International Civil Aviation Organization

The Second Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (APAC ATMAS TF/2)

Video Tele-Conference, 14 - 16 September 2021

Agenda Item 4: ATM Automation System Implementation by States

4.5 Emerging Technology Adaptations and Cybersecurity

CONSIDERATIONS IN DESIGN AND IMPLEMENTATION OF AN APPROACH SPACING TOOL

(Presented by Hong Kong China)

SUMMARY

In connection with the implementation of enhanced Wake Turbulence Separation (eWTS) scheme for arrival traffic of Hong Kong International Airport (HKIA), an Approach Spacing Tool is being implemented at the HKIA to assist controllers in handling final approach operation under eWTS scheme while improving consistency in delivering the arrival traffic according to the intended runway capacity. This paper presents the considerations in the design and implementation of an Approach Spacing Tool to fit into an operational environment with track records of busy air traffic.

1. INTRODUCTION

1.1 In November 2020, Hong Kong China has successfully implemented distance-based wake turbulence separation minima of ICAO eWTS scheme for all arrival flights of Hong Kong International Airport (HKIA). Under the new eWTS scheme, the wake turbulence categorization of aircraft is migrated from the conventional four categories into the new seven wake turbulence groups. The eWTS scheme allows a reduction in wake turbulence separation between some aircraft pairs depending on the leading and the following aircraft type, as well as increases in wake turbulence separation for the smaller and more vulnerable aircraft type.

1.2 With more wake turbulence groups in place, the matrix of separation minima of aircraft pairs inevitably becomes more complex than that of the conventional scheme. More processing would be required by controllers in applying different separation minima to the increased number of wake turbulence pairs in the arrival traffic. Therefore Hong Kong China has acquired an Approach Spacing Tool (AST) for assisting approach controllers to cope with the increased air traffic under the eWTS scheme and improve the consistency in the delivery of arrival traffic according to the intended runway capacity of HKIA. The AST has been customized to fit into the local operational environment of Hong Kong Flight Information Region and HKIA. The following paragraphs provide details in the considerations in the design and implementation of AST.

2. DISCUSSION

2.1 The AST is designed to project the required spacing between aircraft along the final approach sequence and provide advisories, in the form of graphical indicators on the Air Situation Display, to indicate the optimal positions of aircraft along the final approach path. In addition, monitoring aids are implemented in AST to enhance controllers' situation awareness for arrival flights under management by AST.

2.2 The AST allows the selection of operational modes between Distance-Based Separation (DBS) and Time-Based Separation (TBS) for determining aircraft spacing. Among these two modes, TBS mode is particularly helpful in managing the traffic safely without reduction in airport capacity under strong and consistent headwind conditions.

2.3 Projection of Spacing

2.3.1 During the computation of spacing guidance, the AST would consider all the required separation criteria for a given aircraft pair, including wake turbulence separation minima, minimum radar separation and dependent parallel approach separation. Then the tool would apply the most stringent criteria to ensure that none of the required separation is infringed.

2.3.2 Apart from the required minimum separation, the AST would also consider other operational parameters which could affect the spacing between aircraft such as runway occupancy times, specific minimum separation defined for a runway, extra gap required between specific landing aircraft, etc. Together with the operational mode on the aircraft spacing and runway mode, the AST would provide spacing guidance in form of graphical cues illustrated in the subsequent paragraphs.

2.4 AST Guidance Cues

2.4.1 Two guidance cues, namely Initial/Intermediate Target Distance (ITD) and Final Target Distance (FTD) are provided by the AST.

a) ITD represents the optimal distance for the following aircraft to be positioned behind a leading aircraft with the consideration of the deceleration compression buffer calculated based on the estimated 3D trajectory, the estimated speed profile, environment data (including wind, temperature, etc.) and the target FTD.

b) FTD represents the appropriate position for the following aircraft behind a leading aircraft at the required minimum spacing applied at the runway threshold. The follower shall always be behind its respective FTD indicator along the final approach path.

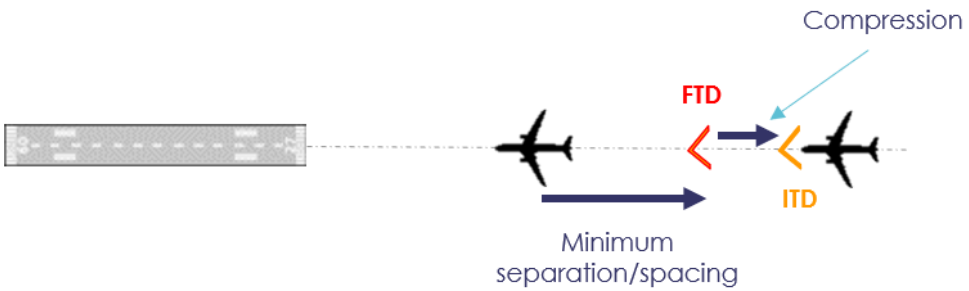

Figure 1: Presentation of ITD and FTD in AST

2.4.2 The AST calculates and updates the geographical positions of ITD and FTD indicators for each arrival pair at every track update based on the latest wind information, flight

profile, aircraft performance as well as spacing requirements. To cater for different operational environments, the positions of the FTD and ITD guidance cues could be chosen to be displayed along the planned flight path or a predefined common path in the approach airspace. The following figures illustrate the differences in the implementation of guidance cues under the two approaches.

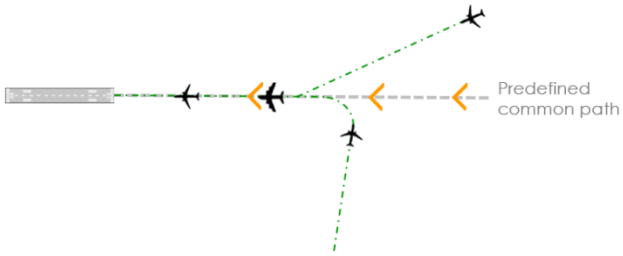

Figure 2: Guidance Cues along a Predefined Common Path

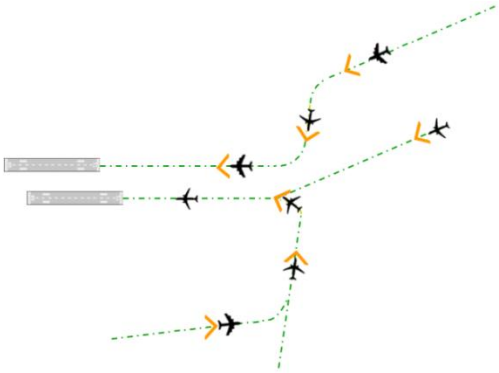

Figure 3: Guidance Cues along Planned Flight Path

2.5 Final Approach Sequence Management

2.5.1 The planned Final Approach sequence provides necessary information in determining the required wake turbulence separation between arrival pairs and is crucial in the generation of AST Guidance Cues. If State/Administration has implemented Arrival Manager (AMAN) in its operation, its arrival sequence data would be the best candidate for processing by the AST. If AMAN is not available, an arrival sequence based on the flight trajectories from ATMAS would be an alternate option.

2.5.2 The AST provides a sequence management list with arrival flights listed in sequential order. Depending on the runway modes (i.e. independent or dependent runway mode), controllers are allowed to choose one or multiple sequence management lists to be displayed on the air situation display.

2.5.3 Arrival flights in the sequence management list will be automatically sorted according to the Scheduled Time of Arrival (STA) from AMAN or the Estimated Time of Arrival (ETA) if AMAN data is not available. In case of sequence mismatch between the planned sequence and actual traffic pattern, controllers can manually update the sequence within the sequence management list. In addition, to prevent the manual actions by controllers from being overwritten by AMAN updates, AST would prevent changes to a flight's sequence when the STA/ETA falls within the frozen window based on current time.

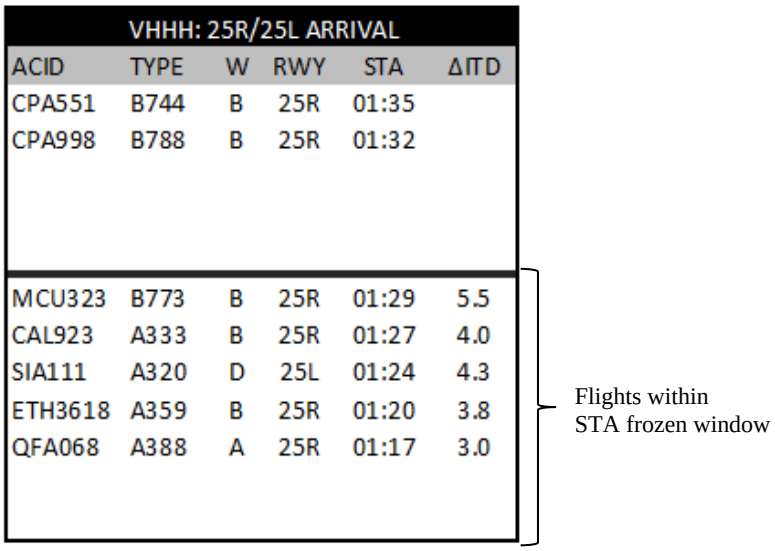

Figure 4: Sequence Management List

2.6 Monitoring Aids in Approach Spacing Tool

2.6.1 To enhance controllers' situation awareness, the following monitoring aids could be implemented for aircraft under management by AST:

a) **FTD Catch-up Alert:** when predicted trajectory of an aircraft infringe the FTD;

b) **ITD Catch-up Alert:** when predicted trajectory of an aircraft infringe the ITD;

c) **FTD Infringement Alert (FTDA)**: when the FTD is infringed;

d) **ITD Infringement Alert (ITDA)**: when the ITD is infringed;

e) **Arrival Sequence Discrepancy Alert (ASDA)**: when the actual aircraft sequence differs from the planned arrival sequence, as computed by the Arrival Manager, or as manually sequenced by controllers; and

f) **Arrival Speed Conformance Alert (ASCA)**: when the aircraft speed differs by an adapted tolerance from the speed requirement in the STAR and approach procedure assigned to the aircraft within a defined distance from the runway threshold.

2.6.2 The alerts of monitoring aids are displayed to controllers based on the jurisdiction and roles/positions with the flexibility of selecting visual and/or aural alerts by controllers. The following figure shows the display of ITD Catch Up alert for a flight on its track label in AST.

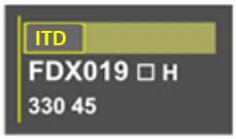

Figure 4: Example of Alert Display in Approach Spacing Tool

2.7 AST Implementation for Hong Kong Flight Information Region

2.7.1 In 2019, Hong Kong China has engaged a competent contractor to provide the AST for HKIA. After reviewing the local environment and operational procedures, a common line approach for AST Guidance Cues was chosen for AST implementation, which was considered more suitable as most of the arrival traffic were tactically being radar vectored off-track for sequencing.

2.7.2 The adopted common lines for the two different runway directions are illustrated in the figures below:

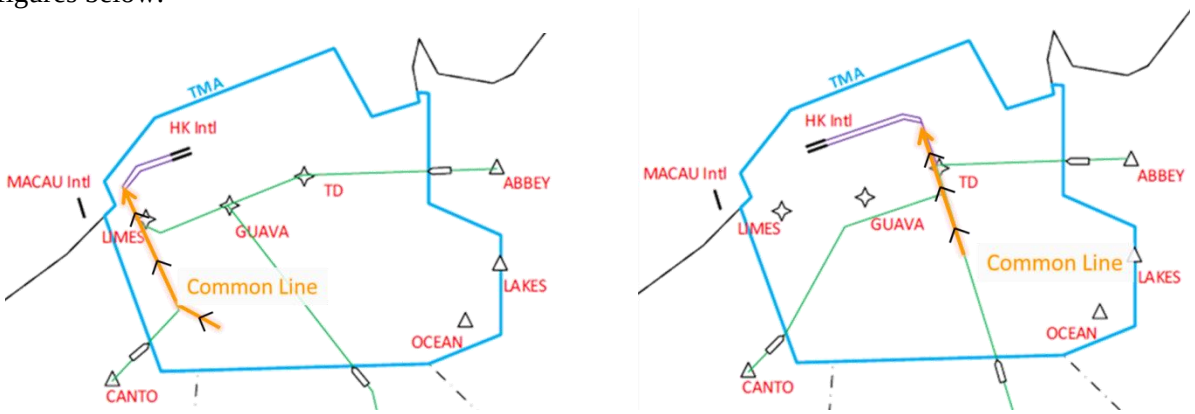

Figure 5: Common Line for (a) Runway 07 Approach and (b) Runway 25 Approach

2.7.3 The installation of AST at HKIA has been completed and system acceptance tests are planned to commence in Q4 2021. Operational trial of the AST using the DBS mode at the Final Approach Director (FAD) position would follow after the completion of system acceptance, optimization and controller.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the considerations in the design and implementation of an Approach Spacing Tool;

b) note the progress of Approach Spacing Tool implementation in Hong Kong China;

c) consider to incorporate the relevant design considerations of Approach Spacing Tool into the ATMAS IGD;

d) encourage States/Administration, who have implemented/would implement the eWTS scheme, to consider implementation of an Approach Spacing Tool to assist controllers in applying separation minima to the increased number of wake turbulence pair combination and to improve consistency in delivering the required spacing according to the intended capacity, where such implementation is considered justified with cost benefits; and

e) discuss any relevant matter as appropriate.

– – – – – – – – — – – – –