International Civil Aviation Organization

The Twentieth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/20)

Bangkok, Thailand, 26 – 29 May 2015

Agenda Item 3: Reports from Asia/Pacific RMAs and EMAs

ATS ROUTES A461 AND A583 HORIZONTAL SAFETY ASSESSMENT

(Presented by Singapore)

SUMMARY

This paper presents the results of an assessment of the risk associated with the implementation of 50NM lateral and 50NM longitudinal separation standards on ATS routes A461 and A583. The risk associated with the 50NM lateral and 50NM longitudinal separation standard is estimated to be in compliance with the Regional Target Level of Safety (TLS). In light of favorable risk estimates, the safety assessment supports the introduction of 50NM lateral and 50NM longitudinal separation standards on A461 and A583.

1. INTRODUCTION

1.1 This paper provides the details of the airspace safety assessment for the proposed implementation of reduced horizontal separation minima on ATS routes A461 and A583 between Hong Kong, China and Philippines. The full report is in Appendix A.

1.2 SEASMA is the En-route Monitoring Agency for Hong Kong and Manila FIR. It is SEASMA responsibility to ensure that the airspace safety assessment is conducted prior to implementation of reduced horizontal separation minima.

2. DISCUSSION

<u>Executive Summary</u>

2.1 In March 2015, at the Twenty-Second Meeting of the ICAO Southeast Asia ATM Coordination Group (SEACG/22), Hong Kong, China and Philippines agreed to designate ATS Routes A461 and A583 to RNAV routes. By designating it to a RNAV routes, reduced horizontal separation minima may be applied. This will help to increase the capacity and efficiency for flights operating between Hong Kong, China and Philippines.

2.2 The main source of data used in the safety assessment was information extracted from the December 2014 Traffic Sample Data (TSD) collection. The navigation performance of aircraft on these two routes is not available as there is currently no programme to monitor it. The navigation performance of aircraft will affect the collision risk. However, as A461 and A583 are in close proximity to the six parallel routes in the South China Sea (L642, M771, N892, L625, N884 and M767), we can assume that the navigation performance will be quite similar.

2.3 **Table 1** summarizes the result of the airspace risk assessment.

Type of risk	Risk estimation	TLS	Remarks
Lateral Risk	0.002×10^{-9}	5×10^{-9}	Below TLS
Longitudinal Risk	2.998×10^{-9}	5×10^{-9}	Below TLS

Table 1: Comparison of Risk Estimates with TLS for the 2 Routes

2.4 As can be seen, both the estimates of lateral and longitudinal risk show compliance with the corresponding TLS values.

3. ACTION BY THE MEETING

3.1 The Meeting is invited to:

a) Note the information contained in this paper;

b) Note the need to monitor the navigation performance of aircraft on A461 and A583;

c) Note that the safety assessment supports the implementation of 50NM lateral and longitudinal separation minima on the A461 and A583; and

d) Discuss any relevant matters as appropriate.

Appendix A

1. BACKGROUND

1.1 In March 2015, at the Twenty-Second Meeting of the ICAO Southeast Asia ATM Coordination Group (SEACG/22), Hong Kong, China and Philippines agreed to designate ATS Routes A461 and A583 to RNAV routes. By designating it to a RNAV 10 routes, reduced horizontal separation minima may be applied. This will help to increase capacity and efficiency of traffic operating between Hong Kong, China and Philippines.

2. Description of Airways A461 and A583

2.1 A461 and A583 are conventional ATS routes and separated by less than 100NM at NOMAN/A461 and SABNO/A583. Flights passing NOMAN and SABNO at the same level are deemed separate. The longitudinal separation for both airways is 10 minutes with Mach Number Technique. There is no radar coverage between NOMAN to MUMOT on A461 and between SABNO to AKOTA on A583.

2.2 Figure 1 shows the map of A461 and A583.

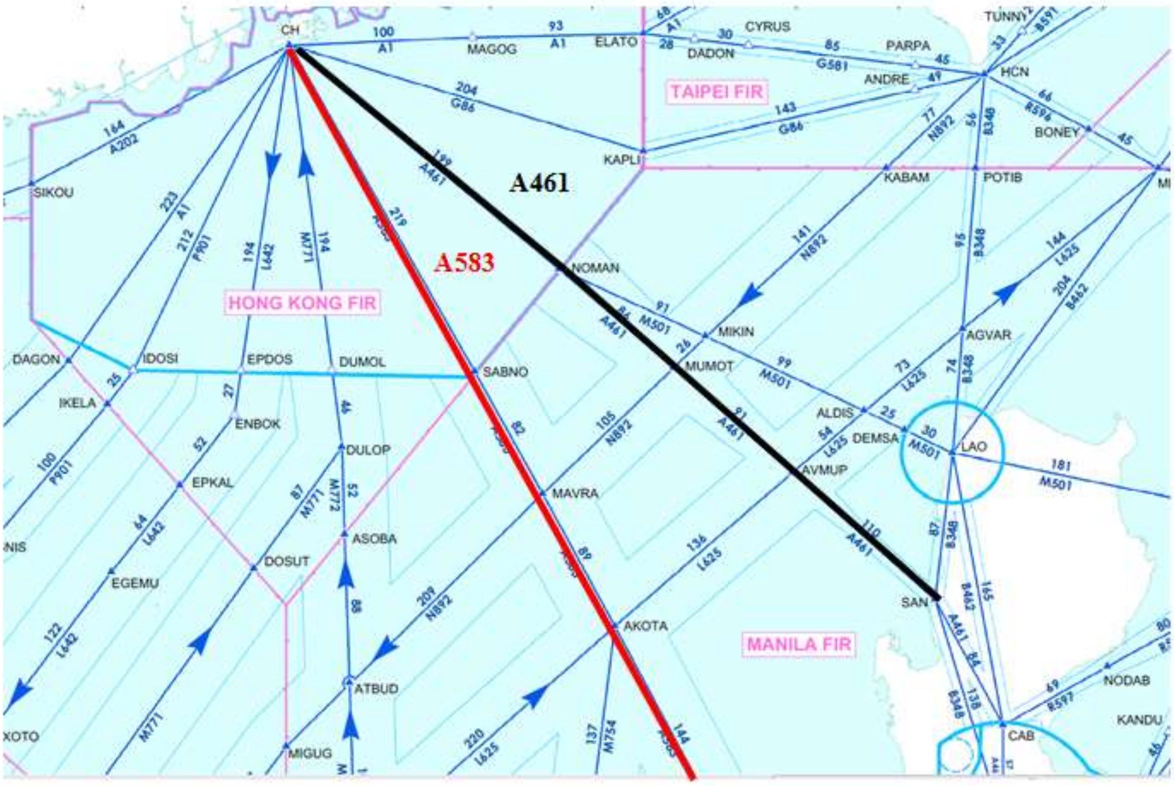

Figure 1: A461 and A583

3. Results of Data Collection

3.1 The December 2014 Traffic Sample Data (TSD) were obtained from Hong Kong, China and Philippines.

3.2 There were no data on the navigation performance of aircraft on these two routes as there is currently no program to monitor it. However, as A461 and A583 are in close proximity to the six parallel routes in the South China Sea (L642, M771, N892, L625, N884 and M767), we assume that the navigation performance will be quite similar.

4. Risk Assessment and Safety Oversight

4.1 The safety assessment has been conducted using the internationally applied collision risk methodology which has supported airspace separation changes in several ICAO regions. As applied to a proposed separation change, the methodology consists of using a mathematical model to estimate the risk of midair collision for the proposed standard and comparing the estimated risk to a safety goal, the Target Level of Safety (TLS), which is a value of risk agreed as tolerable by decision makers. If the estimated risk is less than the TLS, the outcome of applying the methodology is to support the proposed change.

4.2 The APANPIRG has adopted the value 5×10^{-9} fatal accidents per flight hour as the TLS for each separation dimension – lateral, longitudinal and vertical – in the Asia and Pacific Region.

4.3 <u>Factors Affecting the Risk of Collision in the Airspace</u>

3.3.1 One of the assumptions made in developing the collision risk model is that there is no independent surveillance of aircraft position. As a result, there is no allowance made for the value of air traffic control intervention to reduce the risk that a pair of aircraft loses planned separation. Consequently, the risk estimates presented in this working paper should be considered conservative, that is, higher than is likely the case in the airspace.

3.3.2 Operators and aircraft flying at or above FL290 on these routes will require State RNP 10 approval. Compliance with this requirement is equivalent to stating that 95 percent of lateral deviations from route centerline are 10NM or less. In turn, under the assumptions made in the development of the RNP 10 standard, this containment percentage is equivalent to requiring that the standard deviation of lateral errors is roughly 5NM. Since A461 and A583 are in close proximity to the six parallel routes in the South China Sea (L642, M771, N892, L625, N884 and M767), we assume that the navigation performance will be quite similar. Therefore, based on the Radar-based measurements of the positions of aircraft on the South China Seas, it indicated that the standard deviation of lateral errors is on the order of 0.5 NM. As a result, decision makers should have confidence that RNP 10 requirements for lateral navigational performance will be met on A461 and A583.

3.4 <u>Estimation of the CRM Parameters</u>

3.4.1 The targeted lateral separation standard between A461 and A583 is 50NM. The form of the lateral collision risk model used in assessing the safety of operations on these routes is:

$$N_{ay} = P_y(S_y)P_z(0)\frac{\lambda_x}{S_x}\left\{E_y(same)\left[\frac{\overline{|\dot{x}|}}{2\lambda_x}+\frac{\overline{|\dot{y}(S_y)|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]+E_y(opp)\left[\frac{\overline{V}}{\lambda_x}+\frac{\overline{|\dot{y}(S_y)|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]\right\}$$

3.4.2 The longitudinal separation standard for co-altitude aircraft on A461 and A583 to be implemented is 50NM; the current longitudinal separation standard is either 10 minutes with Mach Number Technique (MNT) or 80NM otherwise for the routes.

3.4.3 The form of the longitudinal collision risk model used in assessing the safety of operations on these two routes is:

$$N_{ax} = P_y(0)P_z(0)\frac{2\lambda_x}{|\dot{x}|}\left[\frac{|\dot{x}|}{2\lambda_x} + \frac{|\dot{y}(0)|}{2\lambda_y} + \frac{|\dot{z}|}{2\lambda_z}\right] \times \sum_{k=m}^{N}\sum_{K=k}^{M} Q(k) \times P(K > k)$$

3.4.4 Table 1 summarizes the value and source material for estimating the values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM).

Model Parameter	**Description**	**Value Used in Preliminary Safety**	**Source for Value**
For Lateral Collision Risk Model			
N_{ay}	Risk of collision between two aircraft with planned 50-NM lateral separation	5.0 x 10^{-9} fatal accidents per flight hour	TLS adopted by APANPIRG as safety goal for changes in separation minima
S_y	Lateral separation minimum	50 NM	Targeted lateral separation minimum on A461 and A583.
$P_y(50)$	Probability that two aircraft assigned to parallel routes with 50-NM lateral separation will lose all planned lateral separation	5.98 x 10^{-7}	Value required to meet exactly the TLS value of 5 x 10^{-9} fatal accidents per flight hour, given other parameters used in the safety assessment.
$P_z(0)$	Probability that two aircraft assigned to same flight level are at same geometric height	0.538	Commonly used in safety assessments
λ_x	Aircraft length	0.0399 NM	Merged December 2014 TSDs
λ_y	Aircraft wingspan	0.0350 NM	
λ_z	Aircraft height	0.0099 NM	
S_x	Length of the interval, in NM, used to count proximate aircraft at adjacent fix for occupancy estimates	+120 NM to -120 NM, equivalent to the +15-minute to -15-minute pairing criterion used in the preliminary safety assessment, for aircraft operating at 480 kts.	Arbitrary criterion which does not affect the value of risk
E_y(same)	Same-direction lateral occupancy	0.005	December 2014 TSD
E_y(opp)	Opposite-direction lateral occupancy	0.0	NA

Model Parameter	Description	Value Used in Preliminary Safety	Source for Value
$\lvert\bar{\dot{x}}\rvert$	Average relative along-track speed of 2 aircraft travelling in the same direction	46.5 kts.	December 2014 TSD
$\lvert\bar{\dot{y}}\rvert$	Average relative speed of a pair of aircraft as they lose all planned 50-NM lateral separation	75 kts.	Reference 1
$\lvert\bar{\dot{z}}\rvert$	Average relative vertical speed of a co altitude aircraft pair assigned to the same route	1.5 kts.	Conservative value commonly used in safety assessments
For Longitudinal Collision Risk Model			
N_{ax}	Risk of collision between two co-altitude aircraft with planned longitudinal separation equal to at least the applicable minimum	5.0 x 10^{-9} fatal accidents per flight hour	TLS adopted by APANPIRG for changes in separation minima
$P_y(0)$	Probability that two aircraft assigned to same route will be at same across-track	0.2	Reference 2
$\overline{\lvert\dot{x}(m)\rvert}$	Minimum relative along-track speed necessary for following aircraft in a pair separated by m at a reporting point to overtake lead aircraft at next reporting point	75 knots	December 2014 TSDs
$\overline{\lvert\dot{y}(0)\rvert}$	Relative across-track speed of same-route aircraft pair	1 knot	Reference 2
m	Longitudinal separation minimum in NM	50NM	Targeted longitudinal separation minimum on A461 and A583.
N	Maximum initial longitudinal separation in NM between aircraft pair which will be monitored by air traffic control in order to prevent loss of longitudinal separation standard	150NM	Arbitrary value of actual initial separation beyond which there is negligible chance that actual longitudinal separation will erode completely before next air traffic control check of longitudinal separation based on

Model Parameter	**Description**	**Value Used in Preliminary Safety**	**Source for Value**
M	Maximum longitudinal separation loss in NM observed over all pairs of co-altitude aircraft	Dependent on initial longitudinal separation distance	December 2014 TSD
$Q(k)$	Proportion of aircraft pairs with initial longitudinal separation k	Initial distribution of longitudinal separation for ATS routes A461 and A583.	December 2014 TSD
$P(\ K > k)$	Probability that a pair of same-route, co-altitude aircraft with initial longitudinal separation of k NM will lose at least as much as k NM longitudinal separation before correction by air traffic control	Values derived to satisfy TLS of 50NM longitudinal separation minimum	December 2014 TSD

Table 1: Summary of Risk Model Parameters Used in the CRM

3.5 Safety Oversight - Lateral

3.5.1 For the lateral safety assessment, the 2 routes were considered and the parameters used for the lateral collision risk model were calculated.

3.5.2 The lateral collision risk is estimated to be 0.002 x 10^{-9} which meets the TLS.

3.6 Safety Oversight – Longitudinal

3.6.1 Given the values of $P_y(0)$, $P_z(0)$ and other risk model parameters, the value of the summation of [Q(s) · P(S ≥ s)] for all values of s needed to meet the TLS is 4.24 x10^{-8} for a value of T equal to 30 minutes, the interval between position updates allowing air traffic control to intervene, if necessary, to increase separation.

3.6.2 The resulting value for summation of [Q(s) • P(S ≥ s)] for all values of s, 2.54 x 10^{-8}, is less than the required value of 4.24 x 10^{-8}. The longitudinal collision risk is then estimated to be 2.99 x 10^{-9}.

3.7 Table 2 summarizes the result of the airspace risk assessment.

Type of risk	Risk estimation	TLS	Remarks
Lateral Risk	0.002 x 10^{-9}	5 x 10^{-9}	Below TLS
Longitudinal Risk	2.998 x 10^{-9}	5 x 10^{-9}	Below TLS

Table 2: Comparison of Risk Estimates with TLS for the 2 Routes

3.9 Conclusion

3.9.1 As can be seen, both the estimates of lateral and longitudinal risk shows compliance with the corresponding TLS.