



International Civil Aviation Organization

The 18th Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/18)

Bangkok, Thailand, 01 – 04 April 2013

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

M774 and M635 50NM lateral and longitudinal Separation Safety Assessment

(Presented by South East Asia Safety Monitoring Agency)

SUMMARY

This paper presents the results of the assessment of the risk associated with the implementation of 50NM lateral and 50NM longitudinal separation standards on RNAV routes M635 and M774. Examination of the risk associated with the 50NM longitudinal separation standard also indicates that the TLS is satisfied with high confidence. The assessment concludes that the Asia and Pacific Region Target Level of Safety (TLS) values established for lateral and longitudinal separation standards were satisfied for M635 and M774 with high statistical confidence during the 12-month period examined.

This paper relates to –

Strategic Objectives:

A: *Safety – Enhance global civil aviation safety*

1. INTRODUCTION

1.1 In March 2010, the Second Meeting of the ICAO South East Asia Route Review Task Force, SEA-RR/TF-2, Indonesia and Singapore agreed to implement the realignment of ATS routes to meet RNAV 10 requirement on a step by step basis in the respective FIRs. In this regard, one of the steps is to focus on two of the major routes that operate to/from South-East Asia and Australasia. These two routes are ATS routes A464 and A576. The current minimum longitudinal separation on these 2 routes is 10 minutes based on the Mach number technique and these 2 routes already have RNAV10 capabilities

1.2 The following tasks were planned:

- a) Realignment of RNAV10 route M774 and lowering the upper limit of ATS route A464.
- b) Implementation of new RNAV10 route M635 and lowering the upper limit of ATS route A576 and implementation of 50NM lateral separation in Jakarta and Singapore FIR.
- c) Implementation of 50NM longitudinal separation on both M635 and M774.

2. DISCUSSION

Executive Summary

2.1 Prior to the implementation of the EMARSSH Route Structure which involved routes to/from Australia, Indonesia implemented RNAV10 routes within Indonesia airspace. One such route was L511 which served flights to/from Australia to South East Asia. However L511 has some route segments which are less than 50NM laterally separated with ATS route A576. In order to have both routes laterally separated for RNAV10 operations, Indonesia modified A576 to an RNAV10 route and designated it as M635. Both M635 and M774 were realigned to the north. This action will give a small increase in mileage however the overall benefit with the implementation of both RNAV10 routes will more than compensate this small mileage increase.

2.2 **Table 1** summarizes the result of the airspace risk assessment. **Figure 1** presents the results of the collision risk estimate for each month using the cumulative twelve month LLDs and LLEs report since Jan 2012.

Risk	Risk Estimation	TLS	Remarks
<i>Pre-implementation Lateral Risk</i>	0.00122×10^{-9}	5.0×10^{-9}	<i>Below TLS</i>
<i>Pre-implementation Longitudinal Risk</i>	0.0213×10^{-9}	5.0×10^{-9}	<i>Below TLS</i>
Lateral Risk	0.00171×10^{-9}	5.0×10^{-9}	Below TLS
Lateral Risk	0.0241×10^{-9}	5.0×10^{-9}	Below TLS

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

2.3 There are nil reports of of Large Lateral Deviations (LLD) and Large Longitudinal Errors (LLE) received between Jan 2012 to Dec 2012.

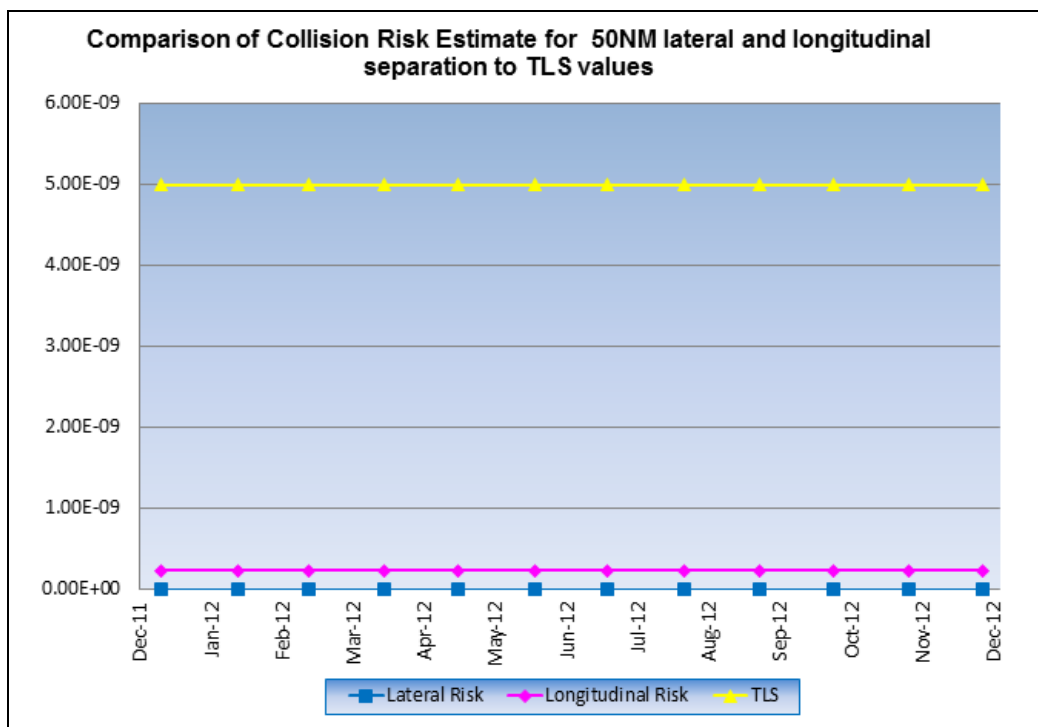


Figure 1: Assessment of Compliance with Lateral and Longitudinal TLS

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) Note the information contained in this paper;
- b) performance on M635 and M774 RNAV routes is compliant with the APANPIRG-agreed lateral and longitudinal TLS.

Appendix

BACKGROUND

3.1 Description of Routes A464 and A576 Airspace

3.2 Prior to the implementation of the EMARSSH Route Structure which involved routes to/from Australia, Indonesia implemented RNAV10 routes within Indonesia airspace. One such route was L511 which served flights to/from Australia to South East Asia. However L511 has some route segments which are less than 50NM laterally separated with ATS route A576. In order to have both routes laterally separated for RNAV10 operations, Indonesia modified A576 to an RNAV10 route and designated it as M635. Both M635 and M774 were realigned to the north. This action will give a small increase in mileage however the overall benefit with the implementation of both RNAV10 routes will more than compensate this small mileage increase.

3.3 Figure 1 shows the map of the New RNAV route M635 and the realigned M774.

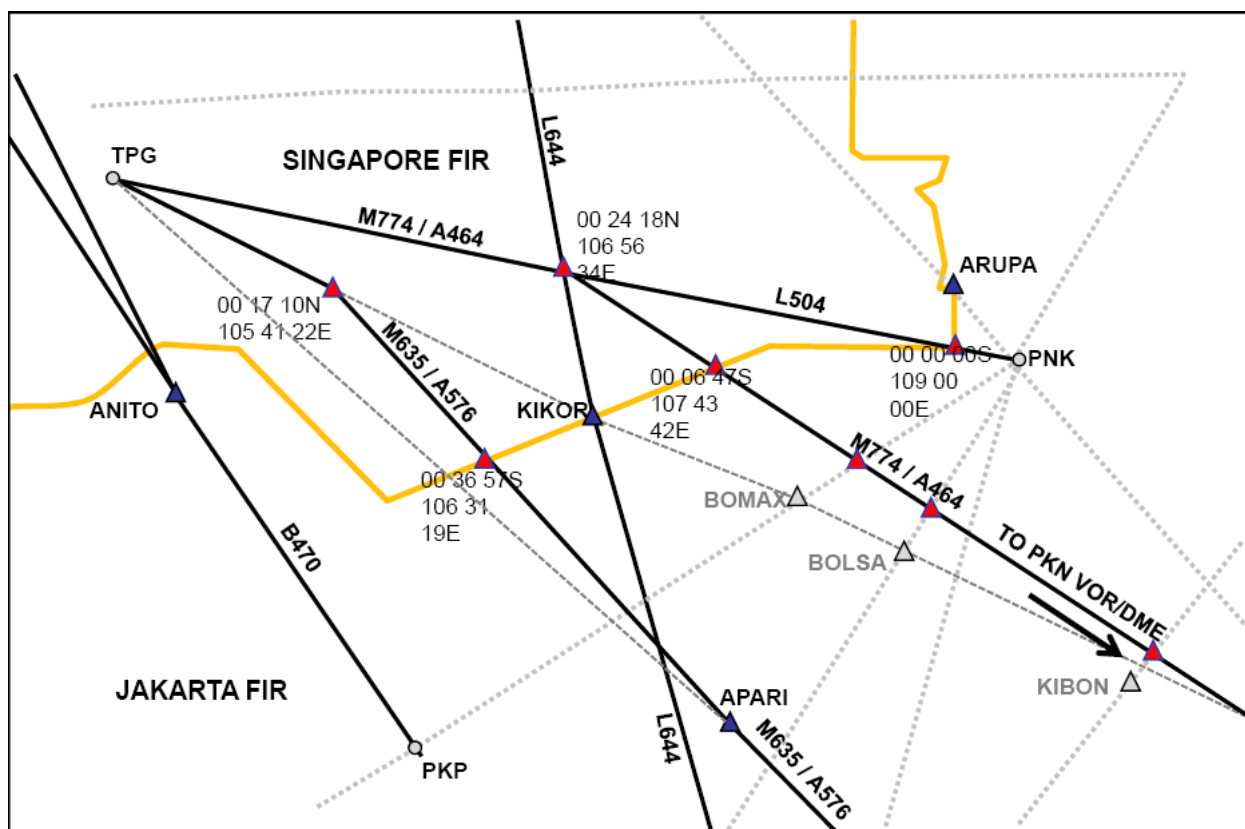


Figure 1: Implementation of M635 and Realignment of M774

4. RESULTS OF DATA COLLECTION

4.1 The December 2012 Traffic Sample Data (TSDs) from Indonesia was not received in time, therefore the Dec 2011 TSD was used in this risk assessment.

4.2 There were no Navigational Error reports reported for the period Jan 2012 through Dec 2012.

4.3 Table 1 presents the total traffic counts reported by month for ATS routes M635 and M774 monitoring fixes for the period Jan 2012 through Dec 2012.

Monitoring Month	Total Monthly Traffic Count Reported over Monitored Fixes	Cumulative 6-Month Count of Traffic reported Over Monitored Fixes Through Monitoring Month
January 2012	4697	49073
February 2012	2638	47562
March 2012	3896	47098
April 2012	3668	46508
May 2012	3742	45868
June 2012	3717	45222
July 2012	3872	44571
August 2012	3829	43847
September 2012	3732	43196
October 2012	4017	43017
November 2012	3925	42591
December 2012	4169	42011

Table 1: Monthly Count of Monitored Flights Operating on M635 and M774 for the period Jan 2012 through Dec 2012

4.4 Table 2 presents the cumulative totals of Large Lateral Deviations (LLDs) and Large Longitudinal Errors (LLEs) for the Monitoring Period Jan 2012 through Dec 2012 period.

Monitoring Month	Cumulative 6-Month Count of LLDs Reported Over Monitored Fixes Through Monitoring Month	Cumulative 6-Month Count of LLEs Reported Over Monitored Fixes Through Monitoring Month
January 2012	0	0
February 2012	0	0
March 2012	0	0
April 2012	0	0
May 2012	0	0
June 2012	0	0
July 2012	0	0
August 2012	0	0
September 2012	0	0
October 2012	0	0
November 2012	0	0
December 2012	0	0

Table 2: Monthly Count of LLDs and LLEs Reported on M635 and M774 for the period Jan 2012 through Dec 2012

4.5 It is of the utmost importance that relevant information be provided so that the safety assessment will be correct and effective. States are strongly urged to provide accurate data to facilitate the conduct of the safety assessment and to identify trends.

5. Risk Assessment and Safety Oversight

5.1 This section presents the results of safety oversight to the lateral and longitudinal separations standards applied in RNAV routes M635 and M774. Analysis techniques used are in conformance with the internationally applied collision risk methodology.

5.2 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.

5.3 Estimate of the Collision Risk Model Parameters

5.4 The targeted lateral separation standard between M635 and M774 is 50NM. The form of the lateral collision risk model used in assessing the safety of operations on these routes is:

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

5.5 The longitudinal separation standard for co-altitude aircraft on M635 and M774 is 50NM. The form of the longitudinal collision risk model used in assessing the safety of operations on these two routes is:

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

5.6 Table 3 summarizes the value and source material for estimating the values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM). Appendix A provides the details in deriving the parameters used in the lateral and longitudinal collision risk model.

Model Parameter	Description	Value Used in Preliminary Safety Assessment	Source for Value
For Lateral Collision Risk Model			
N_{ay}	Risk of collision between two aircraft with planned 50-NM lateral separation	5.0×10^{-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 RNAV routes M635 and M774.
$P_y(50)$	Probability that two aircraft assigned to parallel routes with 50-NM lateral separation will lose all planned lateral separation	1.40×10^{-8}	Value required to meet exactly the TLS value of 5×10^{-9} fatal accidents per flight hour, given other parameters used in the safety assessment.
$P_z(0)$	Probability of vertical overlap for airplanes assigned to the same flight level	0.538	Commonly used in safety assessments
λ_x	Aircraft length	0.0399 NM	Merged December 2011 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
$E_y(\text{same})$	Same-direction lateral occupancy	0.017	December 2011 TSD
$E_y(\text{opp})$	Opposite-direction lateral occupancy	0.0	NA
$ \bar{x} $	Average relative along-track speed of 2 aircraft travelling in the same direction	67.6 kts.	December 2011 TSD
$ \dot{\bar{y}} $	Average relative speed of a pair of aircraft as they lose all planned 50-NM lateral separation	75 kts.	Reference 1
$ \bar{z} $	Average relative vertical speed of a co altitude aircraft pair	1.5 kts.	Conservative value commonly used in safety

Model Parameter	Description	Value Used in Preliminary Safety Assessment	Source for Value
	assigned to the same route		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 longitudinal separation standard	5.0×10^{-9} fatal accidents per flight hour	TLS adopted by APANPIRG for changes in separation minima
$P_y(0)$	Probability of lateral overlap for airplanes assigned to the same route	0.2	Reference 2
$ \dot{x}(m) $	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	100 knots	December 2011 TSD
$ \dot{y}(0) $	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 RNAV routes M635 and M774.
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 position reports
M	Maximum longitudinal separation loss in NM observed over all pairs of co-altitude aircraft	Dependent on initial longitudinal separation distance	December 2011 TSD

Model Parameter	Description	Value Used in Preliminary Safety Assessment	Source for Value
$Q(k)$	Proportion of aircraft pairs with initial longitudinal separation k	Initial distribution of longitudinal separation for ATS routes M635 and M774.	December 2011 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 2011 TSD

Table 3: Summary of Risk Model Parameters Used in the CRM

5.7 Safety Oversight

5.8 Table 4 summarizes the result of the airspace risk assessment.

Type of risk	Risk estimation	TLS	Remarks
Lateral Risk	0.00171×10^{-9}	5×10^{-9}	Below TLS
Longitudinal Risk	0.0241×10^{-9}	5×10^{-9}	Below TLS

Table 4: Comparison of Risk Estimates with TLS for the 2 Routes

5.9 Figure 3 presents the results of the collision risk estimate for each month using the cumulative twelve month LLDs and LLEs report since Jan 2012.

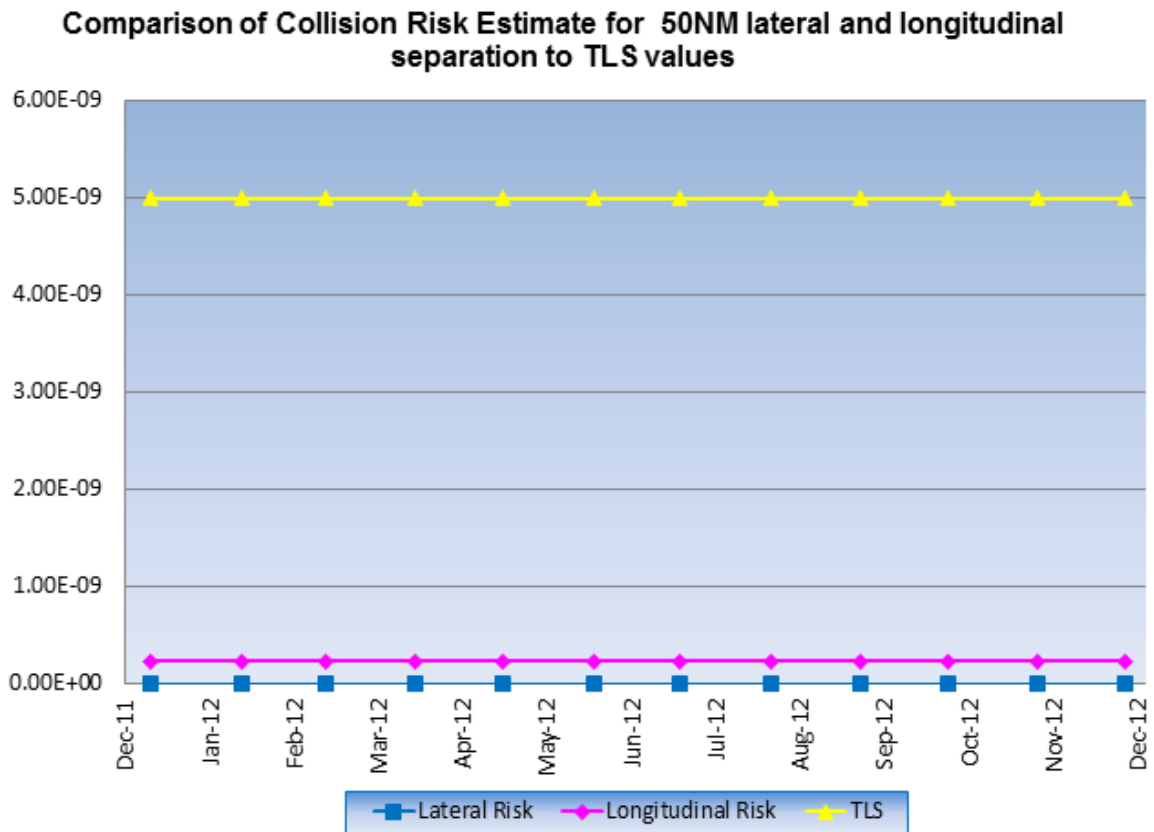


Figure 3: Assessment of Compliance with Lateral and Longitudinal TLS

5.10 Conclusions and Recommendations from the Safety Assessment concerning the implementation of the 50-NM Lateral and the implementation of 50NM Longitudinal Separation Standard on RNAV routes M635 and M774.

5.11 As can be seen, both the estimates for lateral and longitudinal risk show compliance with the corresponding TLS values during the months of the monitoring period.

References

1. Information Paper on the Examination of Operations Conducted On ATS Routes in the Bay of Bengal Region (BOB/RHS/TF/5)
2. “A Summary of Airspace Characteristics Related to the Operational Trial of 30/30NM lateral and longitudinal separation standards in the Oakland Oceanic Flight Information Region (FIR),” Twenty-fifth meeting of the informal pacific ATC coordinating group (IPACG/25), Tokyo, Japan, 24-27 October 2006, IP-4 Rev.1.