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**Agenda Item 4: Provision of AOP in the Asia/Pacific Region
- Certification and Operations of Aerodromes**

**AUTONOMOUS VEHICLE APPLICATIONS
AT THE HONG KONG INTERNATIONAL AIRPORT: A REGULATORY PERSPECTIVE**

(Presented by Hong Kong, China)

SUMMARY

Autonomous vehicles are rapidly developing with the potential to revolutionize transportation and possess the potential to further improve safety, security efficiency, environmental friendliness and convenience in a variety of applications, including airport operations. In operationalizing autonomous vehicles at the airport, a regulatory framework needs to be established to verify the safety capabilities of autonomous vehicles before they can be safely and effectively deployed. This paper presents the experience sharing from regulatory perspective regarding the autonomous vehicle applications at the Hong Kong International Airport and calls for the development of new industry best practice / guidance material leading to new ICAO Standards and Recommended Practices (SARPs) to cater for the deployment of autonomous vehicles at the airports.

1. INTRODUCTION

1.1 The autonomous vehicles technology and the versatility of usage have continued to evolve rapidly in recent years. Aerodrome operators and civil aviation authorities around the world are reviewing ways to capitalize on the technological development and diversifying applications of autonomous vehicles at the airports. Given the unique operational complexities and challenges within an airport environment, both aerodrome operators and civil aviation authorities have to take into account local situations in evaluating the applications of autonomous vehicles which best suit the local operational needs.

1.2 Airport Authority Hong Kong (AAHK), the aerodrome operator of Hong Kong International Airport (HKIA), continues to transform the airport operations of the HKIA through innovation and technology. One of the new initiatives is targeted at the utilization of autonomous vehicles technology in airport operations. In recent years, AAHK has progressively implemented its airport master plan, which includes the expanded deployment of autonomous vehicles to baggage transfer and cargo transportation as well as airport staff transportation.

1.3 In this regard, the Civil Aviation Department (HKCAD), Hong Kong, China, as the regulator for aerodrome safety and security for the HKIA, has been working closely with AAHK. While recognizing that the use of autonomous vehicles is a game changer for the labour-intensive airport operations, HKCAD remains mindful of safeguarding aerodrome safety and security throughout the planning, design, implementation, transition and regular reviews for utilization of autonomous vehicles at the HKIA.

2. DISCUSSION

2.1 With the advancement of autonomous vehicles technology, the HKIA has been progressively adopting autonomous vehicles for airside operations. With the successful introduction of Autonomous Electric Tractors (AETs) into live operations for baggage conveyance in 2019 after more than one and a half years of comprehensive trials and development (see Figure 1), AETs for cargo towing (see Figure 2) and Autonomous Patrol Cars (APCs) (see Figure 3) for security patrolling along the airport perimeter were subsequently put into operation in 2021. AAHK further deployed Autonomous Shuttle Bus (ASB) for airport staff in April 2023 (see Figure 4).



Figure 1 AET for baggage conveyance



Figure 2 AET for cargo towing



Figure 3 APC for security patrolling



Figure 4 ASB

2.2 Airside is a complex and dynamic environment with various activities, including concurrent aircraft manoeuvring, moving vehicles and airport operating personnel performing aircraft handling. There is minimal tolerance for error as autonomous vehicles are required to be able to safely navigate at the airside without putting people or property at risk whilst upholding the safety and efficiency of the airside operations.

2.3 In view of the above, a rigorous and evidence-based approach for evaluating the technical viability, operational viability / applicability and safety of autonomous vehicles has been formulated to ensure that all aspects of operations including both vehicle manoeuvring and its application to airside environment, and potential safety hazards are carefully identified, duly considered and suitably mitigated so as to ensure that the vehicles can be safely and effectively integrated into airport operations.

Rigorous and evidence-based approach in operationalizing autonomous vehicles at the airport

2.4 With a view to meeting the operational needs while safeguarding aerodrome safety, HKCAD has worked closely with AAHK to formulate the overall strategy for engineering and operational testing/trial approach from the aerodrome safety and security perspective, and ensure that the autonomous vehicles possess the required safety capabilities and are able to demonstrate satisfactory results in the areas of automatic obstacle detection, decision-making, communication and safety features.

2.5 Operations at HKIA had long been challenged by readily available skilled labour, including tractor drivers. AAHK continues to explore operational opportunities for adopting the autonomous driving technology. The replacement of manually driven vehicles by autonomous vehicles does not only relieve the HKIA from such challenge in the long run but has also provided a more safe, secure, effective and efficient service by operating around-the-clock under all weather conditions. AAHK was in close consultation with HKCAD throughout the operationalization process of autonomous vehicles for enhancing the safety, security efficiency, operational effectiveness and environmental friendliness.

2.6 To ensure that the autonomous vehicles can be safely and effectively integrated into airport operations, the autonomous vehicles are required to accurately sense the surrounding environment using various sensors such as cameras, lidar and radar and be able to make quick and accurate decisions based on the information gathered by their sensors. Considering the operational complexities of the airside environment, autonomous vehicles must be able to interact with other vehicles, infrastructure, and pedestrians to ensure safe and efficient operation and must be equipped with various safety features such as collision avoidance emergency braking, and lane departure warning systems. The processes in operationalizing autonomous vehicles at the airport are as follows:

Proof-of-Concept

2.7 To demonstrate that the idea of utilizing autonomous vehicles can be turned into a reality at an airport, AAHK initiated a proof-of-concept stage to verify the capability of various sensors required of the operations of autonomous vehicles. During the process, AAHK conducted intensive market research on the capability of various sensors. In addition, AAHK also engaged various suppliers of vehicles and assessed the sensor installation requirements.

Pre-trial assessment

2.8 Prior to testing the autonomous vehicles in real-world environment, the autonomous vehicles have to be tested with satisfactory results in the factory acceptance test including the vehicle and system test, and the methodology and standards of acceptance test have been reviewed by a third-party consultant. In addition, as part of the change management process under the ICAO Safety Management System concept, a safety risk assessment is required to identify and evaluate potential hazards associated with the proposed use of autonomous vehicles in the HKIA. The assessment should consider factors such as the complexities of airport operations, the potential for interaction with other vehicles and aircraft, and the human factor. In view of the changes in operations brought by the new technology involved, operational procedures for the proposed use of autonomous vehicles in the HKIA covering all aspects of vehicle operations, including maintenance, training, emergency response and occurrence investigation are required. Throughout the iterative process of document submission/vetting and discussions between HKCAD and AAHK, improvement areas were identified to further refine the overall implementation plan.

On-site trials

2.9 To ensure that the autonomous vehicles are safe and reliable on the road, especially within the complex airside environment, one critical aspect is the conduct of on-site trials to evaluate their performance, both technically and operationally, in real-world and under all weather conditions. In view of the aforementioned areas of capability required, during the on-site trials the autonomous vehicles are required to successfully demonstrate that: (1) the sensors are working properly and the vehicle can accurately manoeuvre, detect and identify objects in its surrounding environment; (2) the vehicle's decision-making algorithms are working properly and the vehicle can respond appropriately to different scenarios; (3) the vehicle's communication systems are working properly and the vehicle can receive and respond to messages from other sources and (4) the safety features are working properly and the vehicle can respond appropriately in emergency situations.

2.10 To support the real-life operational needs and the existing road design in airside area, the autonomous vehicles are required to be thoroughly tested under different scenarios, including (1) docking accurately; (2) manoeuvring in merging traffic appropriately i.e. across junctions and roundabout; (3) manoeuvring precisely along the vehicular lane; (4) demonstrating correct reaction with obstacles, etc. under various operating conditions, such as weather conditions, day and night time, traffic scenarios and other operational environments. In view of the specific operational characteristics of autonomous vehicles at the HKIA, specific testing/trial scenarios had been designed. For instance, APC is designed for assisting in daily patrols along the boundary of the restricted area. The test case for APC specifically covered its security functions including detection for human intrusion and fencing wire irregularity. As ASB is designed for transporting airport staff to various work locations across the airport restricted area, its test case covered passenger safety related features including closure of passenger doors before bus departure and seat belt fastened sensor, etc.

2.11 Taking into consideration the operational complexities of different types of autonomous vehicles, repeated on-site trials in autonomous mode had been conducted to demonstrate the full capabilities of the autonomous vehicles. To mitigate the autonomous driving risks on road, the on-site trials were conducted in stages, with progressively thinner manned support on vehicle. In parallel, on-site inspections were conducted by HKCAD on the quality control duties by AAHK during their trials to ensure that the testing on different scenarios were properly and successfully conducted by AAHK. Followed by HKCAD's reviews on the test reports and other quality control documents, the quality assurance of live operation readiness was further enhanced.

2.12 For transitioning from trial to the operational phase, in order to ensure that all stakeholders at the HKIA are aware of the introduction of autonomous vehicles for the particular application, change management activities for engaging stakeholders including operating procedures dissemination, airport community briefings / meetings, information promulgation by means of circulars or other publications had been completed. Furthermore, the regulations for airside driving were holistically reviewed and the relevant enforcement schemes were further strengthened in order to promote safe airside driving. Failure to give way to autonomous vehicles will be an offence and offenders will be subject to traffic offences related penalties.

2.13 The applications of autonomous vehicles at airports represent immense potential to revolutionize transportation and enhance the efficiency and safety of airport operations. The successful operationalization of the applications of autonomous vehicles at the HKIA has been shared with airport communities. To address the challenges, adopting a rigorous and evidence-based approach and engaging stakeholders are important for paving the way for the successful deployment of autonomous vehicles at airports.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- (a) note the information contained in this paper;
- (b) share the experience and information from regulatory perspective regarding the applications of autonomous vehicles in different airports; and
- (c) call for the development of industry best practice / guidance material leading to new ICAO SARPs to cater for the deployment of autonomous vehicles at the airports through a rigorous and evidence-based approach.