Concept of Operations for Advanced Air Mobility (ConOps for AAM)

※The Japanese version is the original and the English version is for reference purposes only.

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Public-Private Committee for Advanced Air Mobility

Preface

Our country faces many challenges, such as the concentration of population in urban areas and the exhaustion of regional economies due to population decline, falling birthrates, and aging populations, as well as the need to respond to severe international competition resulting from the advance of globalization, the risk of natural disasters such as large-scale earthquakes, and the need to address global-scale climate change and the Sustainable Development Goals (SDGs). In addition, people's behavior patterns and values are diversifying as the economy and society mature and as we move toward a post-COVID society, and new values and services are needed to meet diverse needs.

Advanced Air Mobility (AAM) will contribute to solving the various social issues mentioned above and to realizing a future society in which people can enjoy the rich experience of safe and flexible transportation in the sky in their daily lives. Currently, AAM aircraft development and studies are underway around the world.

In order to promote the development and growth of AAM in Japan, it is essential to provide necessary information on the main elements of AAM and the phases of its gradual introduction to all parties concerned. It is also important to share and cooperate with other parties concerned. To this end, this document summarizes the concept of operation for AAM in Japan.

Revision History

First Issue	
All Pages	New Issue
First Issue Revision A	
Overall	• Updated on domestic and international activities, and corrections to the descriptions were made.
Chapter 1 Introduction	• New Section 1.4 “Activities for the Introduction of AAM Operations” was newly added.
Chapter 2 Overview of Advanced Air Mobility	• Section 2.1 "AAM Phases" was moved from the latter section and the subsequent section numbers were forwarded in order. • “Transportation of personnel during disasters” was added as use case #9 in Section 2.3.1 “Passenger Carrying.” • The document by the Use Case Review Meeting was assigned as APPENDIX 2 (new) and referenced from Section 2.3 "Use Cases" • Deleted the description of Vertiport airspace and UAM Routes & UAM Corridors from Section 2.5.2 "AAM use of Low-level airspace," and moved them to the newly added Chapter 3. • Deleted the detailed description of UATM Services from Section 2.5.3 "Air Traffic Management," and moved it to the newly added Chapter 3. • Chapter 2.7, "AAM Operation Flow," was newly added to refer to APPENDIX 3.
Chapter 3 Key Challenges for Advanced Air Mobility	• New Chapter 3 was added to describe key challenges for AAM. The subsequent chapter numbers were forwarded in order.
Chapter 4 Phases of Advanced Air Mobility Introduction	• Section 4.1 "AAM Phases" was deleted and moved to Section 2.1 at the beginning of this document. • Challenges to be addressed in each phase were noted.
APPENDIX 2 AAM Use Cases	• The document by the Use Case Review Meeting under the Public-Private Council for the Air Mobility Revolution is attached and assigned as APPENDIX 2. The subsequent APPENDIX numbers were forwarded in order.

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1 Introduction

1.1 Purpose

This document presents a Concept of Operations (CONOPS) for realization and further expansion of the scale and operations of the Advanced Air Mobility (AAM) in Japan, which is expected to become the next generation of air mobility. It outlines the key components and stakeholders, and describes the phases of gradual implementation.

AAM is an accessible and sustainable next generation means of air transportation, made possible by aeronautical technologies such as electrification and automation, as well as vertical take-off and landing and other modes of operation[1]. In this document, a distinction may be made between AAM operations in urban areas over short distances and at low altitudes which is referred to as Urban Air Mobility (UAM) and AAM operations over longer distances which is referred to as Regional Air Mobility (RAM).

To enable the development and growth of AAM operations, active discussion among stakeholders on regulations and system design and specifications for AAM operations is needed. Therefore, this document aims to provide industry stakeholders who are considering entering the AAM industry in Japan with necessary information and shared awareness.

The AAM industry is still developing and is expected to evolve further in the future. As such, this document is based on current knowledge and projections regarding future AAM operations and is expected to constantly evolve based on technological advances, overseas trends, and feedback from stakeholders.

1.2 Scope

In order to promote the development of AAM industry in Japan through steady progress in environmental and technological development as outlined in the roadmap by the Public-Private Committee for Advanced Air Mobility (APPENDIX 1), this document describes the overall ecosystem while focusing on the main components of AAM: the aircraft, ground infrastructure and air traffic management. It also introduces relevant use cases for Japanese AAM operations, including passenger carrying and cargo transport operations that use Electric Vertical Take-off and Landing (eVTOL) aircraft as well as the roles and responsibilities of the parties involved and key challenges. In addition, it describes the likely phases of AAM operations from initial introduction to mature, high-density and autonomous operations.

This holistic approach is important for the development of AAM operations. It is important to consider both short- and long-term objectives to minimise the amount of rework and cost that could arise at a later stage due to initial decisions.

This document also considers air traffic management mechanism that AAM needs to achieve harmonized flight with other low-level airspace users. Other low-level airspace users include drones, general aviation aircraft, and commercial operations on approach or departure, etc.

[1] AAM does not include drones. (Ref. APPENDIX 4)

1.3 Reference Documents

This document is built in accordance with the Japanese operating environment and legal system, and it has been prepared with reference to regulations related to Japan Civil Aeronautics Act and materials from the Public-Private Council for the Air Mobility Revolution, as well as overseas ConOps, etc. (see APPENDIX 6) to ensure international harmonization and consistency.

Where practical, references have been included in the document to show the source of material used. These publications provide additional detail about some of the concepts described in this document and should be considered appropriately in any development and implementation activities.

1.4 Activities for the Introduction of AAM Operations

Preparations are underway to smoothly introduce AAM operations based on the roadmap of the Public-Private Committee for Advanced Air Mobility.

The Public-Private Committee has been discussing the approach to set standards for aircraft, take-off/landing areas, airmen competence certifications, aircraft operations and air transport services, and from FY2023, the government has been establishing standards in turn. From now on, to establish actual operations, discussions on the details of traffic management methods, etc. are expected to get underway in earnest.

In Revision A of the first edition of this document, the discussion of use cases has been advanced and information has been added on other topics that need to be considered in order to realize AAM, such as social acceptability. It also updated information on the status of preparation of domestic and international regulations and standards. The details of traffic management methods will continue to be discussed, taking into consideration harmonization with other countries' schemes, by the public and private sectors, and a second edition reflecting these discussions will be published when available.

2 Overview of Advanced Air Mobility

AAM encompasses a range of innovative aviation technologies to transform aviation's role in everyday life and achieve a revolution in air mobility, including the movement of goods and people [4]. Central to AAM is the development, operation and evolution of new types of aircraft. eVTOL aircraft use electric power for their operation, and take-off and land vertically. They have a number of potential benefits over traditional air mobility aircraft including zero emissions during operations, lower operational costs and lower noise profile. These benefits and their impacts are described in more detail later in this document.

The various benefits of eVTOL aircraft will enable the utilization and expansion of new air mobility for both passenger-carrying and cargo operations. In the initial stage, it is envisioned that in addition to passenger and cargo transport with a pilot on board, remotely piloted cargo transport will also be implemented. Thereafter, over time, greater use of remotely piloted and autonomous operations is expected for both passenger-carrying and cargo use cases.

AAM operations will require new infrastructure, both on the ground and for airspace and traffic management. At present, the AAM market is still in an early stage of development, whilst showing increasing momentum. Globally, many companies are emerging across the entire value chain. Business is expected to spread to various fields in the future, and it is essential for the development of the AAM industry that more companies enter the market in Japan as well.

This chapter provides further detail on each component that will form part of new AAM enabled by eVTOL aircraft.

2.1 AAM Phases [5]

The introduction and growth of AAM operations will occur over a number of Phases:

- Phase 0 – Test flights and proof of concept flights prior to commercial operations
- Phase 1 – Commencement of commercial operations - low density (pilot on board, cargo transport with remotely piloted operations) : Around 2025
- Phase 2 － Scaled operations - medium to high density (pilot on board and/or remotely piloted) : Late 2020's or later
- Phase 3 – Establishment of AAM operations which include autonomy - high density (integrated with automated / autonomous operations) : 2030's and beyond

In this document, the phases are separated from qualitative perspectives, such as whether or not a pilot is on board, developments in automation/autonomy, and complexity of traffic management. Further accumulation of knowledge and experience, and verification, etc. are needed to define qualitative figures for the density of operations, etc. in each phase. [9]

Trials and demonstrations of more advanced technology will continue to occur through all phases, and airspace/traffic management to support these phases is also described in a later section.

2.2 Aircraft

Aircraft intended for AAM (Hereinafter referred to as AAM aircraft) are currently at various levels of technology readiness. Although, the most likely types of aircraft to commence commercial AAM operations in Phase 1 are eVTOLs powered by rechargeable batteries, hybrid types could also be introduced in Phase 1. Hydrogen fuel cell-powered aircraft may also provide AAM operations, but this type of aircraft is expected to be introduced in Phases 2 or 3, or later. As a rough estimate of range, the aircraft are expected to be able to fly from a few kms to several hundred kms.

In the initial stage, aircraft which carry about 1-5 persons that are controlled manually or automatically with a pilot on board and aircraft remotely piloted without a pilot on board, mainly for cargo transport are envisioned. In the future, it is envisioned that aircraft with a larger number of passengers will emerge, and that aircraft including passenger transport, will be operated by automated flight operations or autonomous operations, with only remote monitoring and no pilot on board.

Although AAM aircraft are initially expected to operate under Visual Flight Rules (VFR), it is expected that progress toward higher density and automation/autonomy will occur, as well as the development of aircraft capable of flying in more severe weather.

2.2.1 Aircraft Concept Types[2]

AAM eVTOL aircraft can be categorised into three types mainly:
- Multirotor
- Lift + Cruise
- Vectored Thrust

Multirotor
This concept provides the main lift and propulsion by means of three or more electric powered rotors rotating around a nearly vertical axis. By changing the “rotation speed” of these multiple motors, each rotor blade (rotor) generates thrust and counter-torque in accordance with its rotation speed, which becomes torque in various directions depending on structural factors such as rotor positioning, direction of rotation, and positive or negative rotor pitch. These combined forces change the aircraft's attitude to achieve flight. Due to a high battery drainage for the cruise phase, these aircraft are limited to short-distance journeys.

Lift + Cruise

[2] Definitions and meanings of terms used in this section include those given for ease of reading. Formal terms used in the evaluation for type certification are determined by consideration of individual design features.

This concept has multi rotors, but also fixed wings for cruise, with one or more propellers for thrust. It uses different electric propulsion systems for vertical take-off and landing and for cruise. During take-off and landing, multi rotors are used to generate upward thrust. During cruise, the upward rotors turn off and one or more forward-facing propellers are used for level flight and wings create the necessary lift. This concept can enable greater energy efficiency than multirotor AAM aircraft in cruise due to the use of wing-based lift and is therefore suited to longer distances.

Vectored Thrust

This concept has fixed wings for cruise and uses some or all of the electric propulsion systems in common for vertical take-off and landing and for cruising. At take-off and landing, the vertically positioned propulsion system (e.g. propellers or fans) generate lift. During cruise, the propulsion systems tilt to generate forward thrust and lift is generated by the wings. This concept is suited to longer distances than multirotor AAM aircraft. It can potentially enable higher cruise speeds and distances than other concepts.

Under the Civil Aeronautics Act, for the time being, lift+cruise type and vectored thrust type aircraft that fly with fixed wings which provide the main lift will be classified as "airplanes" and multirotor type aircraft that obtain their main lift and propulsion from rotor blades will be classified as "rotorcraft.

2.2.2 Comparison with existing air mobilities

AAM aircraft have the following characteristics compared to existing air mobility.

[Environmental Burden]

- The use of batteries as the power source is expected to reduce emissions that adversely affect the environment.
- The aircraft is expected to reduce noise during take-off/landing/cruise because it is battery-powered and equipped with rotors that are smaller in size than those of a helicopter and new technologies are employed, etc. The use of wing based lift is also expected to reduce the noise in cruise compared to helicopters.

[Design/Performance]

- High redundancy is expected due to the multiple motors/rotors and other features.
- Features such as vertical take-off and landing are expected to enable take-off and landing in confined spaces.
- Operational control is expected to be simplified due to employment of new technologies, etc., and designs suitable for remote-pilot and autonomous operation are expected to become mainstream.
- It is expected that efficiency will improve in the cruise phase of flight, where wing-based lift is used compared to rotorcraft such as helicopters.

[Energy Source]

- Infrastructure and requirements for battery powered operation such as battery swapping or fast charging, will be required.

- Batteries currently in use have lower energy density than liquid fuels, which may limit AAM aircraft range, payload and others. This will be especially true for multirotor types.
- Battery-powered operation can be ready for operation in a shorter time after start-up (power-on).

[Cost]

- The cost of maintenance may be reduced by reducing the frequency and simplifying process of parts replacement and maintenance practices, while maintaining safety.
- Aircraft production and operating costs may be reduced over the long term because of reduced number of parts used, etc.

2.3 Use Cases

The use cases presented in this section are based on the Use Case Review Meeting under the Public-Private Council for the Air Mobility Revolution. The use case of cargo transport has much in common with drones. Utilisation of AAM aircraft is expected to deliver some of the following benefits compared with conventional helicopter operations and/or other transport options:

- Passenger/Logistics Company: Increased availability (locations and frequency), time saving (compared to other transport modes), quieter comfortable cabin, potentially lower cost, simple boarding procedure, improved multi-modal transport connectivity.
- Community/Society: Lower noise, lower emissions, larger network of operations, vitalization of local economy, improved remote area access, increased emergency response capability, reduced infrastructure costs (compared to other ground/surface based transport modes).

2.3.1 Passenger Carrying

1. Airport shuttle: Transporting passengers from/to airport and their onward destination.
2. Intra-urban: Transporting passengers within urban areas.
3. Routes to suburban areas: Transporting passenger from urban centres from/to suburban/remote areas.
4. Entertainment: Excursion flights around recreational facilities and tourist destinations.
5. Access to tourist areas: Transporting tourists, etc. from/to recreational facilities and tourist destinations.
6. Routes connecting remote islands or mountainous areas: Transporting passengers between remote islands and the mainland, between islands and between mountainous and urban areas.
7. Emergency Medical Transport (EMT) (for doctors): Transporting doctors for emergency medical purposes over urban and rural areas in the event of a disaster or sudden illness, etc.
8. EMT (for doctors and patients, etc.): Emergency transport of doctors who have provided initial treatment and patients in the event of a disaster or sudden illness, etc.

9. Transportation of personnel during disasters: Transporting personnel from isolated areas due to disasters such as earthquakes.

2.3.2 Cargo Transport

1. Emergency transport of goods: Transporting required goods when disaster event occurs.
2. Inter-facilities: Transporting goods or products between facilities owned by a company/organization.
3. Cargo delivery (sea and mountainous areas): Transporting cargo along routes over the sea and within mountain areas (incl. remote medical care).
4. Cargo delivery (urban areas): Transporting cargo in urban areas.

In addition to the above, AAM is expected to include use cases in which companies independently introduce and use for their own purposes as well as, in the future, private ownership and use by individuals for their own personal use.

The Use Case Review Meeting under the Public-Private Council for the Air Mobility Revolution presents use cases for each phase of implementation (Refer to APPENDIX 2).

2.4 On-ground infrastructure

2.4.1 Vertiports

Definition/Overview
A "vertiport" is considered an "airport, etc." under the Civil Aeronautics Act, as a type of "heliport" dedicated to AAM. In the AAM operating environment, it is anticipated that there will be vertiports of various sizes with single or multiple Final Approach and Take-Off Areas (FATOs).

Vertiports may be dedicated to passenger transit, cargo loading, maintenance, or a blend of these functions. It is expected that they will be established more quickly and less capital intensive than traditional aerodromes and airports due to the smaller scale of operations and smaller site area required. Once the take-off and landing performance of AAM aircraft is demonstrated and the obstacle limitation surfaces can be set to take advantage of them, it is expected that there will be flexibility in the selection of deployment sites.

Variations may exist in how vertiports will serve the local area including connections to other transportation services and partnerships with local businesses. Unlike conventional airports, etc., many vertiports with different operators may be established within a city.

In the beginning, AAM operations are expected to utilize existing rules, including for the use of existing aerodromes/airports (referred to hereinafter to include heliports.) and permissions for off-site take-off and landing. Existing aerodromes/airports can be used for eVTOL operations if the necessary requirements are met, however there is a possibility that additional facilities, for instance, electrical chargers, battery swapping equipment and fire extinguishing equipment for battery fires will be needed.

Facilities

For vertiports, the infrastructures appropriate to the size, performance, and operating conditions of the anticipated AAM aircraft will be required. Vertiports may be required to establish instrument flight procedures and/or to install air navigation facilities and other equipment to ensure safe operations during night-time and/or inclement weather conditions. But, it is not expected that operations during such conditions will be included in the early stages of AAM implementation. Infrastructure and equipment requirements for safety purposes will need to be standardized at vertiports.

Some vertiports may have dedicated spaces for AAM aircraft to park (Stand). The location where an AAM aircraft parks will be coordinated between the vertiport operator and the AAM aircraft operator. Movement between a FATO and an aircraft stand will take place while the AAM aircraft is on the ground (either moved using ground movement equipment or ground taxi under its own power) or in a low hover (if possible, at the vertiport).

Configuration

Vertiports have various configurations, and in addition to facilities that must be maintained, such as FATOs, TLOFs, and markings, there are other facilities such as stands, taxiways, and charging facilities that are maintained depending on site conditions and operational methods, and the processing capacity, such as the number of flights that can be realized, varies. For example, the availability of stands and taxiways and the number of FATOs affect the throughput capacity of vertiports. It is anticipated that vertiport capacity will affect the capacity of the whole AAM network, especially in the early stages when there are expected to be few vertiports available.

Since it is anticipated that the vertiports may be required to be used by AAM or other aircraft in off-nominal and emergency situations, preparedness for emergencies that might occur at the vertiport or another nearby vertiport should be considered.

Vertiport capacity will largely depend on the number and throughput of the FATO as well as the number of stands. This capacity will be impacted by the following.

- FATO occupancy time (arrivals)
- FATO occupancy time (departures)
- Departure's profile, arrival’s profile
- Effect of wake turbulence and separation
- Noise abatement or other specific airspace procedures required at the vertiport
- Turnaround time at stand (including charging time)

International Regulations and Standards

Currently, international and national unified design standards dedicated for vertiports do not exist. In Europe, EASA published Prototype Technical Specifications (PTS) for the design of VFR vertiports for the operation of manned aircraft with VTOL capability certified in the enhanced category in early 2022. The FAA issued an Engineering Brief, an interim design standards for vertiports in September 2022 ahead of a performance-based Advisory Circular around 2025.

In Japan, the " Vertiports Design Guidelines" was issued in December 2023 as interim guidance until domestic standards are established, providing basic ideas and considerations for the design of vertiport facilities.

ICAO is working on international standards (SARPs) for vertiports but standardization is expected around 2028. Similarly, standards for vertiport operations, which are anticipated for passenger transport VTOL flights, do not yet exist. The international standards development organisations are in the process of developing guidance for vertiport operations for piloted VFR VTOL operations. It is expected that these guidance documents can be used as a foundation for developing a vertiport certification regime.

Existing design and operational standards for aerodromes and heliports do not adequately account for the performance of eVTOL aircraft. The application of Obstacle Limitation Surfaces (OLS) requirements for eVTOL aircraft performance to vertiports is expected to promote the establishment of vertiports in urban areas and introduction and widespread use of AAM aircraft.

Regulations and standards will define the capability of vertiports for normal and off-nominal operating conditions. To enable the safe and timely introduction of vertiports in urban areas especially, and to support commercial AAM aircraft operations, the design and operational requirements (in partnership with industry where appropriate) need to be developed.

2.4.2 Non-public/public vertiports

A wide range of AAM aircraft types, configurations and performances are expected. The diversity of AAM aircraft is anticipated to increase in the long term with new market entrants, but on the other hand, it may reduce when there is industry consolidation. Vertiport design standards will need to be AAM aircraft agnostic and be able to accommodate the configurations and capabilities of any AAM aircraft.

Like existing heliports, there are public (available for unspecified operators) and non-public vertiports. For public use, the specifications must in principle be able to accommodate any AAM aircraft that is expected to be operated, and it is assumed that an entity independent from AAM aircraft operators will operate them. On the other hand, for non-public use vertiports, a few models of operation are envisioned such as an aircraft operator operates a vertiport directly, a vertiport operator enters into a contract with specific AAM aircraft operators only, and others.

AAM aircraft agnostic vertiports servicing many AAM aircraft operators will create a network effect of connections between RAM and UAM, as well as increase the utilization of the vertiports and AAM aircraft with the growth in scope and number of flights, which in turn is expected to reduce the cost of AAM aircraft operations and ticket prices for the passengers. To make this possible, it is expected that there will be different mission and take-off/landing profiles available at the vertiport with multiple operators of AAM aircraft. In addition, considering challenges such as airspace constraints and the lack of suitable vertiport installation sites in urban areas, there is a greater need for AAM aircraft agnostic vertiports.

2.4.3 Integration with existing aviation infrastructure

Locating vertiports at existing aviation infrastructure will maximise the use of existing airport facilities and provide seamless connectivity between AAM aircraft services and commercial air transport services. It can provide customers with a quick and comfortable means of transportation between the airport and city, and as a result, AAM can complement or replace surface transportation to and from airport. Secondary traffic from airports is expected to be an initial use case for AAM.

Airports are complex operating environments with a wide range of challenges and changing needs. When locating a vertiport at an airport, there are a number of factors to consider, including aerodrome approaches/departures of existing aircraft and runway capacity, safeguarding and other local requirements. The location of the vertiport should avoid areas that affect approaching or departing aircraft as possible in order to maintain safety and protect the throughput of existing runway operations. At airports with high traffic volumes and limited new airspace capacity, it is necessary to consider ways to minimize overall capacity reduction, such as operating AAM aircraft independently of other aircraft operations as much as possible, taking into account their performance characteristics.

The introduction of AAM operations close to the airport, in the controlled airspace, will require air traffic control to have a clear understanding of the processes and procedures being used at the vertiport to maintain safety and optimise traffic flow. It will be essential that the control agency always ensures that operations remain deconflicted in the event of baulked landings or when traffic needs to ‘go around’.

The positioning of any vertiport must also take into consideration its impact on obstacle limitation surfaces of the airport to ensure safety and understand its impact on airport and aircraft operations and the neighbouring communities.

Integration of vertiports and AAM operations within an aerodrome/airport will depend on many factors, and will depend on the physical size of the airport, the apron area that the AAM aircraft will use, proximity to other aircraft, as well as existing traffic levels.

It is desirable that AAM operations are deconflicted with existing aircraft operations but remain within the airport area so that AAM passengers are close to terminal buildings. Passengers will need to connect with the air services, and the existing surface access infrastructure. Also, vertiports may be located within the airfield but in an area separate from existing operations, so that AAM operations are deconflicted with existing aircraft or vehicles moving on the ground. In addition, locating the vertiport in a separate area will allow passengers to avoid any security screening that would have been required to enter the secure areas of an airside (restricted zone).

The following areas will need to be considered when planning a vertiport on or close to an existing airport:

– If conflicts with existing aircraft are anticipated, emergency response methods and means of communication should be clarified so as not to affect the operation of existing aircraft.

- Interchangeability between AAM services and existing air and ground services are desired to be as frictionless and fast as possible for passengers.
- The hazards when AAM aircraft operate within the airfield apron and adjacent to traditional aircraft should be considered.
- While ensuring the safety of the vertiport, the impact on the existing Obstacle Limitation Surfaces of the airport need to be considered.
- The vertiport operator or AAM operator may need to manage how AAM aircraft and their equipment impact the environmental assessment, noise profile, etc. of existing airport.
- At airports where air traffic control services are provided, the air traffic control operations of vertiports co-located with airports must be specified.

It is necessary to consider measures that will enable smooth operation of AAMs at high densities while ensuring safety and taking into consideration not to affect the operation of existing passenger aircraft.

2.4.4 Charging Equipment

Since multiple specifications are expected for charging facilities, especially for connectors, it is necessary to consider the AAM aircraft that are expected to be operated at each vertiport.

There are currently two known methods of charging of AAM aircraft: (1) battery replacement and (2) direct charging, and the requirements on charging facilities are different.

Battery replacement may require space in the vertiport for battery charging facilities and storage. There is also an operational need to locate these facilities close to the aircraft stand for fast swapping to enable fast AAM aircraft turnaround.

Direct charging requires charging equipment to be installed at aircraft stands to facilitate fast charging during AAM aircraft turnaround.

From the perspective of promoting infrastructure development, standardization of charging specifications and batteries is expected to be encouraged. At this time, the details of the charging system, etc. of AAM aircraft have not been clarified, but the parties involved will need to coordinate the division of responsibilities for the installation and operation of charging and power receiving facilities in the future.

2.5 Airspace, Traffic Management

2.5.1 Current Airspace Context

The current airspace conditions are shown in the figure below.

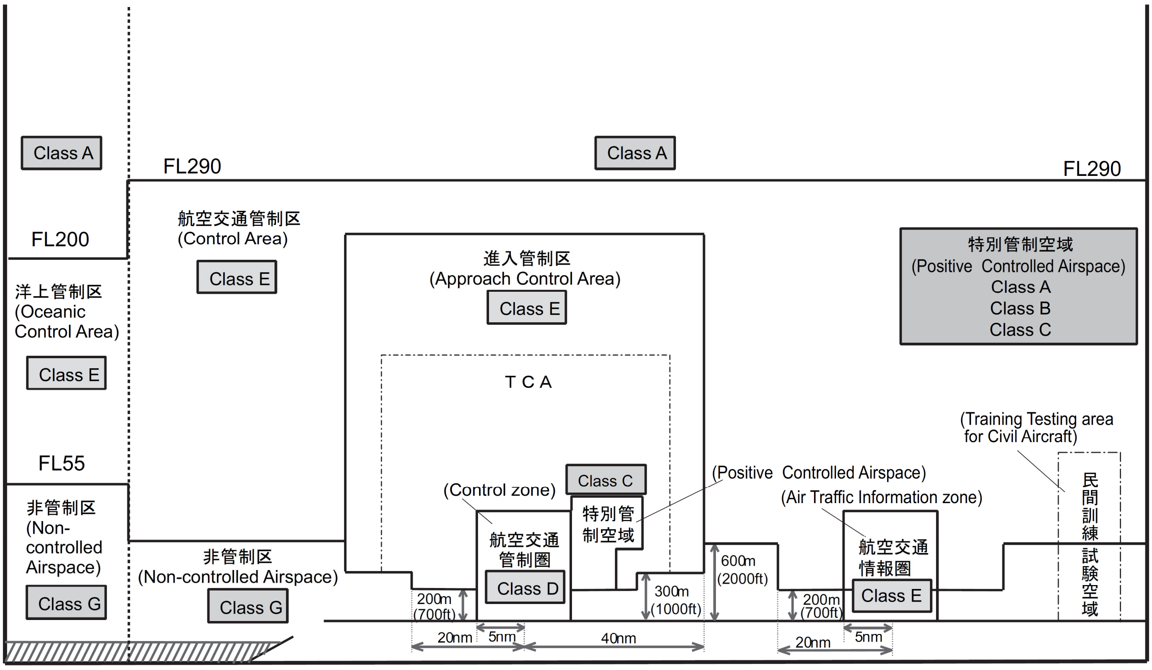


Figure 2-1 Airspace Conditions (extracted from AIP)

2.5.2 AAM use of Low-level airspace

This section describes how both UAM and RAM will operate in airspace.

UAM will operate in low-level airspace mainly inside the urban environment. Drones are basically required to fly less than 500 ft (150m) above ground level. UAM, on the other hand, are required under Article 81 of the Civil Aeronautics Act to fly at an altitude at or above the minimum safety altitude specified by ministerial ordinance, except when taking off or landing. Therefore, the airspace in which drones and UAM cruise is considered to be separated to a certain degree. However, there are cases where drones fly at or above 500 ft (150 m) with permission, and UAM flights for search and rescue to which Article 81-2 of the Civil Aeronautics Act applies and UAM flights based on permission under the proviso of Article 81 of the Civil Aeronautics Act may fly at altitudes below the minimum safety altitude. Also, UAM aircraft will operate in the same airspace as drones around aerodromes and vertiport locations. In such cases, it would be necessary to maintain safety intervals between the UAM aircraft and the drones.

When drones are flown in the airspace around airports, etc., permission must be obtained in advance pursuant to Article 132-85 of the Civil Aeronautics Act. However, it should be noted that until standards for the design of vertiports are established and a vertiport with permission is constructed, this provision on drone flights will not be applied.

Depending on the flight path and destination, UAM aircraft may need to transit through airspace that is both controlled and uncontrolled.

In the future, there will be more variety in the types of aircraft, operators and missions in the low-level airspace, including a mix of piloted and autonomous aircraft, etc. No single category of operators will have exclusive use of airspace, and it is envisioned that all operations will need to be integrated.

Considering that UAM operations will expand significantly due to urban traffic, etc., and the remote control or automated/autonomous operations are envisioned, etc., only the current safety measures with VFR will eventually reach its limits. Therefore, in order to respond to the increasing scale and upgrading operation configuration of UAM, a new concept of airspace and traffic management is needed to ensure safe and smooth air traffic by coordinating operations in certain airspace from the planning phase. The airspace in which new traffic management services (see UATM services in the next section) will be provided based on the expected UAM traffic conditions is defined as "UATM Service Area (UASA)". UASA may include both controlled and uncontrolled airspace. The UASA is determined by ANSP on a flexible basis, based on the density and frequency of UAM operations and surrounding traffic conditions, and is not limited to the urban area.

Long-range RAM operations are expected to fly at higher altitudes than UAM operations. Due to the operational characteristics and scale of operations, it is expected that existing airspace and traffic management concepts are used for RAM operations for part or all of their flight.

2.5.3 Air Traffic Management

Existing aircraft flight has been increasing in sophistication and refinement in response to the need for segregation of airspace and appropriate separation distances between aircraft due to the increase in number of aircraft, and the subsequent increase in the number of users and diversification of operations.

Initially, AAM aircraft are expected to operate within the requirements of the current ATM operating environment in accordance with existing procedures and/or concessions. As the AAM industry matures, various aircraft with varying levels of automation/autonomy (including piloted, partially automated and fully autonomous operations) are expected to operate within the low-level airspace. Increased density of operations, development of automation/autonomy, and the diversity of airspace users in the UASA are expected to require upgrading of the current ATM system.

New "Urban Air Traffic Management (UATM)" systems and services will be needed to support the operation of AAM aircraft in the UASA.

UATM services will support AAM aircraft operators in meeting AAM operational requirements that enable safe, efficient, and secure use of the UASA [3]. It may also provide value-added services to AAM aircraft operators. These services will optimize operations of diverse airspace users in the UASA including non-AAM aircraft and drones, and a framework will be established to provide various types of operational data to appropriate stakeholders. Also, UATM services will be provided with various supporting data including, but not limited to, terrain, obstacle, aerodrome availability, and weather. [3]

UATM services will support AAM operations and the goal is to maximize the performances of UASA. It requires balancing the individual items (e.g., flight efficiency as well as access and equity) while safety must, without exception, always meet acceptable levels as required under regulation. If traffic density is low in the initial AAM operations, they are expected to rely on current ATM services. UATM services will be implemented where benefits can be achieved from the standpoint of maximizing performance.

Integration of ATM, UTM, and UATM

Traffic management systems for AAM aircraft, drones and traditional aircraft will need to interact with one another, or be integrated, to support deconfliction, shared situation awareness and collaborative decision making. As traffic density increases further and greater levels of aircraft autonomy are implemented, this is likely to bring about the need for highly integrated and unified airspace management across all traffic management systems. A common three-dimensional coordinate system of latitude, longitude, and altitude could be an effective means of achieving this.

It will be important to define a framework for the integration and information management between ATM, UATM and UTM services. A common information exchange system will need to be used to share information between ATM, UATM and UTM systems.

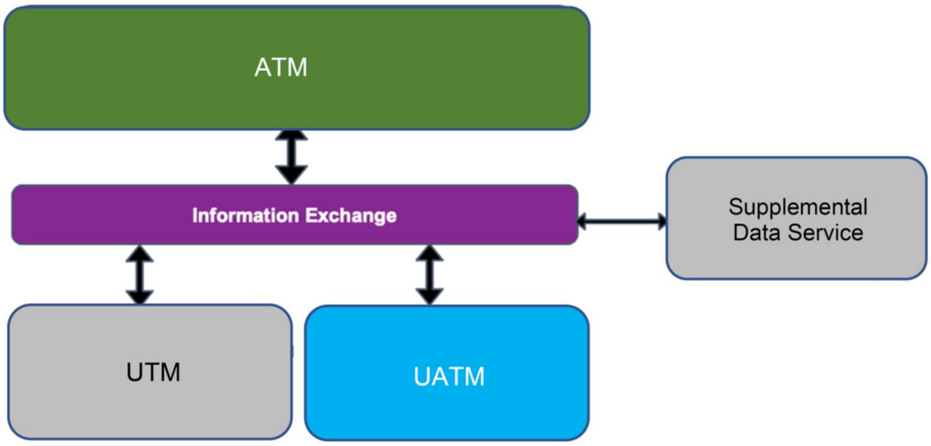


Figure 2-2 UATM, ATM and UTM Interfaces

2.6 Roles & Responsibilities

The roles and responsibilities of key stakeholders are listed below. Depending on the use case of the AAM, other stakeholders may have important roles. (e.g., local firefighting organizations)

2.6.1 AAM Aircraft Maker

AAM aircraft makers are responsible for designing and manufacturing AAM aircraft that meet safety and environmental requirements. They will have to obtain type certification and ensure the continued airworthiness of their respective AAM aircraft.

2.6.2 AAM Aircraft Operator

AAM Operations Management [3][4][5]

AAM aircraft operators manage their respective AAM aircraft operations. They are responsible for selecting the aircraft and pilot for incoming ride requests. In coordination with the pilot, the AAM aircraft operator submits a flight plan.

AAM aircraft operators conduct operations as scheduled service or on-demand service. Also, the AAM aircraft operator holds the operating certificate and is responsible for operational management. In addition, the AAM aircraft operator is responsible for meeting regulatory requirements and certification, planning flights, and sharing flight plan and current position information of its aircraft in the UASA. It is also responsible for pilot training and maintenance regime of the aircraft as well as passenger security screening and boarding procedure. (A study is underway to review the entity that conduct security screening, including existing aircraft.)

Pilot-in-Command (PIC) [4]

The PIC is a person who holds "final authority and responsibility for the operation and safety of the flight" of an AAM aircraft. This individual may be onboard or remotely operating the AAM aircraft.

A PIC who is not onboard while operating the aircraft is a remote PIC (RPIC). The PIC must be qualified for their role in the operation and undergo the required training and examination.

2.6.3 Vertiport Operator [5]

A vertiport operator, in consultation with regulators, defines what services their vertiport provides and to whom those services are provided. Vertiport operators are responsible for ground operations at the vertiport. They are also responsible for overseeing ground safety, security such as entry/exit control and charging or refuelling, although these responsibilities could sit with AAM aircraft operators or other third parties. The vertiport operator provides information regarding the operational status of their vertiport, including the availability of FATOs, stands (where applicable), personnel and charging facilities.

2.6.4 Maintenance and Ground Services Provider [4]

Maintenance and Ground services for AAM aircraft, including recharging, aircraft inspection/maintenance, aircraft servicing (food/beverage), deicing, passenger guidance and safety, security screening, and other applicable services will be similar to those at today's commercial airports and Fixed Base Operators (FBOs, Operator of flight support services). These services will be provided by suitably qualified and trained personnel who will be employed by vertiport operators, AAM aircraft operators, or third parties contracted by either the vertiport operators or AAM aircraft operators, but the AAM aircraft operators are responsible for the aircraft maintenance regime and passenger security screening. (A study is underway to review the entity that conduct security screening, including existing aircraft.) Also, personnel who will be handling the re-charging of the eVTOL should receive the necessary training.

2.6.5 Japan Civil Aviation Bureau (JCAB)

The JCAB serves as both the regulator and the ANSP, although there is a clear distinction between the two roles.

Regulator

The regulator is responsible for certification of all safety-related elements including the aircraft, aircraft crew and vertiport. The regulator is the authority over aircraft operations in all airspace, and the regulatory and oversight authority for civil operations. The regulator maintains an operating environment that ensures airspace users have access to the resources needed to meet specific operational objectives and that shared use of the airspace can be achieved safely and equitably.

The regulator develops or modifies regulations to support operations of AAM aircraft. The regulator may also provide guidelines to ensure that the regulator authority is maintained.

ANSP

The ANSP coordinates aircraft movement through controlled airspace, preventing collisions and ensuring efficient air traffic flow. Depending on the specific mandate, an ANSP provides one or more of the following services to airspace users:

－ ATM services

－ Aeronautical Information Management (AIM)

－ Communication, Navigation and Surveillance (CNS)

－ Meteorological (MET) services for air navigation

－ Search and Rescue (SAR) services

In some States, the ANSP will accommodate AAM operations through the provision of ATM and/or other services. Also, the roles and responsibilities of the traffic management for the AAM environment (UATM) will be executed by the ANSP or delegated to an organisation or organisations. The decision to centralise or decentralise services will vary between countries and determined by each country's airspace conditions and legal framework. In Japan, UATM services are planned to be provided by ANSP. However, while AAM aircraft operations require the same level of safety as operations in a conventional ATM environment, it will continue to be investigated how to specifically ensure a high level of safety, given that in the future AAM aircraft with various speeds and flight characteristics are expected to operate at unprecedentedly high frequencies and densities. (Outside of UASAs, existing ATM services and other services will be provided.)

2.6.6 UAS Service Suppler (USS) [3][5]

USSs are entities that support drone operations under the UTM system. AAM operations are expected in the low-level airspace where drones operate. Some services that are provided by USSs will interact with UATM services as follows:

1. Enable UTM operations to use UATM services
2. Support AAM off-nominal operations as needed

Also, UATM service providers need to exchange information with a USS, which are key roles in UTM.

2.6.7 Supplemental Data Service Provider (SDSP) [3][4]

AAM aircraft operators and UATM services can use SDSPs to access supporting data including, but not limited to, terrain, obstacle, aerodrome availability, and specialized weather. SDSPs may be accessed via the UATM services or directly by AAM aircraft operators. Multiple service providers may provide similar information and be selected at the discretion of the user. The services supplied by an SDSP may be raw data, value added data, one or a suite of decision support tools.

2.6.8 Other Regulators [4][5]

Given the impact of AAM on noise in the urban environment, it will be important to ensure that the roles with respect to aircraft noise management are clearly defined.

Land planning will have important roles with respect to vertiports. Local governments have a greater role in AAM because AAM operations occur largely in cities near local communities and urban areas. Regulations related to urban planning, noise, infrastructure, etc. can impact selection of the locations of vertiports and the number and routes of AAM flights.

Regulators / Authorities which govern other related laws and regulations such as environmental assessment, electric power grid, telecommunications need to be considered.

2.7 AMM Operation Flow

2.7.1 Typical AAM Passenger and Aircraft Journey

Typical AAM flight flows are described in APPENDIX 3, focusing on (1) passengers and (2) AAM aircraft. The purpose of these is to highlight how stakeholders will interact with each other, to show their operational roles and to identify the resources required for AAM operation.

3 Key Challenges for Advanced Air Mobility

To ensure that concepts for AAM are effective in the future, it is important to identify the key challenges associated with the introduction and growth of AAM operations. This chapter describes key challenges and possible solutions in the areas of social acceptance, aircraft and operations, traffic management in low-level airspace and urban integration. Many of the challenges need to be addressed by the initial phase (Phase 1) of the implementation of AAM operations, and it is important to begin working on them at an early stage. How these challenges need to be addressed in each phase is described in the next chapter, " Phases of Advanced Air Mobility Introduction."

For AAM operations to develop as the next generation of new air mobility, it is necessary to establish a profitable and sustainable market for the entire ecosystem, including the airframe, ground infrastructure, and traffic management. In order to realize commercial operations, it is also essential to develop the surrounding environment, such as insurance and coordination with other transportation modes. Responses to the challenges described below must take sustainability into consideration, including the introduction of new billing services.

3.1 Social Acceptance [4, 7]

Social acceptability is one of the most important elements both before and after the introduction of AAM, and should be considered both for the introduction and predicted future growth.

Social acceptance is a prerequisite for establishing a profitable and sustainable AAM market. The business case for viable AAM operations can include a need to scale operations. Without an ability to scale in the future, the cost of establishing operations may be too high.

The most important factors of concern to society are noise and safety, and other important factors include privacy, security, and environmental impact. [7] Various other concerns must also be addressed, such as fare adequacy, unemployment concerns, and, in the future, the reliability of remotely piloted and autonomous flight. On the basis of safety approved by the authorities, various factors must be balanced, including public interest, environmental and community considerations, and urban development such as urban planning.

To address, achieve, and maintain these factors of social acceptability, effective efforts among the AAM industry, regulators and other authorities, and the community must begin early and continue throughout the introduction and growth of AAM.

3.1.1 Safety & Security

Like other parts of aviation, effective risk management, assurance and promotion actions are required to achieve both safety and security. In the following, the measures that should be taken in the future to gain the trust of society are described. During operations, entire system monitoring for AAM is required to ensure contingency management.

Safety
For AAM, safety relates to both the occupants of an aircraft as well as people on the ground. The primacy of safety in aviation will always remain.

Public perception of safety is not always the same as a statistical level of safety and can be influenced by other factors such as the novelty of technology.

Developing public confidence that AAM is acceptably safe and capable of being a trusted mode of transportation will take effort and time by both private industry and government organisations. Through effective and transparent oversight and regulation, regulators play an important role in establishing a strong foundation for social acceptance.

Successful, thorough verification, validation and pilot programs along with the successful gradual deployment of AAM aircraft in low density operations that occur through Phase 1 will enable the society to gain greater confidence in the safety of AAM.

Having a collaborative process among regulators, aircraft manufacturers, AAM operators, other stakeholders and the community to ensure safety objectives and requirements remain appropriate through introduction, changes and growth of AAM operations will support the development of an AAM safety culture. Early, proactive consideration of safety will contribute to establishing public confidence in AAM. It will be necessary to sustain it as operations grow.

Security
Similar to safety, it is important to demonstrate an acceptable level of security. Measures such as those described in the next section, " Aircraft & Operations," will contribute to the safe operation of AAMs and help to establishing public trust.

3.1.2 Noise & Visual Impact

Technologies, operational techniques and community engagement practices have evolved in aviation to address community concerns, including noise. Communities may have concerns about the visual impacts of AAM operations as well as noise. Although noise is expected to be reduced compared to conventional aircraft when the same measurements are made as for conventional aircraft, it may cause problem that were not present with conventional aircraft because the operating environment is closer and the rotors may generate high-frequency sounds.

It will be important to ensure that there are effective national and local processes to engage and consult communities, consider and, where appropriate, address concerns associated with the implementation, operation and growth of AAM. Continued advancements in technology, operational procedures, and community engagement techniques will more effectively balance local community concerns with broader societal benefits of AAM (e.g., noise abatement.)

Means to mitigate noise and visual impacts can include urban land planning and operational techniques (flight routes, operational procedures, operating restrictions, etc.) as well as lower noise aircraft technology.

3.1.3 Privacy

Similarly to noise management, mitigating privacy concerns related to AAM (e.g., photographing people and property on the ground at low altitude airspace) occurs by obtaining sufficient understanding from community and, where appropriate, using privacy policies for AAM aircraft. Unlike privacy policies and/or guidelines developed for drones, it is not possible to take measures such as not pointing a camera at a target, so when flying at a lower altitude than existing aircraft, it is considered necessary to take measures such as identifying in advance facilities that would be affected if photographed from above and taking flight routes into consideration.

3.1.4 Environmental Sustainability

While sufficient consideration must be given to environmental impacts, potential measures to minimise impact could be the establishment of wildlife protection areas and the implementation of bird avoidance systems. Wildlife protection areas may lead to requirements to reroute AAM aircraft along certain paths.

Another concern relates to the environmental and climate impacts of the manufacture and production of AAM aircraft and their batteries. These concerns could be mitigated through the use of renewable energy, recycling, etc.

3.2 Aircraft & Operations

AAM aircraft type certification standards will need to consider diverse designs, and operational safety standards will need to be amended to take into account that AAM aircraft are powered by electric motors. New licensing requirements for pilots and standardisation of battery systems and maintenance processes may also be needed. Furthermore, efforts to assure and manage safety will need to consider how risks will be identified and mitigated as AAM aircraft evolve from operations with a pilot on board, toward autonomous operations. In Japan, the related regulations are being revised in order to start operation in 2025.

3.2.1 Type certification

AAM aircraft will require criteria and means of conformance demonstration in new technical areas such as VTOL/low altitude flight, electrification and no pilot on board, in comparison to traditional aircraft.

It will be necessary to establish airworthiness standards for the safe operation taking the diversity in design and operation of AAM aircraft into consideration. Where possible, approaches to type certification should be internationally harmonised.

3.2.2 Operations

For AAM operations, it will be necessary to set standards and limits from various perspectives such as safety, environmental impact, noise, etc, because their characteristics are different from those of existing aircraft.

In later phases, new flight rules which relate to the advanced technology, performance and piloting capabilities of AAM aircraft and their operations will be needed. It is expected that new flight rules will be internationally harmonised.

Pilot Training

Pilot requirements for AAM aircraft operations may vary from existing airplane or helicopter pilot requirements. Given the potential scale of the industry, there may be challenges related to the increased demand for pilots. A training method/testing approach for the acquisition of knowledge and skills and licensing framework will be needed.

Remote piloting & autonomy

Given the development approach for AAM, it is expected that there will be a desire to introduce remote piloting quicky. It will be necessary to define how the pilot role varies between an onboard pilot and remotely piloted operations.

Definition of roles and responsibilities will need to include clarification of who is in charge during operations. This definition will include a new concept for passenger carrying operation by a Remote Pilot-in-Command (RPIC). A training and licensing framework for remotely piloted AAM operations will be needed.

Requirements will need to be defined for the environment and systems required for remote piloting to ensure safe operation. Like an onboard pilot, an RPIC will fly adhering to the operational rules of the airspace in which the AAM aircraft is flying, avoiding other aircraft, obstructions, etc., and evaluating airspace constraints, weather and other surrounding environments. To achieve remotely piloted and autonomous flight of AAM aircraft, new requirements may arise for methods and technologies of existing Detect and Avoid (DAA) and communication with traffic control.

Security

Various security measures will need to be taken to ensure safe operations.

Cyber Security : Cyber security measures should prevent the hacking (or other malicious actions) of AAM communications or information to avoid the malicious use or control of AAM. Cyber security measures should be considered and implemented where appropriate, assuming all types of attacks including replay attacks, in addition to communication encryption.

Physical Security : Security screening of passengers and/or AAM workers could reduce the risk of malicious passenger or worker actions relating to AAM. Some vertiports will have limited space or infrastructure and therefore, security practices may need to take these limitations into account. Measures need to include scanning of luggage and passengers, as well as limiting the carriage of certain objects.

3.2.3 MRO, Services, Charging / Refuelling, Hanger and Overnight Parking Area

Facilities for Maintenance, Repair, and Overhaul (MRO) and/or service will need to have the electrical facility to recharge AAM aircraft batteries. In addition, the introduction of hydrogen fuel cell-powered aircraft may require the use and storage of hydrogen to refuel AAM aircraft.

Standardization of battery recharging equipment for AAM aircraft equipped with rechargeable batteries will be important for numerous reasons, including:

- Simplify maintenance and ground operations,
- Optimize the efficiency of aircraft recharging procedures,
- Minimise the cost of battery recharging equipment and infrastructure,
- Minimise training time for ground crew and mechanics, and
- Minimise fire risks by simplifying the battery infrastructure required.

To maintain the quality of AAM aircraft, mechanics who intend to perform legal confirmations after maintenance and/or alteration will need to obtain a license. Its requirements will be needed to define the competencies of mechanics. In addition, a training method/testing approach for the acquisition of knowledge and skills necessary for maintenance of AAM aircraft, and licensing framework will be needed. The legal confirmation by a mechanic may be achieved by legal confirmation by an approved maintenance organization.

In urban areas, securing hangars and overnight parking areas may also be a challenge.

3.2.4 Safety Management & Assurance

As with traditional aviation, it will be important for AAM to define appropriate safety management practices and for AAM operators to implement effective safety management systems.

To ensure a good safety culture is established in the AAM operating circumstances, it will be beneficial to establish a framework where safety information can be shared and lessons learnt. A good AAM safety culture will require sharing of information about safety occurrences by industry participants. It is important to create a system for sharing safety information among stakeholders. Sharing of safety information should commence as early as possible.

3.3 Traffic Management in Low-Level Airspace [5]

In the low-level airspace, AAM aircraft as well as new on ground infrastructure (vertiports) will be introduced. Taking into account the performance of AAM aircraft and the scale of operations, it is expected that the method of operation will be different from the current one, and it is also expected that aircraft can be operated in IMC, and eventually, traffic management will be required for aircraft flying autonomously.

The scale of AAM operations close to the community will be an important consideration. In addition to piloted, remotely piloted and fully autonomous AAM aircraft, existing aircraft and drones should be able to operate in the same low-level airspace. A safe rule of operation must be established that allows all of these users to coexist while maximizing performance in the airspace.

Traffic management in low-level airspace may become more complex due to factors such as the variety in aircraft, the need to support on-demand operations, and increasing obstacles such as buildings, and the coordination of ATM, UTM, and UATM will be critical to meeting these challenges in the future.

An important aspect of coordination between ATM, UTM, and UATM is that the information shared between such systems will need to be at a level of integrity which is appropriate for how it will be used to manage safety risks. For example, data received from UTM and used in decision making within UATM or ATM will need to be assured to the level appropriate for the related safety risks. Similarly, data from SDSPs will need to be assured to a level appropriate to mitigate the safety risks for which it is intended to be used.

Data assurance will need to occur across a range of ATM, UATM, UTM and SDSP. There must be a clear understanding of how the data will be used and the safety risks it can impact. Utilisation of data must consider the source and integrity of the data.

3.3.1 Airspace & Procedures Design

Vertiport Airspace
Around a vertiport, airspace will need to be structured to enable aircraft to transition between departure/arrival and cruise phases of flight. Entry and exit points to/from vertiport airspace, arrival departure routes, and missed approach courses will be needed. The design of the obstacle limitation surfaces around vertiports will need to include consideration of obstacles and protection of airspace.

Similar to aerodromes and some heliports, busy vertiports may require proactive traffic management to ensure the capacity of the airspace and landing infrastructure is maximised. Vertiport airspace will be flexibly activated and deactivated as needed.

UAM Routes & UAM Corridors [3][5]
UAM routes and UAM corridors provide means to structure airspace and mitigate the impacts of increased AAM flights volumes. UAM routes are established to increase the predictability of UAM aircraft locations, thereby improve situational awareness of other low-level airspace

users. UAM corridors are established to allow for high-density UAM operations, especially when UAM operations are particularly high-dense and airspace capacity needs to be increased. The establishment of UAM routes and UAM corridors is expected to be based on the consideration of the frequency of UAM flights. It should take into account not only the frequency of UAM flights but also the traffic conditions in the surrounding area.

UAM routes are established to connect airports/vertiports. As a concept they are similar in nature to existing paths used by helicopter or VFR routes and provide routes connected to vertiport airspace entry and exit points, but it may be set as part of a path. In combination with position reporting points, UAM routes have benefits for the pilot and Air Traffic Control through improved awareness of AAM aircraft location. Route design can reduce on ground safety risk and noise impact. Setting UAM route does not necessarily require significant regulatory change compared to UAM corridors.

To enable access and equity, UAM routes can be used by aircraft other than UAM. However, depending on the location of routes, their use may require certain standards. A set of routes in an urban environment will form a network of routes with multiple points of interconnection between routes and to vertiports/airports. Key advantages of using UAM routes is the early adoption and the ability for them to be used with current other types of routes and airspace users.

The UAM corridor is a dedicated airspace which connects airports/vertiports. Aircraft use them complying with specific rules, procedures, and performance requirements. Like UAM routes, it may be set as part of a path. In the case that UAM corridors connecting two points increase, the shape may be changed based on airspace conditions. This type of airspace makes it mandatory to follow UATM services, and could be used where specific performance requirements are required to enable increased capacity of airspace. For example, UAM corridors may be advantageous for paths near airports which may have limited airspace volumes and require high utilisation. Where used with new (currently undefined) flight rules, UAM corridors have the potential to expand the weather conditions under which flights can be conducted.

UAM corridors, UAM routes and vertiport airspace may be used to support both strategic and tactical deconfliction of AAM aircraft through means such as public notification by aeronautical information. To operate in UAM corridors, operators must meet appropriate equipment requirements and performance requirements, and follow specific procedures. UAM corridors restrict access to airspace for airspace users who do not meet applicable requirements. The ability to create UAM corridor networks to support the location of where AAM aircraft want to operate may be challenging due to a need to enable fairness across all airspace users. Introducing UAM corridors would require new regulation and procedures to ensure effective implementation and awareness of the airspace by all airspace users. The use of UAM corridors should be limited to situations where the benefits are required.

3.3.2 UATM Services [5]

UATM's set of services will include the followings.

- Information Exchange/Sharing
- Airspace Management
- Conflict Management
- Flight Plan Confirmation/Authorization
- Conformance Monitoring & Coordination

Not all services will be necessarily required during the initial phase of supporting AAM operations. These services will need to be introduced progressively and mature as the scale of AAM operations grows and technology improves. The maturity level of these services may vary in each UASA depending on their utilization.
It is envisioned that the scope of aircraft and airspaces to which the UATM service will be provided will be expanded depending on the scale of operations, and that all aircraft in the UASA will eventually receive these services with respect to the aircraft to which it applies.

Information Exchange/Sharing
To support the safe and efficient operation of AAM aircraft, the Information Exchange service will initially provide with a voice communication service by ANSP, and will be expanded in phases according to the maturity of AAM operations, progress in technological development, and the actual status of operations and congestion in the airspace. Specifically, it is envisioned that approved data will be exchanged among ANSPs and other concerned parties via an information sharing infrastructure such as System Wide Information Management (SWIM), paying attention to information management and security. This information will include flight data, restrictions, air route information, active special active airspace (SAA), etc. In the future, timely and accurate data exchange among low-altitude airspace users including ANSPs, will ensure shared situational awareness for all low-altitude airspace users.

Airspace Management
Airspace Management will maximise the use of low-level airspace as environmental and operational needs shift. The service also aims to be responsive to traffic management needs during nominal and off-nominal scenarios. Consideration will be given to introducing dynamic airspace management as the scale of operations expands. Airspace and route/corridor availability for AAM operations will vary for a number of reasons. Furthermore, changes to airspace availability (e.g., Priority for rescue and relief operations in the event of an emergency or disaster) will be variously predictable and unpredictable.
Conflict Management and Flight Plan Confirmation/Authorization services will need to be based upon known airspace and route/corridor availability at the time of flight planning. Following changes in airspace and/or route/corridor availability, existing authorisations, including those already in flight, must be reviewed to determine how the changes affect the flight plans and whether the existing flight authorisations need to be cancelled or amended.

Conflict Management
Conflict Management will ensure that demand for AAM is met to the greatest extent practicable in the context of the limited resources in the airspace and vertiports. To maximise the capacity of vertiports, Conflict Management will be required to manage arrival/departure times and slots.
If capacity changes at a vertiport, previously planned flights must be reviewed to ensure that vertiport capacity is not exceeded.

Flight Plan Confirmation/Authorisation

Flight Plan Confirmation/Authorisation will be in response to a flight plan for commencing operations of AAM aircraft. Under the current ATM service, flight plans for VFR operations are accepted after confirming that the items specified by the authorities are clear, but as the scale of operations increase, it will be required to authorize flight plans submitted by operators or pilots after reviewing it and making necessary adjustment. The flight planning including Conflict Management must align with the strategic objectives of the overarching UATM system.

Conformance Monitoring & Coordination

Conformance Monitoring aims to provide timely information and present responses for non-conforming aircraft affecting the operation of UATM services and for other AAM aircraft affected by such non-conforming aircraft.

Conformance monitoring is to ensure that AAM aircraft within the UASA are flying in compliance with the confirmed/authorized flight plan, including monitoring and supporting such operations in the event of off-nominal operations described in APPENDIX 3. Accountability for conformance with the flight plan will lie with pilots or AAM aircraft operators.

Initially, the service will primarily provide for the coordination of changes to the flight plan over time.

In order to achieve a higher level of AAM operations, the parties concerned will continue to discuss the specific services required to avoid conflicts in real time, including spatial and temporal deviations from the planned flight path, altitude, and estimated time of passage. In addition, the performance and reliability of the CNS, including the navigation performance required for each airspace and route, and the means of communication with noncompliant aircraft, will also be studied.

Conformance monitoring will not only function as a means to ensure the safety of both noncompliant aircraft and other AAM aircraft affected by noncompliance and to mitigate risks, but will also contribute to the future development of high-density operations and automated/autonomous operations through the understanding of AAM operational performance.

3.4 Urban Integration

Key challenges in urban integration of vertiports are described below.

3.4.1 Land Planning

In developing a vertiport, it is assumed that coordination with the authority and local community regarding land planning in each area will be required. In addition, it is also assumed that the vertiport operator will be required to coordinate with JCAB on the use of airspace around the vertiport. Strategic site selection for the vertiport is important considering various factors such as social acceptability, community impact, airspace design, economic/demand perspective, integration with existing transportation modes, etc.

3.4.2 Vertiport Design Requirements and Permissions

Existing design requirements for aerodromes and heliports provide a foundation on which to build specific vertiport design requirements. However, since aerodrome design requirements based on ICAO SARPs and current heliport design requirements are not regulations for AAM aircraft operations, it is necessary to set sizing requirements, obstacle limitation surfaces, etc. In addition, since some of these vertiports are proposed to be built on top of buildings, this provides additional design challenges.

Establishment of vertiports will be required to have permissions from the regulator in the future. In Japan, until standards for the development of vertiports are established, the Vertiport Design Guidelines is established that provide ideas and considerations regarding standards, obstacle limitation surfaces, etc. required for vertiport facilities. For actual take-off and landing, AAM operators need permission to take-off and land at locations other than airports, etc. To enable international harmonisation, Japanese vertiport Design Guidelines are aligned whenever possible with publications already being developed by other aviation regulators. In the future, JCAB will determine the minimum standards required at a vertiport, including management systems, operational procedures, physical characteristics, assessment and treatment of obstacles, visual aids, rescue and fire-fighting services (RFFS), etc.

It is expected that there will be a wide range of AAM aircraft types and capabilities. Vertiport design standards will need to be aircraft agnostic and be able to accommodate the full suite of configurations and capabilities Over time, the design guidelines/standards should be iterated where necessary to reduce unnecessary physical requirements and optimise the operating requirements using aircraft maker's performance data.

Several challenges exist in developing performance-based vertiport design standards:

- Lack of sufficient aircraft performance data to be shared;
- Lack of clarity how existing airport assets can safely accommodate AAM aircraft operations and
- Lack of ICAO SARPs for vertiport design

There will also be requirements and regulations set by other regulators such as local city authorities, agency for natural resources and energy, public utilities, emergency response agencies, other transport agencies on the design and operations of the vertiports, such as power requirements, environmental impact, emergency responses and road traffic impact. Continued inspections by the regulator are also expected to guarantee requisite level of safety are maintained.

Existing permission requirements for heliport provide a foundation on which to develop permission criteria for vertiports but there are additional matters to be considered to enable safe passenger transport flights for AAM. Requirements for battery fire suppression and associated rescue and fire-fighting services (RFFS), and the role of supporting traffic management technologies and services, for instance, are not included and will be a vital consideration for the siting and safe operation of a vertiport for electric VTOL.

Efforts by international standards organisations (SDOs) to develop guidance for vertiport operators and operations provide a useful foundation on which to build a vertiport permission regime.

3.4.3 Multi-modal Integration

There is currently a lack of planning guidance on vertiport infrastructure for local urban planning. AAM is a new form of urban transportation that will need careful planning and integration with existing form of transportation. The public and private sectors will need to work together to coordinate the integration of vertiports and their operations with existing urban transport means such as subways, bus, and private cars.

There will also be challenges in ensuring seamless passenger connection between existing, traditional ground transport and AAM since AAM passengers will be subject to security screening. Operational procedures would hence be required to seamlessly and safely integrate vertiport operations into the urban ground transport movement area.

4 Phases of Advanced Air Mobility Introduction

This chapter describes the phases of the incremental implementation of the AAM and the challenges to be addressed in each phase.

4.1 Phase 0

During Phase 0, trials and demonstrations will occur prior to commercial services. Test flights and proof of concept flights will require appropriate approval by JCAB following the safety standards of Civil Aeronautics Act. Operations will occur in a way to mitigate the associated safety risk. For example, operations may be conducted in segregated airspace away from populations on the ground. Trials and demonstrations will be conducted in accordance with the "Guidelines on the Application of the Civil Aeronautics Act to Test Flights, etc. of AAM."

In order to gain public confidence in the safety of AAM operations, it is important to conduct a series of flights with due consideration for safety risks from this stage.

4.1.1 Preparation for Phase 1

During Phase 0, some AAM aircraft will achieve type certification in accordance with the Japanese type certification process. It is also necessary to promote the training of pilots, mechanics, and other personnel involved in the operation, and to establish a framework for this purpose.

The design, planning and implementation of airspace, which are required for initial commercial operations, will commence in Phase 0. Analysis will be undertaken to understand the airspace capacity which can be enabled in Phase 1, prior to Phase 2.

Airspace and associated procedures developed in this phase to support Phase 1 will primarily be based upon existing airspace and ATM concept. Use of existing airspace and ATM concepts will ensure smooth initial implementation of AAM. For the introduction of more complex or new concepts, further sophistication should be sought in Phase 2 and beyond.

Design and construction of the vertiport will begin in accordance with the Vertiport Design Guidelines. Vertiport planning and approval frameworks will need to consider social acceptance and community engagement requirements, as well as integration with existing transportation modes.

Preparation for AAM operations will also need to consider appropriate social acceptance and community engagement at locations overflown by AAM aircraft. Procedures and route structure should consider community impact such as noise & visual Impact, privacy and environment, as well as the impact on other airspace users.

The future scale of operations beyond initial introduction should be included in community and airspace user considerations for vertiport locations and airspace usage.

Various security measures will be demonstrated and prepared in this phase. In the initial stage of Phase 1, physical security measures (security screening) are expected to be used primarily.

4.2 Phase 1

Phase 1 will see the initial introduction of commercial AAM operations in Japan. Preparation for Phase 2 will need to occur in Phase 1.

In Phase1, for passenger carrying AAM operations, initial operations are expected to occur in low density and be piloted under VFR, similar to existing aircraft operations.

Remotely piloted (no pilot on board) AAM operations is also envisioned for cargo transport, and appropriate safety standards need to be established to make this a reality.

In addition to a certified aircraft, AAM aircraft operators who perform air transport services are also required to obtain a business license and authorization and/or approval of documents for the associated operating procedures.

Initially, it is anticipated that existing airports and other existing rules such as off-site take-off/landing permits will be utilized, but relatively small-scale vertiport developments are also envisioned.

A new or amended existing ATM framework will need to be implemented to operate AAM aircraft in surrounding vertiport airspace and at airports and vertiports. Airspace and associated procedures used during this phase will need to be primarily based upon existing airspace and existing ATM framework.

The low density of the Phase 1 will allow for the initial introduction of UATM services, which will operate based on existing ATM concepts but will not require significant regulatory changes or technological innovation. Basic UATM services may be used in Phase 1 to enable vertiport network management as vertiport resource availability may be a constraint on the overall AAM system performance. The services will primarily be used for situation awareness and balancing demand and capacity at vertiports. UATM services are likely to be used by AAM aircraft and vertiport operators.

UATM services in Phase 1 may include:

- Information Exchange/Sharing (Providing information by voice in the vertiport airspace and the UAM route)
- Airspace Management (Implementation of vertiport airspace, UAM route, etc.)
- Conflict Management (Capacity management of congested ports)

- Confirmation of Flight Plan
- Conformance Monitoring & Coordination (Obtaining location information using ADS-B, providing information by voice, etc.)

It is expected that advanced UATM services such as dynamic airspace management will not be used until the start of Phase 2, when an information exchange/sharing system among UATM stakeholders, including ANSP, becomes available and all airspace users in the UASA will use services provided by this system.

During Phase 1 as new vertiports and routes are established/designed, further consideration of the impact on community and other airspace users will be required.

It will be important, by the end of Phase 1, to conduct research, development and trial of more advanced concepts of UATM, etc. and cyber security measures, to prepare for Phase 2 and beyond.

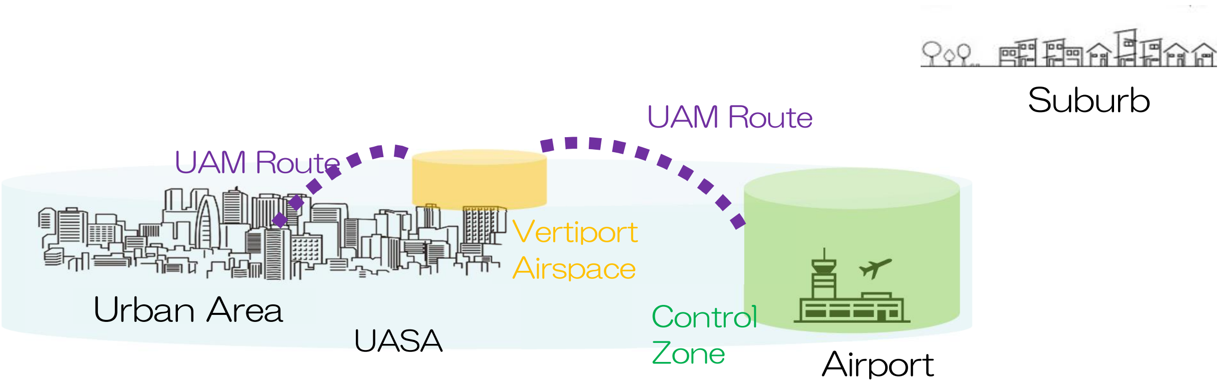


Figure 4-1 Phase 1

4.3 Phase 2

Phase 2 will see scaled Japanese AAM operations. In Phase 2, medium-to-high density, piloted operations are expected. In some urban environments, AAM operations will occur at a rate that is higher than traditional aircraft operations. AAM aircraft piloting may include remotely piloted operations of passenger carrying aircraft from the ground. Operations are expected in bad weather conditions.

Preparation for Phase 3 will need to occur in Phase 2, including significant research and development to enable the integration of autonomous operations.

A greater number, larger and more complex vertiports will be developed enabling higher capacity arrivals and departures. Design and operating requirements evolution maybe required to support more advanced vertiports, including in complex urban environments, e.g. on top of buildings.

Advanced traffic management systems and procedures will be required to support the scale and nature (e.g., remote piloting and IMC) of AAM operations. New airspace concepts and advanced UATM services will be implemented in Phase 2 where required. These new concepts and services may require new equipage and performance capabilities by participating aircraft. UAM routes or UAM corridors, as well as UASA may be used where appropriate.

UATM services in Phase 2 may include:

- Information Exchange/Sharing (Information provision and exchange through data)
- Airspace Management (Implementation of UAM corridors and dynamic airspace management are included)
- Conflict Management (Advanced coordination including capacity management of airspace and flow management)
- Flight Plan Authorisation
- Conformance Monitoring & Coordination (Real-time deconfliction will be also considered.)

In addition to AAM aircraft and vertiport operators, it is expected that other airspace users in the UASA will use UATM services in Phase 2 in a similar way to AAM aircraft.

An information exchange/sharing system between UATM stakeholders, including the ATM and traditional airspace users will be required.

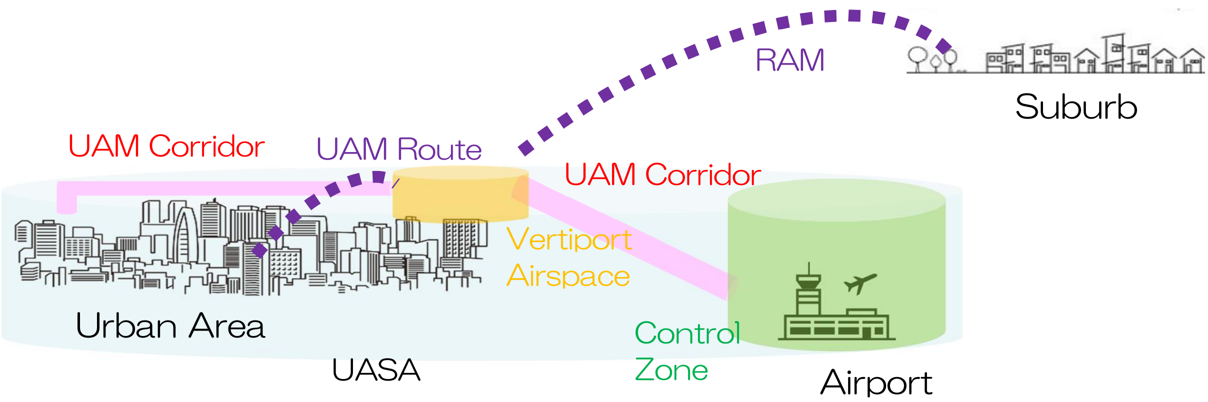


Figure 4-2 Phase 2

4.4 Phase 3

Phase 3 will see scaled Japanese AAM operations which include high-density operations. Operations in the UASA will include a mix of piloted and remotely piloted operations.

It is expected that, at some point, all airspace users in the UASA will use UATM services. UATM concepts may be expanded to other airspace outside of the UASA and integrated with ATM and UTM.

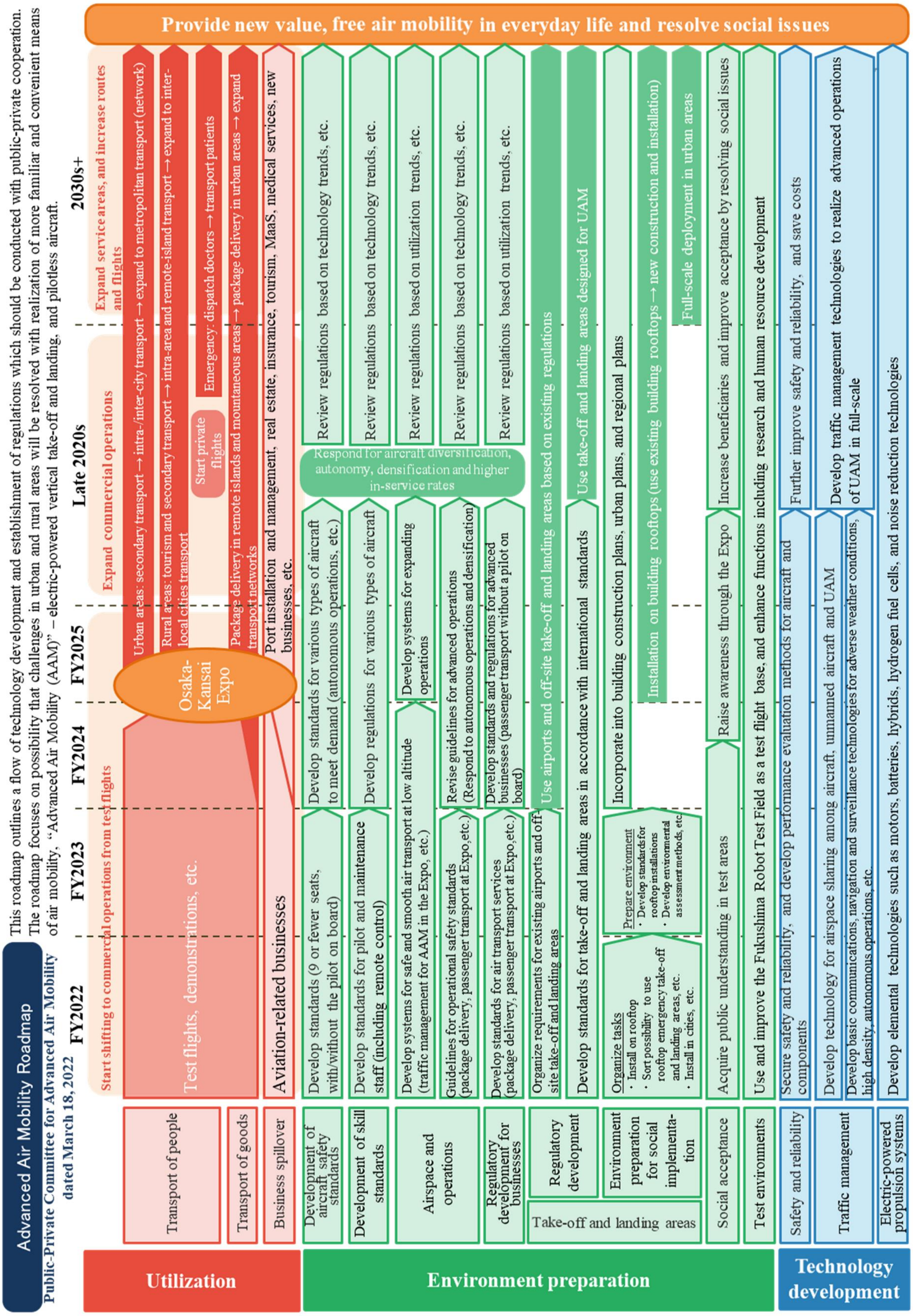
In addition, operations may become more sophisticated as autonomous operations commence.

5 Conclusions

Following discussions at the Officials' Meeting of the Public-Private Council for the Air Mobility Revolution, we have compiled the "Concept of Operations (ConOps) for Advanced Air Mobility," which outlines the overall ecosystem, including the main elements of the AAM (airframe, ground infrastructure and traffic management), as well as the phases of phased introduction.

However, the content described in this document is based on current knowledge and projections, and it is important to constantly evolve the content based on future technological advances, overseas trends, and feedback from stakeholders. Therefore, it is envisioned that discussions will continue at the Public-Private Council for the Air Mobility Revolution, and that updated versions will be issued.

APPENDIX 1 Roadmap for the Advanced Air Mobility



APPENDIX 2 AAM Use Cases

AAM Use Cases

Use Case Review Meeting

The use cases presented in ConOps are classified into five categories, and each of these will be presented for each of the introduction phases (phases indicated in ConOps "AAM Introduction Phases").

In order to promote social implementation of AAM, it is necessary to resolve the general challenges listed in ConOps "Key Challenges for AAM," but at the same time, there are also challenges that are tied to each individual use case and points to be considered for implementation. When implementation is promoted in each region in the future, it is also important to discuss challenges that will be commonly faced in a coordinated manner, so these will be described here also.

The use cases presented are only representative examples. Since social issues to be solved and future visions to be aimed for differ from area to area and municipality to municipality, it is necessary for local governments and business operators aiming to introduce AAM to cooperate in their studies. Furthermore, as the performance of AAM aircraft improves and the number of aircraft introduced increases in the future, the area of operation is expected to expand significantly. Therefore, the study should be conducted with stakeholders while taking a bird's-eye view of a wide area, and should be approached from a future perspective and viewpoint, such as whether it can be sustained as a viable business.

1 Intra-urban and inter-urban transfers

Taking advantage of the merits of AAM aircraft, which can travel in a straight line at high speed, they will be used as flying taxis for short-distance travel within cities and for medium- to long-distance travel between cities. In addition to short distances, for which taxis and other vehicles are used currently on a daily basis, new demand is expected to be generated for medium- to long-distance travel, for which it is less likely to use taxis or other vehicles.

In order to capture a large amount of travel demand and ensure business viability, it is necessary AAM needs to be "readily available at any time" ensuring that they are operated frequently and that fares are set at a level that meets the needs, etc. There are also needs for hardware approaches such as development of a large number of vertiports in easily accessible locations and smooth access to vertiports (e.g., quick access to vertiports on building rooftops, connection with other modes of transportation) and software approaches related to boarding AAM aircraft (e.g., introduction of a convenient reservation system, smooth security checks). In addition, a typical use case for intra-urban and inter-urban transfers would be as a means of airport access. As mentioned above, smooth access is required to capture a large amount of travel demand and ensure business viability, and the flow lines at airports between AAM aircraft and existing aircraft need to be shortened and facilitated. Furthermore, since airport users often carry large luggage, transportation of users' luggage may also need to be considered.

In addition, it is also necessary to consider the establishment of flight paths and procedures that allow AAM aircraft to take-off and land at any time, and to secure take-off and landing sites, while assuming that existing aircraft operations will not be affected.

In urban areas where buildings are densely built, there is expected to be a large demand for mobility, but it may also be difficult to secure a location for a vertiport. Based on the perspective of solving local social issues through AAM, efforts should be made in conjunction with local community development and local governments.

(Use cases for each phase)

AAM Introduction Phase	Use cases for each phase, Perspectives needed for realization
1	Vertiports will be established in stages, starting with routes where a certain travel demand is expected, and AAM aircraft operations will begin. For example, regional airports, city centers, and inter-city operations where vertiports can be secured. This will enable short time, high-speed travel between areas that are not connected by rail or highway networks, and new business trips and travel to areas that could not be reached by a day trip will be beginning to be realized. Since it is possible that awareness and social acceptance of AAM aircraft may not be high enough before or at the beginning of service, the government should be involved in building momentum for the utilization of AAM aircraft when setting the location of vertiports and operation routes.
2	Vertiports will be being developed, operating routes will be being expanded, and medium- to high-density operations will be beginning to be realized. In addition, flights in IMC will be beginning to be introduced and AAM aircraft will be entering service at a higher service rate, and "commonly and widely used flying taxis" will be beginning to become a reality.
3	Air traffic management through ATM, UTM, and UATM coordination will begin, resulting in high-density, high-frequency operations. A wide variety of air transportations such as hub-and-spoke and door-to-door will be realized in various parts of cities. Flights in IMC will enable operation even in bad weather conditions, such as low visibility, and will be increasingly popular as a means of transportation for users who demand speed, punctuality, and operational reliability.

2 Transportation in suburbs, remote islands and mountainous areas

For local residents and tourists visiting the area, for example, on remote islands, they will be used as a new means of transportation to supplement existing means of transportation (e.g., boats, helicopters, etc.). In mountainous areas, they will be used as a means of transportation in areas where it is difficult to move around due to differences in elevation and topography. In addition, in suburban areas, it is expected to be used as a means of transportation in areas where existing transportation systems, such as buses, are not introduced sufficiently.

In some remote islands, helicopter-based passenger transportation has already been introduced. For example, on routes where it is difficult to increase the number of flights, and where the demand for travel is not fully met, there may be a use case for introducing AAM aircraft in coexistence with existing helicopters, thereby contributing to an increase in the total number of flights. Also, by utilizing existing heliports and airport facilities, the cost of AAM infrastructure can be kept low.

In either case, it is assumed that there will be only a limited number of operational routes that can be expected to have high demand for transportation compared to urban areas or inter-cities, so it will be necessary to consider regional development and revitalization when introducing this service.

(Use cases for each phase)

AAM Introduction Phase	Use cases for each phase, Perspectives needed for realization
1	Operations will begin on routes where there is a certain degree of demand for transportation between locations. There may be opportunity to complement the existing public transportation, so it is desirable to construct vertiports at locations that also take these conditions into account. In addition, to increase the effectiveness of introduction of the AAM aircraft, the vertiport may be developed assuming usage for other purposes, such as tourism.
2	Flights will be beginning in IMC, making it possible to operate even in unfavorable weather conditions. In remote islands, for example, AAM could be used as an alternative means of transportation when boats are cancelled due to high waves, thereby contributing to the steady provision of local transportation. In addition, lower fares and an increase in the number of vertiports developed will have led to the establishment of new operating routes and increased flexibility of transportation in the region.
3	With the availability of flights in IMC and improvements of aircraft performance, the introduction of AAM aircraft in various parts of Japan, including high elevation mountainous areas and regions with snowfall, will be accelerated, and flexible transportation in suburban areas, remote islands, and mountainous areas will be a reality.

3 Tourism and entertainment

AAM aircraft will be utilized for excursion flights around tourist destinations and recreational facilities, as well as a means of transportation in tourist areas.

Japan has many tourist destinations that attract both domestic and international travelers, and there is high potential to create a new business model that combines ground-based sightseeing experiences with those viewed from the sky. In particular, the introduction of AAM is highly effective as a means of transportation to places that are difficult to view from the ground (e.g., beauty of a chain of islands, cliffs and canyons, cultural heritage sites with restricted access, ancient tombs, etc.), as well as to tourist spots that are difficult to reach by land. In addition, AAM aircraft can also be used to efficiently tour multiple sightseeing spots by taking advantage of their high-speed travel capabilities.

Also, it is desirable to combine not only a simple flight experience, but also experiences that touch on local history and culture, lodging and food experiences, etc., effectively, and to study how AAM should be used in cooperation with related administrative agencies, destination management organizations (DMOs), tourist facilities, etc., as well as to consider the entire process of tourism from entry to exit, including the development of vertiports at convenient locations and the provision of access to vertiports. At the same time, it is necessary to establish routes and tourism strategies that can attract high value-added travelers such as inbound tourists.

Furthermore, it can be expected to stimulate tourism demand in areas that are attractive tourist destinations but difficult to attract tourists due to lack of accessibility, and it may contribute to the revitalization of the entire area through the dispersion of tourists.

Moreover, theme parks and other entertainment facilities can be expected to offer special experiences such as viewing the facilities from the sky, and transportation services to and from the facilities and lodging.

In addition, in tourist destinations with outstanding natural scenery, environmental considerations such as local landscapes and ecosystems should also be kept in mind.

(Use cases for each phase)

AAM Introduction Phase	Use cases in each phase, Perspectives needed for realization
1	AAM will be introduced from areas with high existing tourism demand (circular use and travel within the sightseeing area). Since these areas are likely to become hubs for AAM aircraft, it is desirable to take into consideration the future expandability of the vertiport when developing the vertiport.
2	In areas where multiple routes can be set up for tourist transportation in an area, a hub and spoke for tourism movement will be being established with the vertiports developed in Phase 1 as the hub.
3	With the availability of flights in IMC and improvements of aircraft performance, the introduction of AAM aircraft in various parts of Japan, including high elevation mountainous areas and regions with snowfall, will be accelerated, and a new way of tourism will become a reality.

4 Emergency medical transport

The AAM aircraft will be used to transport doctors who provide emergency medical treatment to the scene. For example, it is anticipated that the AAM aircraft could be used to promptly transport a doctor to the scene of an accident, etc., requiring initial treatment that cannot be handled by paramedics (emergency medical technicians), and the patient who has received emergency treatment would be transferred for ambulance transport.

In addition to taking the role of a stand-by aircraft (to respond to overlapping emergency calls) at base hospitals of air ambulances (called “doctor helicopters” in Japan), it is expected to be deployed to base hospitals and emergency hospitals in rural areas that currently do not operate doctor helicopters. In addition to existing doctor helicopters and doctor cars, it could serve as a means of expanding pre-hospital first aid.

The AAM aircraft will depart primarily from base hospitals in the same way as a doctor helicopter. Due to the nature of the rapid response required, the takeoff/landing site should be as close to the scene as possible, and given the characteristics of the AAM aircraft, the possible takeoff/landing sites should be determined in advance and communicated to stakeholders and local residents.

It is also anticipated that the AAM aircraft will be used to transport doctors and patients between hospitals, to transport organs, and for house calls in areas where transportation is limited. It may also be used to transport patients in the same way as a doctor helicopter.

(Use cases for each phase)

AAM Introduction Phase	Use cases for each phase, Perspectives needed for realization
1	In some regions, AAM will be positioned as an element of the emergency medical care system, and demonstration tests, etc. will be conducted for its implementation.
2	AAM will be established as a means of transporting doctors and patients, and will play a complementary role to the doctor helicopter, helping to overcome the unavailability of dispatch due to overlapping emergency calls, etc. In addition, its implementation for various emergency medical transport will be promoted.
3	As aircraft prices become lower, implementation will be expanded to all regions of Japan. AAM will also be used to transport medical teams during disasters. In addition to flights in IMC and improved battery performance, as aircraft types become more diverse, AAM will be used in a more demand-oriented manner.

5 Cargo transport

Broadly speaking, there are possible use cases for ordinary and emergency situations.

During ordinary situations, AAM aircraft will be used to transport goods as a new means of logistics.

While faster than existing land transportation methods and capable of transporting more items at once than drones, it requires the development of takeoff and landing sites, etc. Therefore, rather than deliveries to individual residences, it could be used for transportation for high volume customers (companies, factories, etc.), between delivery bases, or between own factories or own facilities. It could also be used as a means of transportation to mountainous areas and remote islands.

In an emergency situation, the transportation of necessary goods in the event of a disaster can be considered. For example, it can be used to transport emergency materials and equipment necessary for restoration to areas where roads have been cut off by disasters, and it can also be an effective means of transporting food and other supplies to evacuated residents.

It is desirable to utilize them not only for emergency response, but also for cargo transportation and other use cases in ordinary situation.

(Use cases for each phase)

AAM Introduction Phase	Use cases for each phase, Perspectives needed for realization
1	Implementation will begin in remote islands and mountainous areas as a less expensive means of transportation compared to existing means of transportation. For example, remote-controlled transportation of goods to a mountain lodge or a steel tower inspection site is possible.
2	In addition to expanding implementation in remote islands and mountainous areas, transportation for high volume customers, between delivery bases, or between own factories or own facilities, in urban and intercity areas with pilot on board will be implemented.
3	By enabling automated / autonomous operations lower-cost cargo transport and implementation will be promoted.

APPENDIX 3 Typical AAM Passenger and Aircraft Journey

The steps of passenger and AAM aircraft reflect operations in a mature AAM environment with medium to high-density operations with a pilot on board (i.e., not autonomous operations). The journeys described are examples. Other additional or different functions and elements may be applicable in other scenarios.

(1) Example of AAM Passenger User Journey

- PREFLIGHT
  - **Book an AAM flight.** Passenger uses an app to book seats on an AAM flight and enter estimated weight of passengers and bags.
    - INTERACTIONS. AAM aircraft operator, Booking platform provider
    - TOOLS. App on mobile device, Desktop booking or in-person booking

  - **Travel to vertiport and check in.** Passenger takes transit or car to vertiport. On the way, they use an app from either the booking platform or AAM aircraft operator to check in for their flight.
    - INTERACTIONS. Ground transportation, Vertiport operator, AAM aircraft operator/Booking platform provider
    - TOOLS. App on mobile device or check-in Kiosk

  - **Weigh all bags and passengers.** Passenger uses a scale to weigh themselves and their bags at the vertiport to verify and update the weight estimated during check in. This information is sent to the AAM aircraft operator to ensure the AAM aircraft is correctly weighed and balanced. This process can be done prior to arrival of vertiport.
    - INTERACTIONS. AAM aircraft operator, Vertiport operator
    - TOOLS. Scale for weighing bags and passengers

  - **Receive safety briefing, undergo security screening and wait for flight.** The passenger views a short safety briefing on their mobile device, undergoes security screening, and waits for the boarding process to begin. A boarding call will be made and there will be a final verification of the passenger to ensure that the passenger boards the correct flight.
    - INTERACTIONS. AAM aircraft operator, Vertiport operator
    - TOOLS. App on mobile device, Waiting area/lounge

- BOARDING AND DEPARTURE
  - **Give bags to ground crew.** Passenger is assisted by ground crew in boarding process. Bags are given to the ground crew for loading.
    - INTERACTIONS. Ground crew
    - TOOLS. AAM aircraft

  - **Board AAM aircraft and follow safety instructions.** Passenger boards the AAM aircraft and puts on seat belts. Flight then takes off.
    - INTERACTIONS. Ground crew, Pilot

- TOOLS. AAM aircraft

- CRUISE
  - **Passenger relaxes during the flight.**
    - INTERACTIONS. --
    - TOOLS. --

- APPROACH AND LANDING
  - **Disembark flight.** AAM aircraft lands on a vertiport and ground taxis or is towed to a stand. Passenger disembarks aircraft at the stand and goes to passenger terminal.
    - INTERACTIONS. Ground crew
    - TOOLS. AAM aircraft

  - **Collect bags and exit vertiport.** Ground crew unloads bags. Passengers pick up bags at designated area and exit vertiport.
    - INTERACTIONS. AAM aircraft operator, Ground crew, Vertiport operator
    - TOOLS. --

(2) Example of AAM Aircraft journey

- PREFLIGHT
  - **Plan flight and coordinate the use of vertiports.** AAM aircraft operator plans flight based on demand, weather conditions and other factors, and share with UATM. AAM aircraft operator gains flight plan authorization, reserves vertiport slots, and gathers various information about operation.
    - INTERACTIONS. ANSP, AAM aircraft operator, Vertiport operator
    - TOOLS. UATM service

  - **Pre-flight inspect AAM aircraft and transmit data about aircraft status.** Ground crews inspect aircraft for flight readiness. AAM aircraft transmits data about its system health to AAM aircraft operator.
    - INTERACTIONS. Ground crew, AAM aircraft operator
    - TOOLS. Cloud platform

  - **Move from hangar to vertiport.** If the AAM aircraft cannot be stored at the vertiport overnight, AAM aircraft needs to be moved from hangar to vertiport / stand for the first flight of the day.
    - INTERACTIONS. Pilot, ANSP, Vertiport operator
    - TOOLS. AAM aircraft, UATM service

  - **Register flight plan information to the AAM aircraft.** AAM aircraft operator sends authorized flight plan to the pilot. Pilot accepts the flight authorization and registers the flight plan information to the avionics system on board.
    - INTERACTIONS. Pilot, AAM aircraft operator, ANSP
    - TOOLS. UATM service, AAM aircraft avionics

- BOARDING AND DEPARTURE
  - **Passengers board.** Ground crew ensures the aircraft is balanced and within weight limits. Passengers have checked in and begin to board. Ground crew loads bags into aircraft.
    - INTERACTIONS. Ground crew, Passengers
    - TOOLS. UATM service, Booking platform

  - **Turn on motors and depart.** Passengers complete boarding and ground crew closes doors. Pilot confirms readiness to depart, receives flight clearance, turns on motors to taxi (or be towed) and then departs vertiport.
    - INTERACTIONS. Pilot, ANSP, AAM aircraft operator, Ground crew
    - TOOLS. UATM service, Vertiport operator

  - **Transmit position and system health data of aircraft.** AAM aircraft continuously transmits its position and system health data to ANSP and AAM aircraft operator throughout the flight.
    - INTERACTIONS. Pilot, ANSP, AAM aircraft operator
    - TOOLS. AAM aircraft, UATM service,

- CRUISE
  - **Fly in accordance with flight plan and survey surroundings.** AAM aircraft fly in accordance with its flight plan and continuously surveys surroundings for aircraft status and potential conflicts.
    - INTERACTIONS. Other AAM aircraft
    - TOOLS. AAM aircraft

- APPROACH AND LANDING
  - **Descend, land and taxi to stand.** Pilot descends to vertiport, lands with confirmation by UATM service, and ground taxis (or be towed) to the stand.
    - INTERACTIONS. ANSP, Vertiport operator, Pilot
    - TOOLS. AAM aircraft

  - **Turn off motors.** At the stand, the pilot turns off the motors (or prior to towing from TLOF). When the rotors or towing stops, the doors open to let passengers disembark. Ground crew unloads baggage from aircraft.
    - INTERACTIONS. Pilot, Ground crew, Vertiport operator
    - TOOLS. AAM aircraft

- POST-FLIGHT / BETWEEN OPERATIONS
  - **Send flight closure notice.** Pilot sends a flight closure notice to UATM service, which is shared with AAM aircraft operator.
    - INTERACTIONS. Pilot, ANSP, AAM aircraft operator
    - TOOLS. UATM service, Cloud platform

  - **Charge / Swap batteries, inspect aircraft and prepare for next flight.** If needed, ground crews recharge or swap AAM aircraft batteries. They clean the cabin, inspect the aircraft, and ensure readiness for the next operation. Ground crews share updates on aircraft status with pilot, and AAM aircraft operator.

  - INTERACTIONS. Ground crew, Pilot, AAM aircraft operator, ANSP
  - TOOLS. Battery charger, Cloud platform, UATM service

- END OF DAY
  - **Move to hangar.** After the last flight, the pilot or ground crew move the AAM aircraft to a hangar for overnight storage if not stored at vertiport.
    - INTERACTIONS. Pilot, Ground crew
    - TOOLS. AAM aircraft

  - **Turn off motors and receive maintenance.** At the hangar, the pilot turns off the aircraft. Ground crews then conduct any maintenance activities and fully recharge the battery in preparation for the next day. This activity could also occur at the vertiport.
    - INTERACTIONS. Pilot, Ground Crew
    - TOOLS. Battery charger, Cloud platform, UATM service

  - **Transmit system health data.** After maintenance is complete, the AAM aircraft automatically sends the AAM aircraft operator an update about its system status and health. This process may also be continuously used during operations.
    - INTERACTIONS. AAM aircraft operator, ANSP
    - TOOLS. AAM aircraft, Cloud platform

(3) Off-nominal Flight [5]

An AAM aircraft may need to change aerodrome or vertiport destination due to technical system malfunctions, sudden illness, disorientation of the pilot or various other reasons. An off-nominal situation may also arise from external issues such as vertiport/airspace unavailability or bad weather.
For example. if a situation arises in which an AAM aircraft has difficulty landing at a landing site while enroute to its destination, it will be necessary to change the landing site and reroute the aircraft to another alternative airport, etc or return to the point of departure. Since the battery capacity of early AMM aircraft is low and it is difficult to hold in the air, it is effective to predefine one or possibly several alternative airports, etc. and suitable take-off and landing sites other than the destination prior to departure to allow for unforeseen circumstances.

APPENDIX 4 Acronyms

The following acronyms are used in this document.

AAM	: Advanced Air Mobility
AIM	: Aeronautical Information Management
AIP	; Aeronautical Information Publication
ANSP	: Air Navigation Service Provider
ATM	: Air Traffic Management
ConOps	: Concept of Operations
CNS	: Communication, navigation and surveillance
DAA	: Detect and Avoid
EASA	: European Aviation Safety Agency
EUROCAE	: European Organisation for Civil Aviation Equipment
eVTOL	: Electric Vertical Take-off and Landing
FAA	: Federal Aviation Administration
FATO	: Final Approach and Take-Off Area
FBO	: Fixed Base Operator
ICAO	: International Civil Aviation Organization
IMC	: Instrument Meteorological Conditions
JCAB	: Japan Civil Aviation Bureau
MET	: Meteorological
MRO	: Maintenance、Repair ＆ Overhaul
NASA	: National Aeronautics and Space Administration
PIC	: Pilot in Command
PTS	: Prototype Technical Specifications
RAM	: Regional Air Mobility
RPIC	: Remote PIC
SAA	: Special Activity Airspace
SAR	: Search and Rescue
SARPs	: Standards and Recommended Practices
SDO	: Standards Developing Organization

SDSP	: Supplemental Data Service Provider
TLOF	: Touchdown and Lift-off area
UAM	: Urban Air Mobility
UATM	: Urban Air Traffic Management
UAS	: Unmanned Aircraft Systems
UASA	: UATM Service Area
USS	: UAS Service Supplier
UTM	: UAS Traffic Management
VFR	: Visual Flight Rules
VTOL	: Vertical Take-off and Landing

APPENDIX 5 Glossary

In this document, the following explanations are applied.

Stand
A defined area within the apron specified for servicing VTOL aircraft. (Parking Space)

Advanced Air Mobility (AAM)
An accessible and sustainable next generation means of air transportation, made possible by aeronautical technologies such as electrification and automation, as well as vertical take-off and landing and other modes of operation.

Drone
"Unmanned Aerial Vehicle" under the Civil Aeronautics Act.

Vertiport
An "airport, etc." under the Civil Aeronautics Act, and its type is a "heliport" dedicated to AAM.

Phase 0
Test flights and proof of concept flights phase of AAM operations prior to commercial operations.

Phase 1
Initial introduction of commercial AAM operations in Japan – low density, piloted operations, cargo transport with remote piloted operations.

Phase 2
Scaled Japanese AAM operations – medium to high density, piloted operations (on board and/or remote).

Phase 3
Establishment of AAM operations which include autonomy - high density, integrated with automated / autonomous operations.

eVTOL (electric Vertical Take-off and Landing)
Aircraft that take-off and land vertically using electric power.

FATO (Final Approach and Take-Off area)
A defined area intended for VTOL aircraft to use for transition from the final approach to touchdown or hovering and from the ground or hovering state to take-off.

RAM (Regional Air Mobility)
RAM is used in contrast to UAM. RAM refers to the longer distances flown by longer range AAM aircraft. Their cruise phase of flight is likely to occur at a higher altitude than UAM operations. Due to the operational characteristics and scale of operations, it is expected that RAM aircraft operations will be able to utilise existing airspace and traffic management

concepts for part or all of their flight. RAM aircraft that operate in the UASA or in a similar way to UAM aircraft will be subject to similar considerations as UAM aircraft.

TLOF (Touchdown and Lift-off area)
A defined area within a FATO or stand for touchdown or lift off (transition from grounded to hovering) of the undercarriage of the VTOL aircraft.

UAM (Urban Air Mobility)
UAM indicates a certain range of operating modes of AAM. UAM operations are likely to occur on shorter distances at a lower altitude than RAM. Low-level airspace includes airspace both inside and outside of the urban environment.

UAM Corridor
Dedicated airspace corridors in which aircraft must comply with specific rules, procedures, and performance requirements, which connects airports/vertiports. It is an area of airspace of defined dimensions and set when UAM operations are particularly dense and airspace capacity needs to be increased.

UAM Route
UAM routes are set to connect airports/vertiports and can organize operation paths. Their implementation does not necessarily require significant regulatory change compared to UAM corridors. To enable access and equity, UAM routes can be used by other airspace users.

UATM (Urban Air Traffic Management)
Over time, new Urban Air Traffic Management (UATM) systems and services will be needed to support the integrated operation of AAM aircraft in the UASA. UATM will support AAM operations and maximise the performance of AAM and the UASA.

UASA (UATM Service Area)
Airspace where new traffic management services (UATM services) will be provided based on UAM traffic conditions. It may include both controlled and uncontrolled airspace. The UASA is determined by aviation authorities on a flexible basis, based on the density and frequency of UAM operations and surrounding traffic conditions, and is not limited to the urban area.

UTM (UAS Traffic Management)
UAS Traffic Management (UTM) is envisioned as a subset of ATM that is aimed at the safe, economical and efficient management of UAS operations through the provision of facilities and a seamless set of services in collaboration with all parties and involving airborne and ground-based functions.

APPENDIX 6 Reference Document

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