A Review on the Aerodrome Standard in the Aviation Industry

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1. Introduction

A statistical report by Malaysia Airports Holdings Berhad (MAHB) (1) revealed that more than 99 million of passengers movements recorded in the year 2018, a surge of 2.6% compared to the previous year which recorded 96.6 million passengers. This report was supported by OAG’s Mega hubs International Index Report (2) for the year 2018 were Kuala Lumpur International Airport (KLIA) was listed as 12th most connected airport globally. Besides, this statistical report was also supported in International Civil Aviation Organization (ICAO)’s (3) passenger traffic movement report in the year 2018 where it reported an increase of 6.4 per cent to 4.3 billion passengers carried by scheduled services compared to the previous year. In a data provided by Department of Statistics, Malaysian Aviation Commission (4) estimated that the aviation industry had contributed 0.6 per cent to the overall Gross Domestic Product (GDP) in Malaysia for the year 2015.

Civil Aviation Authority of Malaysia (CAAM) is the sole aviation authority that oversees and manages the daily technical, safety, maintenance and security operational standards in Malaysia. Established in 1969, CAAM was formerly known as Department of Civil Aviation (DCA) under the Ministry of Transport. CAAM currently headquartered in Putrajaya. DCA was integrated into a statutory body as CAAM since 19th February 2018, and the CAAM currently assumes the duties of DCA. The integration of the CAAM is on par with the ICAO requirement, which called on contacting states to the Chicago Convention to form an independent civil aviation authority to ensure more effective management of civil aviation safety and security (5). There are many

Abstract: The aviation industry consists of a few branches such as Flight Operation, Air Traffic Control Management, Airworthiness and Aerodrome Standards. Aerodrome standard is related to the airport operation, which following the International Civil Aviation Organisation (ICAO). The essential element in aerodrome or airport can be listed such as runway, apron, terminal, maintenance hangar and taxiway. Several issues are highlighted in the taxiway segment, which required further review, especially on the Aeronautical Ground Lighting system. Aeronautical Ground Lighting system is the most crucial part in taxiway because it gives guidance to a pilot in taxiway to avoid aircraft incursion. Therefore, this paper will give focus on the taxiway, especially on the Aeronautical Ground Lighting system, which is related to the daily operation requirements for airports.

Keywords: Aviation, Aerodrome standards, Taxiway lighting guidance, runway, Aeronautical Ground Lighting, Incursion, Air navigation
Divisions established in CAAM since its early days. Among that, only four Divisions shall be discussed, namely Flight Operations Division, Air Traffic Control (ATC) Management Division, Airworthiness Division, and Airport Standards Division, respectively. The organisational chart of CAAM is presented in Figure 1.

Fig. 1 - CAAM Organisation Chart (6)

2. Aviation Industry

Flight Operations Division is among the essential divisions established in the aviation industry. For most airlines’ Flight Operations Division, it is held accountable for a safe and reliable passenger and/or cargo flow, which consequently produced income for the airline (7).

The Air Traffic Control (ATC) Division has the most critical role ensuring the aircraft flying in the skies have adequate safe lateral and vertical separations to avoid mid-air collisions. Benoit et al. pointed out that ATC must instruct pilots to adjust the course of the plane when it comes to a possible traffic collision condition (8). The controllers have in their hands the lives and deaths of thousands of people; as such errors which can cause air accidents are intolerable (9,10). According to Aeronautical Information Publication (AIP) CAAM, there are two Flight Information Regions (FIR) and ATC Centres in Malaysian airspace, namely Kuala Lumpur FIR (KL FIR) and Kota Kinabalu FIR (KK FIR) including a sub-centre in Kuching (11). Figure 2 shows the Malaysia Flight Information Regions.

Fig. 2 - Malaysian Flight Information Region (11)

The Airworthiness Division, CAAM is responsible for performing regulation work on airworthiness by setting up requirements, standard practices and safety recommendations & guidelines, hence implementing them as prescribed by the Civil Aviation Act (CAA) 1969 (12)(13)(14). The previous study by Yin suggested that usually, the airworthiness standards determined the minimum safety level that can be adopted by the public, and every ICAO contracting states has formed the regulation systems to post the airworthiness standards and spent relevant funds to execute the airworthiness management (15).

The ICAO in Annex 14 referred aerodrome as “A defined area on land or water (including any buildings, installations, and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft” (16). There are several aerodrome operators in Malaysia, namely Malaysia Airports Holdings Berhad (MAHB) and Senai Airport. The Aerodrome Standards Division collaborates with the aerodrome operators to develop effective safety management systems to sustain and, where applicable, that safety standard against a backdrop of expected growth and aviation industry demand (17). The security and reliability requirements to be met by the aerodrome operators are set out as Standards and Recommended Practices (SARPS) in the ICAO Annex 14 and Aerodrome Directives (AD) issued by the CAAM (17).

3. Aerodrome Standards Division

In this section, topics on runaways, apron, terminal, taxiway and Aeronautical Ground Lighting (AGL) are reviewed. These topics covered almost the primary system in the airside area. Accident or incursion always occurred due to human error or system fatal (18).

The runway is the central and compulsory elements in an aerodrome to gain speed for take-off run and for reducing speed during touchdown roll. There are several pavement types for runway around the world, such as grass, dirt, ice, concrete or asphalt paved runway. Furthermore, the runway preferably designed to the current direction of the wind so that it could significantly decrease the problems related with
crosswind landing or take-off of an airplane (19). There are three types of runways according to ICAO, namely non-instrument runway, non-precision approach runway and precision approach runway (16).

The apron is where the aircraft parked at for disembarkation or embarkation process. An apron is also known as tarmac or ramp area. Hamzah et al. (20) reviewed that airport’s apron area is the location where aircraft docked at for carrying out unloading and loading operations through the configuration set up. Apart from that, the ramp area’s size is based on the amount of aircraft being served (20) (21).

Horonjeff et al. (21) in his previous research argues that the terminal site is the primary interaction in between the airside and landside of the aerodrome. Beinhaker stated that airport terminal building is often used by airlines, passengers, meeting peoples, as well as a wide variety of airport management staffs, government officials, major airlines, franchisees, and other workers (22). Therefore, the terminal must provide a satisfactory Level of Service (LOS) for passengers as the entire terminal complex is strongly affected by the tighter standards required to handle aircraft manoeuvring (22). Two segments divided that terminal complex, which is landside area and the airside area. The main difference between these two areas is the airside area is a restriction area where only airport personnel or travelling passengers with boarding pass are allowed to enter the airside area.

The ICAO defined taxiway as “path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another” (16). Taxiways allow aircraft to move between the apron and the runway. According to ICAO Annex 14, there are three types of taxiway available such as aircraft stand taxi lane, apron taxiway, and rapid exit taxiway (16). Figure 3 show the difference between all three types of taxiway mentioned in the earlier paragraph. Several researchers.

**Fig. 3 - Different types of taxiway (23)**

Any light specifically constructed to provide air navigation is Aeronautical Ground Lighting (AGL) (16,17). AGL consists of General Airport Lighting, Runway Lighting, Approaching Lighting and Taxiway Lighting. The taxiway lighting shall assist pilots in following the correct taxi route during the night and Low Visibility Operation (LVO) (24). There are three types of AGL in taxiway area, namely Taxiway Edge Lights, In-Ground Centreline Lights, Runway Guard Lights and Stop Bar Lights. Every kind of AGL has a different colour to avoid confusion. According to ICAO Annex 14, aerodrome operators are required to ensure that at least 85 per cent of the AGL are serviceable and useful in any event or situation (12). Taxiway Edge Light is illuminated as blue light used to define the edge of taxiways during low visibility and during at night (25). On the other hand, Runway Guard Lights are installed at the runway holding point, which is intended to warn the pilots that they are approaching an active runway (26). These lights are a pair of elevated flashing alternately with yellow rays and will be switched off when the ATC officer clears the aircraft for take-off. Finally, to reduce runway incursion threats, Stop Bar Lights works. This light is identical to In-Ground Centreline Lights, but they are illuminated in red, meaning that pilots are not permitted to cross the holding point line on the runway. Pilots must receive the verbal take-off clearance of the ATC officer, and the lights will be shut off before they can continue to cross it (26). Figure 4 shows the types of AGL available in taxiway area.

![Fig. 4 - Airfield Ground Lighting (28)](image)

4. Future Recommendation

AGL has contributed significantly to guiding pilots to manoeuvre safely within the aerodrome. AGL increased the situational perception of pilots with vivid colours, various light periods and intensities (29) (30). An effective and efficient AGL should be capable of minimising errors as well as helping to minimise delays and ensure smooth air traffic operations, despite low visibility and nighttime operations. In recent years, the “Follow the Green” Taxi Guidance System has been implemented by Singapore Changi Airport and Seoul Incheon Airport to make the taxi process more efficient and safer. Aerosavvy explained that the device would illuminate a portion of green centerline lights in front of the aircraft and provide personalised guidance from the runway to the gate and vice versa, and if the aircraft needed to maintain the current location, red stop bar lights would be switched on (27). Besides, the ‘Follow the Greens’ technology-enhanced situational awareness and thus contributes to better airport
operations’ safety (31). Depending on the route taken by the aircraft while the aircraft is taxiing, taxi times can depend on path-specific factors and on engagement-specific elements that represent the effects of several aircraft being taxiing at the same time (32). Furthermore, AGL Automation System is ideal for individual switching and monitoring of airfield lighting to comply with ICAO and FAA standards, as well as to strengthen aircraft ground movement safety at hot spot area in aerodrome and the basis for an Advanced Surface Movement Guidance and Control System (A-SMGCS) to be developed (33).

Conclusions

A discussion of the essential aspects of maintaining stable and safe aircraft movements on the ground and the importance of academic and literature reviews were conducted in this paper. It begins by identifying the aviation industry and the organisation that manages national and global aeronautical operations. Different types of AGL systems have been defined earlier and thus distinguish their purposes and features. Over the past few decades, the AGL has contributed significantly to flight safety. Particularly in large and busy aerodromes, the importance of using modern technologies such as ‘Follow the Greens’ is vital due to the effect not only on flight safety but also on the green and eco-friendly climate.

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