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COMMITTEE A

Agenda Item 2: Enabling the global air navigation system
2.1: Aerodrome operations and capacity

RE-CATEGORISATION OF WAKE VORTEX SEPARATION MINIMA AND TIME-BASED SEPARATION

(Presented by Austria on behalf of the European Union and its Member States[1],
the other Member States of the European Civil Aviation Conference[2];
and by EUROCONTROL)

EXECUTIVE SUMMARY

This information paper describes European perspectives regarding implementation of re-categorised wake vortex separation minima (RECAT-EU) and time based separation (TBS) in Europe.

The Conference is invited to take note of the progress of Europe in the implementation of the re-categorisation of wake vortex minima RECAT-EU and time based separation (TBS).

1. INTRODUCTION

1.1 Continued growth in air traffic in Europe of around 2.3 per cent per year and increasing runway congestion during peak hours is driving the need for operational improvements to safely increase runway throughput whilst addressing the challenges of wake vortex to reduce separation minima.

1.2 European airports have improved arrival and departure separation minima by implementing RECAT-EU, a six category wake-vortex separation minima.

1.3 Further capacity benefits have been achieved through the implementation of time-based separations (TBS) that mitigates the impact of wind on runway throughput.

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[1] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom.

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Moldova, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and Ukraine.

2. RUNWAY THROUGHPUT IMPROVEMENTS

2.1 With the advent of large aircraft types, significant collection of wake vortex data and major advances in methods and metrics associated with wake analysis and definition of separation minima, Europe has developed and implemented reduced wake vortex separation minima for arrival and departure traffic.

2.2 A380 and B747-8 wake evaluation campaigns involving teams from EUROCONTROL, AIRBUS, BOEING and the Federal Aviation Administration (FAA), led to an enhanced understanding of wake physics and how an aircraft generates wake and resists the impact of wake, setting foundations for change wake vortex separation.

2.3 A European wake data base was established with data captured in a number of measurement campaigns at Frankfurt, Paris Charles de Gaulle, London Heathrow, and more recently through partnership with Dubai. This data supported both RECAT-EU and TBS development.

2.4 Metrics and methodologies were developed to quantify the wake turbulence risk and establish the safety arguments to reduce wake separation. This knowledge was first used to deploy wake independent departure and arrival operations at Paris Charles de Gaulle and then to develop RECAT EU (wake re-categorisation).

2.5 In 2001, EUROCONTROL developed a concept called time-based separation, commonly known as TBS. Today, this concept has been fully validated in the Single European Sky ATM Research programme (SESAR) and deployed at Heathrow airport. A further sixteen airports are mandated for deployment in the SESAR Deployment program.

2.6 RECAT-EU

2.6.1 Initial work with the FAA was performed to elaborate a new six categorisation scheme that splits each of the ICAO HEAVY and MEDIUM categories into two parts (‘Upper’ and ‘Lower’) and includes Super and Light categories.

2.6.2 This split is based on aircraft type characteristics in terms of wake generation and wake resistance, enabling a reduction of separation minima for some leader-follower pairs of aircraft categories, therefore bringing a runway throughput increase whilst maintaining acceptable levels of safety.

2.6.3 RECAT-EU incorporates reduced separation minima for the Upper Medium (i.e. A320 family/B737 NG family/C-Series family) behind Heavies (A330/A350/B777/B787) and behind A380 and A225, while separation minima for the Light category behind Upper Medium are kept unchanged.

2.6.4 The European Aviation Safety Agency (EASA) has agreed the RECAT-EU Safety Case, advising States and air navigation services providers (ANSPs) that it may be used as a basis to update their current aircraft separation schemes for approach and departure.

2.6.5 RECAT-EU has been deployed at Paris CDG since March 2016, providing significant runway throughput benefits of around five to ten per cent. It fully incorporates reduced separation minima for the A380 aircraft type. RECAT-EU has subsequently been deployed at London Heathrow (in combination with TBS) in 2018 and a partial version covering predominantly operated lower heavy cargo aircraft at Leipzig-Halle. Further European implementation is underway.

2.6.6 RECAT-EU deployment typically brings runway capacity benefits, with additional movements in peak traffic periods, and/or reduced time to land or depart a traffic sequence. These benefits are expected to further increase over time as the overall fleet mix is forecasted to evolve towards larger aircraft – a mitigation for the lack of runway capacity foreseen in EUROCONTROL's 2013 'Challenges of Growth' study.

2.6.7 RECAT-EU also provides a rapid recovery from adverse conditions, helping to reduce overall delay and enabling improvements in air traffic flow management (ATFM) slot compliance through the flexibility afforded by reduced departure separations.

2.6.8 The cost of RECAT-EU deployment is low, limited to local flight data processing system changes associated with the new wake vortex categories, and controller training. Some resources may also have to be dedicated to awareness of flight crews. There is no change to the ICAO flight plan format used by aircraft operators.

2.6.9 RECAT-EU deployment necessitates a collaborative approach involving all stakeholders: ANSPs, airport-based airline(s), airport company and authorities.

2.6.10 RECAT-EU, together with the United States RECAT, has been used as a basis to develop a proposal for amendment of the *Procedures for Air Navigation Services — Air Traffic* Management (PANS-ATM, Doc 4444), including enhanced wake separation provisions supporting capacity-constrained airports worldwide. This will be a seven group categorisation scheme.

2.7 **Time-based separation**

2.7.1 TBS addresses the negative impact of strong headwinds on runway throughput. Strong wind reduces aircraft ground speed during approach increasing the time elapsed between successive runway movements. This decreases the landing rate, resulting in delays. As an example, in Vienna this can result in thirty five landings per hour instead of forty one under normal circumstances.

2.7.2 This negative impact is not only on capacity, but also on the predictability of operations leading to service disruption, particularly exacerbated if this occurs on the first rotation of the day, time and fuel efficiency, and environment (emissions). The impact on predictability for core hubs is particularly important with significant delay impact in the air navigation system at the network level.

2.7.3 TBS helps to maintain runway throughput and landing rate resilience to a range of headwind conditions on final approach by changing the separation metric on final approach from distance to time based separation.

2.7.4 This is witnessed by London Heathrow experience where delay due to headwind is reduced by sixty four per cent due to TBS and in simulations for Vienna where throughput is even increased beyond forty one landings.

2.7.5 The principle of TBS is to dynamically adjust the applicable minimum in-trail distance separation as a function of headwind, in order to maintain a constant time separation as observed in low headwinds, hence maintain a landing rate across the wind conditions.

2.7.6 TBS takes advantage of reliable predicted and real time wind data and an in-depth understanding of the impact of wind on wake vortex. The performance of aircraft on final approach is critical as aircraft speed profiles and behaviour need to be considered to avoid un-safe compression of aircraft spacing (catch-up) between leader and follower aircraft, particularly during the final four miles of approach.

2.7.7 Final approach and tower runway controllers are provided with a TBS separation delivery tool to support the controller accurately apply the time separation between arrival traffic pairs, and importantly to help monitor the compression effect.

2.7.8 The controller working methodology is comparable to today's radar vectoring so there is minimum impact on operational control techniques. A typical separation delivery tool will display a target chevron to the controller on the radar screen as a system aid to position the aircraft on the final approach axis, whilst a second chevron is used to identify the separation minima to be delivered by the threshold.

2.7.9 TBS automation brings consistency, increased resilience and safety by enhancing the controller's role without changing working methods, ensuring the controller is able to retain control in the event of reduction in system performance.

2.7.10 Since TBS automation supports the controller separation task, specifically optimised wake separation minima between aircraft pairs can now be used for reducing separation. New operational improvements such as reduced minimum surveillance separation, runway occupancy, final approach speed compression and advanced approach procedures such as increased glide slopes and displaced thresholds used for noise reduction and wake avoidance can be integrated into the separation delivery tool helping the controller deliver improved runway safety and throughput.

2.7.11 In 2018, RECAT-EU was implemented in TBS system at Heathrow providing additional runway throughput and the airport anticipates further benefits by updating to RECAT-EU-Pairwise in early 2020. TBS deployment is ongoing at Vienna and starting at Paris CDG.

2.8 **Future**

2.8.1 In the context of SESAR, a new set of optimised wake separation minima, RECAT-EU-Pairwise have been developed to provide separation minima between pairs of aircraft types. RECAT-EU-Pairwise will require a separation delivery tool such as TBS.

2.8.2 Weather dependent separations (WDS) will be ready for implementation from 2020. WDS mitigates crosswinds providing an expected increase in capacity and throughput proportional to the number of wake-constrained aircraft pairs. WDS will require a separation delivery tool such as TBS.

2.8.3 SESAR development of procedures and supporting technology to avoid wake and mitigate noise impact using displaced thresholds and adapted glide slopes is reaching maturity. The concepts use differentiated glide paths and displaced thresholds enabled by instrument landing system (ILS) and ground-based augmentation system (GBAS)/satellite-based augmentation system (SBAS) technology to support the reduction of an aircraft noise footprint, moving the noise into the airport, whilst also enabling a reduction of separation between aircraft on final approach by ensuring reduced risk of wake turbulence.

3. **CONCLUSION**

3.1.1 The Conference is invited to take note of the progress of Europe in the implementation of the re-categorisation of wake vortex minima RECAT-EU and TBS.

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