

**59th CONFERENCE OF
DIRECTORS GENERAL OF CIVIL AVIATION
ASIA AND PACIFIC REGIONS**

*Cebu, Philippines
14 to 18 October 2024*

AGENDA ITEM 3: AVIATION SAFETY

**OPERATIONALIZATION OF AUTONOMOUS VEHICLES
AT THE HONG KONG INTERNATIONAL AIRPORT:
A REGULATORY PERSPECTIVE**

(Presented by Hong Kong, China)

SUMMARY

The pioneer integration of autonomous vehicle technology into airport operations at the Hong Kong International Airport (HKIA) marks a significant advancement in airport management. This paper shares the experience of the Civil Aviation Department of Hong Kong, China in facilitating the successful operationalization of various autonomous vehicles at the HKIA through a rigorous, evidence-based and competence-based approach from a regulatory perspective. The paper also calls for the development of guidance materials and standards to ensure a harmonized approach for expediting wider deployment of autonomous vehicle technology at airports.

OPERATIONALIZATION OF AUTONOMOUS VEHICLES AT THE HONG KONG INTERNATIONAL AIRPORT: A REGULATORY PERSPECTIVE

1. INTRODUCTION

1.1 The integration of autonomous vehicle technology into airport operations marks a transformative era for the aviation industry. Aerodrome operators and civil aviation authorities around the world are exploring ways to leverage new technological developments to enhance the level of safety and efficiency of airport operations. Given the unique operational complexities and challenges present in the airport environments, due considerations must be made to assess how the applications of autonomous vehicles fulfill the operational needs in a safe and cohesive manner under the local contexts.

1.2 The Hong Kong International Airport (HKIA) is expanding into a Three-Runway System (3RS). The new North Runway was commissioned in November 2022, while the reconfiguration of the Centre Runway is nearing completion. With the operation footprint at the HKIA expected to increase by over 50% upon the commencement of 3RS operations by end of 2024, there was a pressing need for a more effective and efficient way of baggage, cargo and personnel conveyance across the airport, as well as security patrolling along the airport perimeter. The need has become more prominent as the operations of the HKIA, like many other airports, have been challenged by a shortage of labour, including tractor drivers. To address these challenges, Airport Authority Hong Kong (AAHK), the aerodrome operator of the HKIA, is committed to transforming airport operations through innovation and technology. Amongst others, AAHK eyed on the utilization of various autonomous vehicles.

1.3 As the regulatory body responsible for aerodrome safety and security, the Civil Aviation Department of Hong Kong, China (HKCAD) has been collaborating closely with AAHK on its application of autonomous vehicle technology at the HKIA since its infancy stage. Similar to any other new technological applications, the application of autonomous vehicles has initially posed challenges for regulators due to the lack of proven safety records. However, HKCAD is supportive to and determined to facilitate the innovative idea as it recognizes that embracing this new technology can enhance both operational efficiency and safety. Autonomous vehicles not only have the potential to mitigate certain human errors, but they also optimize workforce utilization. Furthermore, these vehicles can operate under all weather conditions, providing uninterrupted support and ensuring consistent performance regardless of external factors. By integrating these technologies thoughtfully, a safer and more efficient airport environment can be achieved. While recognizing the benefits that such technology offers, HKCAD remains mindful of ensuring aerodrome safety and security are not compromised by adopting a rigorous, evidence-based and competence-based approach in facilitating the technological transformation of the HKIA.

2. DISCUSSION

2.1 Since 2018, AAHK has been actively exploring the technical feasibility on the use of autonomous vehicles in the airside environment. Considering the dynamic operations at airfield and apron, AAHK had identified the deployment of Autonomous Electric Tractors (AETs) for baggage conveyance (*Figure 1*) at a dedicated bonded road as an initial trial. The HKIA was the first airport in deploying AETs into live operations for baggage conveyance in 2019. Building on the success, the technology was later extended to cargo towing between the Main Cargo Apron and West Cargo Apron via vehicular tunnel in 2022, and into-aircraft stand operations in 2023. AAHK then introduced the Autonomous Patrol Car (APC) for security patrolling (*Figure 2*) along the airport perimeter in 2021, and the Autonomous Shuttle Bus (ASB) for transporting airport staff (*Figure 3*) across airside facilities in 2023.

2.2 HKCAD has been working closely with AAHK throughout different stages of project development to ensure each type of autonomous vehicles could be safely and effectively integrated into airport operations from regulatory perspective. A rigorous, evidence-based and competence-based approach was adopted in the operationalization of all types of autonomous vehicles, which involved

various stages of project development as summarized below before live operations.

Proof-of-Concept

2.3 The operations of autonomous vehicles are highly dependent on the capabilities of various sensors installed on these vehicles. Given the operational complexities of the airside environment, autonomous vehicles must be able to manoeuvre accurately along their assigned routes, detect nearby obstacles and make decisions and perform respective precise and accurate actions in order to uphold apron and airfield safety.

2.4 To demonstrate that the concept of utilizing autonomous vehicles could be realized at the HKIA, AAHK initiated a proof-of-concept stage to validate the capabilities of various sensors required for the operations. During the process, AAHK engaged different suppliers and conducted intensive market research on the capabilities of sensors which would allow the vehicles to accurately sense the surrounding environment and react accordingly. The key findings of market research were shared with HKCAD.

Pre-trial assessment

2.5 Apart from passing the factory acceptance tests conducted by AAHK and the suppliers as with other new equipment, prior to on-site trials, AAHK was required to prove the technical capabilities of these autonomous vehicles in terms of roadworthiness and demonstrate the operational capabilities in performing their designated tasks. While pending for relevant international standards and guidelines, HKCAD worked closely with AAHK to formulate the assessment and acceptance criteria for each type of autonomous vehicles, covering the vehicles' capabilities in accurate positioning, obstacle detection, eliciting proper reaction and overall system resilience. Comprehensive test plans were developed and agreed prior to the assessments.

2.6 In addition, as a critical element of the change management process in the ICAO Safety Management System framework, AAHK was required to conduct safety risk assessments to identify and evaluate potential hazards associated with the planned use of autonomous vehicles at the HKIA. These assessments had taken into account factors such as complexities of airport operations, likelihood of interactions with aircraft and other vehicles, and human factors. Detailed operational procedures for the deployment of autonomous vehicles at the HKIA were also required to cover all aspects of their operations, including maintenance, training, emergency response and occurrence investigation. Throughout the iterative process of document submission and vetting, as well as discussions between HKCAD and AAHK, areas for improvement were identified for further enhancement of the overall implementation plan.

On-site trial

2.7 On-site trial was a critical stage before the autonomous vehicles could commence live operations. Thorough trials were conducted to demonstrate the competence of autonomous vehicles in real-world so as to ensure they can operate safely and reliably in the complex airside environment. As general testing principles, the autonomous vehicles are required to successfully demonstrate that the vehicle's sensors, decision-making algorithms, communication systems and other safety features are all working properly.

2.8 To meet the potential operational needs, on-site trials were conducted thoroughly under different scenarios. These included docking accurately, manoeuvring in merging traffic appropriately, manoeuvring precisely along the vehicular lane, and demonstrating appropriate reaction with obstacles. Besides, these trials had to be performed under various operating conditions, such as weather conditions, day and night time, traffic scenarios and other operational environments. Specific trial scenarios were also drawn up to validate the designated operational functions of autonomous vehicles (e.g. for APC, functions in detecting human intrusion and fence wire irregularity).

2.9 Before formal acceptance of live operations, repeated on-site trials in accordance with

the agreed test plans were required to demonstrate the competence of the autonomous vehicles. To minimize the potential risks associated with unmanned driving on active airside roads, the trials were conducted in phases starting with a driver onboard then a progressive decrease in manned support onboard. From an oversight perspective, on-site inspections were conducted by HKCAD to ensure the trials were properly and successfully conducted by AAHK. Test reports and other quality control documents were also reviewed by HKCAD with an aim to further assure the readiness of live operation.

Transition from trial to operational phase

2.10 The final stage is the transition from trial to operational phase. Various change management activities were implemented by AAHK to ensure all stakeholders at the HKIA were aware of the introduction of autonomous vehicles for the particular application. These activities included review of the relevant regulations, operating procedures dissemination, airport community briefings / meetings, information promulgation by means of publications, etc. In particular, the regulations for airside driving were holistically reviewed and updated to clearly stipulate that vehicles other than emergency and recovery vehicles are required to give way to autonomous vehicles and the respective enforcement actions against failure to promote safe airside driving.

2.11 Airport operations have traditionally been relying heavily on manual labour for various tasks, including airside driving. The integration of autonomous vehicle technology in airport operations is beginning to shift this paradigm. Apart from alleviating the long-term reliance on manpower, its applications also enhance the safety and efficiency of airport operations, particularly under adverse weather conditions. The successful operationalization of autonomous vehicles at the HKIA does not only reap the benefits of operational advantages from the utilization of autonomous vehicles, it also demonstrates the possibility to realize the application of new technologies at airport by adopting a rigorous, evidence-based and competence-based approach.

2.12 As we navigate the challenges ahead, a coordinated plan on the way forward in respect of the use of autonomous vehicles at the HKIA will be instrumental in sustaining the ongoing success. With operations maturing, the fleet size of AETs, APC and ASB will be further expanded in the near term to cover more extensive areas of the airport, particularly when the Terminal 2 Concourse is commissioned. In the medium term, AAHK plans to undertake a holistic review of autonomous vehicle fleet management to optimize the deployment and maintenance control, thereby ensuring streamlined operations across various types of vehicles. Looking further ahead, the installation of vehicle-to-everything (V2X) infrastructure will be explored by AAHK in enabling a smart transportation system at the HKIA and further enhancing safety and efficiency of autonomous vehicles operations at the airport.

3. ACTION BY THE CONFERENCE

3.1 The Conference is invited to:

- a) note the information and experiences shared by Hong Kong, China in leveraging autonomous vehicle technology for further enhancing safety and efficiency of airport operations at the HKIA;
- b) invite States / Administrations to share their relevant experiences; and
- c) request the ICAO to collaborate with the industry to develop guidance materials and standards to ensure a harmonized approach for expediting wider deployment of autonomous vehicle technology at airports.

— END —

Appendix



Figure 1: Autonomous Electric Tractor (AET) for baggage conveyance



Figure 2: Autonomous Patrol Car (APC) for security patrolling



Figure 3: Autonomous Shuttle Bus (ASB) for airport staff transportation