport, or as a rotary wing at a pad).
- ➔ PSUs could increasingly become a vital part of traffic management in AAM and may be the primary driver of avoiding conflict with other flight operators in the same airspace.





Training, Vehicle Development, and Insurance

TRAINING CONSIDERATIONS

As with other types of aviation, training will be a critical component of AAM, especially for initial operations.

Workforce training will need to support various components of the entire AAM ecosystem, including pilots, mechanics, engineers, traffic managers, designers, and flight and ground instructors.

Pilot Training

Pilots will be an integral component of this industry from its inception, whether on board or off board (remotely operated aircraft). They will safely navigate AAM aircraft through the National Airspace System in the same manner as traditional aviation operations. Access to a qualified, professionally trained pilot workforce will strengthen public acceptance and earliest entry into commercialized service of this new transportation modality.

Regulators are still in the early stages of defining the requirements for AAM pilot training and aircrew qualifications, ratings, and certifications. Initial AAM operations will likely mirror current commercial operations. However, several aspects will differ as AAM ramps up, requiring the need for agile flight

departments that can adapt and scale training requirements as needed.

Initially, pilots of AAM aircraft will be required to hold either a commercial pilot license (or certificate, in the United States) for airplane with a single or multiengine class (CPL-A), or for rotorcraft with a helicopter class (CPL-H), or for powered lift (CPL-PL) and will undergo transition training. The development of a transition training course will depend upon the anticipated type certification of the AAM aircraft and the pilot may also be required to hold a make-and-model-specific type rating. The need for ab initio pilots with specific training requirements to meet the capabilities of AAM aircraft will need to be determined, with rule-making efforts established and requirements defined before ab initio pilots will be able to operate these aircraft. To be aligned with the targeted first commercial operation date, the development of specific training syllabi, courseware, and simulators must commence well in advance of aircraft certification.

The Special Federal Aviation Regulation (SFAR) currently being drafted by the FAA to clarify powered-lift pilot and operation certification is a welcome and necessary development to allow the entry into service of eVTOL. We encourage the FAA to self-impose a deadline to have the SFAR in place



Most new AAM aircraft will be initially operated by a single pilot with a single set of flight controls, **leveraging the principle of simplified vehicle operations (SVO).**

by the end of 2024 to ensure AAM entry into service is not delayed. Furthermore, because the SFAR is for initial operations (piloted, VFR, etc.), we recommend that the FAA prioritize an additional, parallel rulemaking effort to enable the far-term success of AAM (safe scalability, more complex operations, degrees of autonomy, etc.).

Standards organizations like SAE International and its Committee G-35, Modeling, Simulation, and Training for Emerging Aviation Technologies, will publish aerospace standards to support the certification of aircraft using modeling and simulation, the qualification of training devices that use mixed reality (MR)/virtual reality (VR)/augmented reality (AR) technology, and the certification and training of pilots. The pilot training and certification standard will rely on competency-based training and assessment (CBTA) and performance-based training and certification. These standards may be adopted by global regulatory bodies as a means of compliance leading to codification.

Most new AAM aircraft will be initially operated by a single pilot with a single set of flight controls, leveraging the principle of simplified vehicle operations (SVO). SVO will require new techniques for the training of the on-board pilot. Currently, regulations require in-aircraft training utilizing fully functioning dual controls. Adoption of novel AAM aircraft may instead depend on simulator/simulation-based training and certification that use advanced technologies to enhance the learning experience and shift the training paradigm toward cost-effective scalability that ensures the highest level of safety.



Maintenance Technician Training

An important element of safety considerations for AAM is maintenance requirements. Within the anticipated high-density AAM ecosystem, there will be a significant number of daily flights, warranting maintenance to maintain the integrity of the entire AAM industry. For AAM, the maintenance requirements include vehicle inspections and procedures whether on-site at AAM ground infrastructure (i.e., vertiports) or off-site. There will be a demand for maintenance services at each AAM ground infrastructure facility to cover scheduled and unscheduled (nonroutine items and aircraft on ground, or AOG, events) services. Off-site maintenance services will also be required for line maintenance, full vehicle repairs, component replacement, component overhauls, and typical maintenance inspections. Like training requirements, maintenance standards will need to accommodate various types of AAM aircraft.

Maintenance technicians and engineers must be prepared to support the diverse field of new AAM aircraft. New or revamped maintenance processes and procedures may be necessary as these AAM aircraft may have different designs and components as compared to traditional aircraft. Aviation maintenance technician training that meets current regulatory requirements could include new concepts and more specialized training such as using MR/VR/AR technologies to effectively address these new systems and operational requirements.

Current aviation maintenance training standards cover a large variety of aviation segments that may not fully prepare technicians to meet the specific needs of AAM. Training standards must be updated to emphasize new technologies in AAM, while older technologies that are out of scope should be deprioritized. This may create an opportunity for the FAA to mandate that technicians receive AAM type-specific training to create a robust and safe maintenance ecosystem for near-term operations, similar to the requirements that EASA imposes for type-specific aircraft maintenance providers. Strategies like these will be essential to the timely creation of a skilled AAM maintenance workforce.

VEHICLE DEVELOPMENT

..... Aircraft manufacturers and regulators must develop vehicle airworthiness criteria, standards, and acceptable means of compliance for AAM vehicle development.
.....

Issuance of a type certificate should be considered only when the developer meets the airworthiness requirements and the adequate safety level for operation in the airspace. When appropriate and possible, vehicle developers should align their efforts to fit into existing structures, for example, leveraging powered-lift category certification when appropriate. Other novel performance requirements for AAM aircraft must be developed for future certification standards.

An aircraft's performance capabilities are the driving factor for certification and should be the determining factor as to whether a specific aircraft can safely operate at a specific type of infrastructure. Key aircraft performance requirements include aircraft controllability, aircraft maneuverability, in-ground effect performance, out-of-ground effect performance, available power limitations, reliance on electrical infrastructure, and link to flightpath routing. For some characteristics, tradeoff studies can be applicable for AAM vehicles. Current aircraft, for example, can trade off payload for performance to achieve regulatory compliance.

Regulators develop standards for aircraft type certification that ensure the safety of the aircraft in the national airspace. In the United States, this is done through an FAA Flight Standardization Board (FSB) or, for EASA, through Operational Suitability Data (OSD). In each case, the regulator works in concert with original equipment manufacturers (OEMs) to ensure the design meets the safety standards. The new AAM designs may rely more on modeling and simulation or a digital twin to support certification and supplement flight-testing requirements for

type certification as new designs may not allow for the traditional means of in-aircraft flight testing. Battery sustainability and other factors may demonstrate the need for more simulator/simulation testing for aircraft certification.

The use of engineering simulation to find and fix integration issues and to demonstrate failure modes provides value in the certification process. Engineering simulations allow for human factors assessment and acceleration of the cockpit design. Integrated system test and certification rigs reduce flight time and systems testing, with the added value that edge-of-envelope tests can be performed with sufficient repeatability and without putting the safety of test pilots at risk. High-fidelity simulation has a proven and successful track record in helicopters, business aviation, and the commercial aircraft industry. OEMs pursuing high-fidelity simulation and concurrent simulator development early in their certification efforts may enjoy significant overall cost savings, as well as significantly accelerating the timeline for the certification of training simulators.

Industry must collaborate to develop a broader scope of items that can be considered challenges to AAM aircraft certification, including operations, training, maintenance, insurance, and others. It is critical to develop harmonized certification, standards, and guidance for AAM among the international aviation authorities. There is also an industry need for the FAA to clarify the pathway for powered-lift operation, given that some operators have targeted flight operations starting in 2024.

INSURANCE CONSIDERATIONS

A high-density AAM ecosystem will present the potential for damage and injury, likely resulting in strict insurance requirements to meet risk and liability. HAI is positioned to leverage its network to start early conversations with the insurance industry for AAM considerations. The industry will need to develop initial standards to help inform insurance underwriters about the risk exposure for early AAM operations. Other considerations, such as the size of the aircraft and type of operation, will play into insurance requirements, and such, the industry must be prepared to address those issues and provide meaningful justifications for risk assessment and management.

The adoption of a safety management systems (SMSs) for both aircraft operations as well as infrastructure is one mitigation strategy open to industry that will pave the way forward for affordable insurance premiums.

SUMMARY OF DESIGN AND CERTIFICATION PRIORITIES

Near-Term

- ➔ The AAM community may utilize existing maintenance training standards for initial operations until exemptions or alternate means of compliance are in place. Operators will pull from the existing CPL(A), CPL(H), or CPL(PL) communities with pilots undergoing transition training.
- ➔ Aircraft OEMs and regulators should align efforts to address the unique certification requirements of AAM

aircraft designs. It would be a mistake to try to fit these aircraft into helicopter or airplane type certification standards. Aircraft performance capabilities are among the driving factors in aircraft type certification.

- ➔ Insurance coverage will be required for addressing AAM's unique risk exposures. Industry and partners should begin discussions with the insurance industry to identify risk assessment and mitigation for AAM operations.
- ➔ Maintenance requirements must be addressed to enable early entry into commercial operations. Industry OEMs should determine the required maintenance for these unique aircraft and work with regulators to develop policy for maintenance providers.

Mid-Term

- ➔ As operations scale, maintenance requirements and standards may need revamping to accommodate the AAM systems and technologies.
- ➔ As various models of AAM aircraft are introduced, considerations such as size of aircraft, type of operations, pilot training, qualifications, and certifications will influence specific insurance requirements.
- ➔ Workforce training will need to support various components of the entire AAM ecosystem, including pilots, mechanics, traffic management, and engineers. Complexities of the varied types of AAM aircraft may lead to the need for a pilot type rating for each unique aircraft design.

- ➔ Autonomy certification processes, standards, and incorporation for scaling and safety need to be developed. The pilot qualifications for remotely operated or autonomous aircraft should be reviewed; the current commercial pilot shortage will be exacerbated if we do not take the opportunity to review the appropriate skills needed for operations that will not include a pilot on board.

Far-Term

- ➔ Pilot and technician ab initio pathways need to be created to address the looming workforce shortage.
- ➔ Within a high-density AAM ecosystem, there will be a significant number of flights per day, requiring different and unique or new types of maintenance. There may be the need for on-site and off-site maintenance teams at vertiports for emergency repairs and/or extensive vehicle repairs, respectively.
- ➔ There is a need to create a new workforce pipeline for pilots, remote pilots, supervisors, mechanics, and additional ground or aircrew personnel. This pipeline should be tailored to this new technology rather than forcing workers into the existing pipelines for pilots and mechanics, where a majority of what they learn and get trained to do will not be applicable to eVTOL. Tailoring the development of the AAM workforce to AAM requirements could create a more efficient workforce pipeline.



AAM Enterprise

MEMBER ENGAGEMENT

HAI members and stakeholders can benefit from outreach programs to enhance industry understanding and appreciation of AAM aircraft and operations.

HAI's goal is to highlight opportunities, especially for current and new operators, and to build paths for the industry to succeed. For the rotorcraft industry, eVTOL aircraft will simply represent the addition of a new aircraft to their fleets. The experience that current operators have in the full scope of vertical lift missions, including safety and regulatory requirements, will be of critical value to advancing AAM eVTOL operations.

COMMUNITY VALUE, SOCIETAL ACCEPTANCE, AND PUBLIC ENGAGEMENT

Community outreach and societal acceptance is a vital element of enhancing and scaling the AAM ecosystem. Industry must work with local government, businesses, and community organizations to safely integrate AAM operations. There is value in programs and efforts that will educate and influence society, as well as in efforts to align and harmonize various federal, state, and local government agencies. Changes in state and municipal codes for AAM could be expected to take five years or more and will largely depend on community acceptance and support. There also may be opportunities to work with rotorcraft/drone pilots and

operators to collaborate on AAM operations in the community.

The industry should focus on developing programs and initiatives to educate the general public, build support for AAM, build the AAM environment, and expand the reach and impact of aviation in general. There is a need to establish community talking points focused on the importance of AAM to the aviation industry and communities. It is vital to assess community reaction on the effects of aircraft-generated sound from AAM operations and to continue to build momentum for community acceptance. In particular, industry should communicate the much lower sound levels associated with eVTOLs (as compared to traditional helicopters), particularly in the cruise phase of operations.

Finally, local authorities have a role to play in helping to make the case to their constituent populations. If jurisdictions desire AAM to come to their localities and provide benefit to their population, we encourage them to use their influence to complement industry efforts. A bidirectional partnership between localities and industry will be beneficial to both.

SUPPORT PROGRAMS

Support programs must be developed by the industry, including by HAI, to address member and public engagement for AAM operations. These support programs should address the full scope of support and service-related issues such as insurance pro-

grams, harmonization across nation states, safety programs (for example, SMS, maintenance resource management, flight-data monitoring and the FAA's Aviation Safety Information Analysis and Sharing system, and simulation), and cross-association programs with holistic industry objectives. Finally, the practice of demonstrations will be a crucial stepping stone into early operations for AAM. There is value in supporting programs that could demonstrate the effectiveness of AAM, including demonstration operations and ConOps testing.

SUMMARY OF AAM ENTERPRISE PRIORITIES

Near-Term

- ➔ Community outreach campaigns will be critical to the success of AAM. The industry must educate and influence the public, policymakers, and non-AAM industry stakeholders, as well as pursue efforts to align the various government agencies.
- ➔ For the rotorcraft industry, eVTOL aircraft will simply represent the addition of a new aircraft to their fleets, thus, current operators have the full scope of vertical lift missions, including safety and regulatory backgrounds.
- ➔ Workforce remains an issue for initial operations, and the industry will need to focus on building the workforce pipeline to support future operations. There is utility in the outreach to other rotorcraft/drone pilots and operators to raise an initial workforce for early AAM operations.

- ➔ Supporting programs can demonstrate the effectiveness of AAM, including demonstration operations and ConOps testing.
- ➔ Support programs must be developed to address member and public engagement on the full scope of support and service-related issues for AAM including fire codes (National Fire Protection Association).

Mid-Term

- ➔ There is a need to establish community talking points focused on the importance of AAM to the aviation industry and communities. Changes in state and municipal codes for AAM could be expected to take five years or more and will depend on the acceptance and support of communities.
- ➔ Industry must monitor community reaction to the effects of aircraft-generated sound and promote the low sound profiles of AAM aircraft through demonstrations and use cases to continue to build momentum for community acceptance.

Far-Term

- ➔ As the AAM industry scales, community engagement must also scale, with continued education and outreach. The success of initial piloted AAM operations will provide the public confidence in both the safety and benefits as increasing levels of autonomy are incorporated and introduced.

Conclusion

For 75 years, HAI has held a unique position amongst the aviation associations in that it represents all stakeholders within the vertical aviation industry, including operators, maintainers, manufacturers, service providers, and individuals.

HAI members operate and support traditional rotorcraft, as well as current and future next-generation vertical lift aircraft, including eVTOL, optionally/remotely piloted aircraft, and fully autonomous aircraft.

HAI fully recognizes the future vertical aviation industry will encompass a broad range of vehicles. Its members are already shifting toward a broader range of aircraft in their fleets to take advantage of the wide range

of specialized capabilities found across the growing pool of current and future vertical lift aircraft. As such, HAI members will require support to not only keep their legacy aircraft flying but to also successfully integrate the next generation of vehicles and services into their fleets.

To ensure its members' success, HAI will continue with its robust advocacy programs, including legislative, regulatory, safety, and standards, as well as member services offerings and industry promotion services. No other organization is better positioned to assist the vertical aviation industry in its efforts to achieve these goals.

This roadmap highlights HAI's plan to make AAM operations a reality in the near-, mid-, and far-term.



Appendix A: European Comments

Introduction

The current HAI AAM Roadmap primarily reflects a U.S. point of view regarding AAM adoption. In this section, we aim to address recommendations and concerns on the advancement of AAM in other regions of the world. Further coordination is needed as issues and challenges can be interpreted differently in other regions, or within regions, due to existing and proposed regulatory frameworks. Specifically, in Europe, the European Union Aviation Safety Agency (EASA) and the European Helicopter Association (EHA) have strong voices in the adoption of AAM technologies and there are some differences that will need to be addressed for the successful rollout of a full AAM ecosystem through collaborations and best-practices.

The terms, acronyms, and definitions that are used throughout the document may differ from other regions of the world that are already in the process of adopting AAM services. For example, the term “unmanned” can be interpreted differently. In Europe, “unmanned” can imply “with no one onboard,” (e.g., drones) whereas some politicians and media can interpret it as “without a pilot onboard” (e.g., remotely and/or automatically controlled with passengers). Similarly, AAM is referred to as “innovative air mobility (IAM)” in Europe. The term encapsulates commercial and non-commercial operations with VTOL-capable aircraft in congested and non-congested areas.

Infrastructure

Regarding vertiports, EASA recommends limiting access to VTOL-capable aircraft only. By contrast, EHA expects both helicopters and eVTOLs to share the airspace. Therefore, EHA advocates for vertiport usage by both helicopters and eVTOLs (with certain conditions). With growing sensibility in urban areas regarding aircraft sound, pollution, and risks to third parties on the ground, vertiport locations and operational concepts will require close collaboration with stakeholders.

While infrastructure is a major concern for both HAI and EHA, in Europe there are other obstacles that prevent helicopters from operating in the current regulatory environment. The biggest limitation is the prohi-

bition of single engine helicopters to fly over densely populated areas as well as take off and landing there. As such, only multi-engine helicopters are allowed to operate under CAT over cities in Europe.

Another issue that needs to be addressed is the approach and departure path limitations that exist to and from heliports and vertiports. During these phases of flight, aircraft are often at their most vulnerable states and will need to prove successful continuation of flight in the case of engine/power failures.

Ground space at vertiports is equally important to consider when developing landing zones for eVTOLs. Although many current eVTOL designs have two or four seats, they are noticeably wider than light and medium helicopters. Those with mixed airlift (rotors + wings) need larger ground space than most of the heavy helicopters today. However, the introduction of AAM is systematically regarded by public opinion and politics as an opportunity to reduce the size of the existing helipads. As AAM has the potential to transform the means of transport over cities, the size and the number of vertiports will both need to increase.

In terms of vertiport electric supply and charging, there are other solutions that could be considered. Some projects have supposed the exchange of power cells as the quickest and smartest way to address the problem of charging time. It is important to note that no technique is yet mature enough to consider defining a standard that could be imposed on all certified eVTOL designs. Therefore, topics such as energy storage and handling of electric power banks for aircraft will need to be considered as well as emergency procedures in case of battery fires.

Given these differences and constraints, the leaders of the eVTOL industry who are involved in the experimentation of their offers at the occasion of the Paris Olympic Games in 2024 argue that presently a vertiport dedicated to multiple models of aircraft is not feasible.

Regulations and Airspace Use

Regulatory frameworks also differ by region in terms

of classifying vertical take-off and landing vehicles and helicopters. In EASA, there is a clear distinction between aircraft with vertical take-off and landing capability and helicopters. This leads to a separate framework that is addressing the operational needs of VTOLs; however, this can introduce complexities, as operators may want to operate helicopters as well as eVTOL.

In EASA, VTOL operations are part of the current Ops Regulation. This indicates that operators under EASA rules will need to have an operator certification. The regulatory framework for VTOL operators is expanded by a Part-IAM, including VTOL-capable aircraft (manned and unmanned), meaning that VTOL are part of regular aircraft operations and not regulated under part-UAS (drones).

EASA has already published a draft on all relevant parts of the aircraft development and operation process (Initial Airworthiness, Continued Airworthiness, Operations and Pilot Training). While these regulations have not yet been approved, EASA is pushing to get them published. This implies that the two major regulatory powers (FAA and EASA) will differ greatly in their interpretation of how, and under which parts of the law, eVTOLs should be regulated.

The variety of technologies and flight domains of the numerous eVTOL aircraft projects will add regulatory requirements that will depend on their performances and technologies. Therefore, the real impact of AAM growth for the development of the future urban environment would increase in proportions that are hard to predict at this time.

In terms of airspace, EASA is pursuing the U-Space concept. U-Space is a special type of airspace to enable fair and efficient sharing and use of the airspace, ranging from dense drone operations (complex and long distance UAS operations such as BVLOS) to operations in urban environments. The U-Space concept is meant to ensure safe separation between manned aircraft and drones, and to ensure safe flights and operations of drones in the airspace. This concept will help employ the safe operation in urban areas where there are many different participants in a single block of airspace.

In the case of manned VTOL-capable aircraft that enter a U-space in controlled airspace, the ATC unit will segregate manned VTOL-capable aircraft from UAS by taking both vehicles' navigational performance into account. This will force UAS operators to discontinue their flights, vacate the restricted part of the U-space airspace, or conform with amended flight authorizations. It will require an agreement on the equipment required to enter U-Space as well as substantial investments in infrastructure.

One of the biggest issues for the successful start of eVTOL operations is the expected level of risk that must be considered. eVTOL operators would have to guarantee an equivalent level of safety as for current airline operations. Current concepts will likely make this requirement unachievable and might prevent certification of aircraft. It will also have a significant impact on operational procedures and reduce the types of operations that may be legally performed.

It is important not to put overly severe limitations on initial operational requirements and certification standards. This could severely limit the development of this nascent industry. At the same time, risk management and safety management systems (SMS) are key to detect and manage hazards before any worst case scenarios would occur.

Training, Vehicle Development, and Insurance

The growth of AAM could produce an increase in opportunities to offer new ways to enter the industry such as a push for more credits for cross-entrants from other industrial sectors (e.g., an electronics specialist could align to become an Avionics or FMS specialist).

AAM Enterprise

Growing eVTOL operations from existing helicopter operators should be seen as a best practice for initial AAM operations. This would allow the industry to best leverage existing know-how and safely grow these new operations. International organization partnerships, such as the International Federation of Helicopter Associations (IFHA) and the Vertical Aviation Safety Team (VAST), should be leveraged as much as possible to build a platform where best practices can be shared to develop an AAM ecosystem of the future.

Appendix B: HAI AAM-IAC Member Aircraft



Airbus CityAirbus

www.airbus.com/en

- ➔ Munich, Germany
- ➔ Capacity: Pilot + 3 passengers
- ➔ Range: 80km
- ➔ Speed: 120km/h
- ➔ 8 propellers

Archer Midnight

www.flyarcher.com

- ➔ San Jose, CA, USA
- ➔ Pilot + 4 passenger
- ➔ 12 electric propellers; forward 6 tilting
- ➔ Range: 100 miles
- ➔ Speed: 150 mph
- ➔ Delivery: 2024
- ➔ Orders: Up to \$1.5B order from United Airlines for up to 200; \$10M predelivery deposit



Beta Technologies Alia

www.beta.team

- ➔ Vermont, USA
- ➔ 5 + 1 passengers or 1,400 pounds of cargo
- ➔ Range: 250 miles
- ➔ Speed: 170 mph
- ➔ Delivery: Upon certification
- ➔ Orders: United Therapeutics (firm order for 10), UPS (firm order for 10, options up to 150), Bristow (firm order for 5, options up to 55), LCI (firm order for 50, options up to 125), Blade (firm order for 5, options up to 20), Air New Zealand (Mission NextGen partner)



Eve Air Mobility (Embraer)

www.eveairmobility.com

- ➔ Melbourne, FL, USA
- ➔ Pilot + 4 passengers or 6 passengers
- ➔ 8 rotors and 2 ducted fans
- ➔ Range: 60 miles
- ➔ Speed: 125 mph
- ➔ Delivery: 2026
- ➔ Orders: 2,770

Jaunt Air Mobility Journey

www.JauntAirMobility.com

- ➔ Dallas, TX, USA
- ➔ Pilot + 4 passengers
- ➔ 1 lifting rotor and 4 anti-torque/cruise propellers
- ➔ Range: 120 miles
- ➔ Speed: 175 mph
- ➔ Certification: 2026



Joby S4

www.JobyAviation.com

- ➔ Santa Cruz, CA, USA
- ➔ Pilot + 4 passengers
- ➔ 6 tilting propellers
- ➔ Range: 150 miles
- ➔ Speed: 200 mph
- ➔ Delivery: 2024





Overair Butterfly

www.overair.com

- ➔ Santa Ana, CA, USA
- ➔ Pilot+ 5 passengers
- ➔ 4 tilting propellers
- ➔ Range: 100 miles
- ➔ Speed: 200 mph
- ➔ Acoustics: <40 db
- ➔ Delivery: upon certification

Supernal S-A1 (Hyundai)

www.Supernal.aero

- ➔ Seoul, South Korea
- ➔ Pilot + 4 passengers
- ➔ 6 rotors
- ➔ Range: 60 miles
- ➔ Speed: 180 mph
- ➔ Delivery: 2028



Vertical Aerospace VX4

www.vertical-aerospace.com

- ➔ Bristol, UK
- ➔ Pilot + 4 passengers
- ➔ Eight propellers
- ➔ Range: 100 miles
- ➔ Speed: 150 mph
- ➔ Certification: 2025
- ➔ Orders: 1,400+ from American Airlines, Virgin, and others totaling \$5.6 billion





Volocopter VoloCity

www.Volocopter.com

- ➔ Bruschal, Germany
- ➔ Pilot + 1 passenger
- ➔ 18 fixed-pitch propellers
- ➔ Range: 22 miles
- ➔ Speed: 62 mph
- ➔ Certification and Delivery: 2024
- ➔ Orders: Volocopter will be owner/operator

Volocopter VoloRegion

www.Volocopter.com

- ➔ Bruschal, Germany
- ➔ Pilot + 4 passenger
- ➔ 6 lift rotors + 2 propulsive fans
- ➔ Range: 60 miles
- ➔ Speed: 110 mph
- ➔ Delivery: 2026



Wisk Aero

www.wisk.aero

- ➔ Mountain View, CA, USA
- ➔ 4-passenger autonomous eVTOL with 12 lifting propellers, 6 tilting
- ➔ Joint venture with The Boeing Company and Kitty Hawk
- ➔ Range: 90 miles (w/Reserves)
- ➔ Speed: 110-120 knots
- ➔ Delivery: Not public
- ➔ Wisk will build and operate aircraft, focused on urban air mobility

Appendix C: Acronyms

AAM	advanced air mobility	IBAC	International Business Aviation Council
AARF	aircraft rescue and fire fighting	ICAO	International Civil Aviation Organization
AC	(FAA) advisory circular	IFR	instrument flight rules
ADO	(FAA) regional airports division and district office	IS-BAO	(IBAC) International Standard for Business Aircraft Operations
AOG	aircraft on ground	MR	mixed reality
AR	augmented reality	NARI	NASA Aeronautics Research Institute
ATC	air traffic control	NPRM	(FAA) notice of proposed rulemaking
CBTA	competency-based training and assessment	OEM	original equipment manufacturer
CFR	Code of Federal Regulations	OSD	(EASA) Operational Suitability Data
ConOps	concepts of operation	PSU	provider of services for urban air mobility
CPL	commercial pilot license	RAM	regional air mobility
CPL-A	commercial pilot license for airplane	SFAR	(FAA) Special Federal Aviation Regulation
CPL-H	commercial pilot license for helicopter	SMS	safety management system
CPL-PL	commercial pilot license for powered lift	SUAS	small uncrewed aircraft systems
DFR	digital flight rules	SVO	simplified vehicle operations
DOT	Department of Transportation	TLOF	touchdown liftoff
EASA	European Union Aviation Safety Agency	UAS	uncrewed aircraft system
EB	(FAA) engineering brief	UAM	urban air mobility
eSTOL	electric short takeoff and landing	USC	United States Code
eVTOL	electric vertical takeoff and landing	V2G	vehicle-to-ground
FAA	Federal Aviation Administration	V2V	vehicle-to-vehicle
FSB	(FAA) Flight Standardization Board	VFR	visual flight rules
FSDO	(FAA) Flight Standard District Office	VR	virtual reality



HELICOPTER ASSOCIATION INTERNATIONAL

HAI is the professional trade association for the international helicopter industry and represents more than 1,100 companies and over 16,000 industry professionals in more than 65 countries. Each year, HAI members safely operate more than 3,700 helicopters and remotely piloted aircraft approximately 2.9 million hours. HAI is dedicated to the promotion of vertical aviation as a safe, effective method of commerce and to the advancement of the international vertical aviation community.

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