



*International Civil Aviation Organization*

**The Sixteenth Meeting of the Regional Airspace Safety Monitoring  
Advisory Group (RASMAG/16)**

Bangkok, Thailand, 20 – 24 February 2012

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

**Report from the South East Asia Safety Monitoring Agency:  
December 2010 – November 2011**

(Presented by South East Asia Safety Monitoring Agency)

**SUMMARY**

This working paper examines the operations on the six major air traffic service routes in South China Sea. The examination covers the period 1 December 2010 through 30 November 2011. 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 the six-route system with high statistical confidence during the 12-month period examined.

This paper relates to –

**Strategic Objectives:**

- A. *Safety – Enhance global civil aviation safety*

Action by the Meeting is at Section 5.

## 1. Introduction

1.1 This working paper is a periodic assessment of whether flight operations on the six major South China Sea routes comply with APANPIRG-agreed Target Level of Safety (TLS) values for lateral and longitudinal separation standards. The examination period covered is from 1 December 2010 till 30 November 2011.

## 2. Background

2.1 The lateral separation standard applied in the six South China Sea routes – L642, M771, N892, L625, N884 and M767 – is 50NM. The longitudinal separation minimum applied almost everywhere in the airspace is 10 minutes, with Mach number technique applied, or 80NM RNAV. Pairs of co-altitude aircraft cleared on either L642 or M771 have been eligible for a 50NM longitudinal separation minimum since 3 July 2008 based on an analysis which demonstrated compliance with the applicable TLS value.

## 3. Results of Data Collection

3.1 The fidelity of large-error and traffic-count reporting by each responsible air navigation service provider (ANSP) for the period December 2010 through November 2011 is shown in table 1.

Month	Report Received from:		
	Hong Kong, China	Philippines	Singapore
December 2010	Yes	Yes	Yes
January 2011	Yes	Yes	Yes
February 2011	Yes	Yes	Yes
March 2011	Yes	Yes	Yes
April 2011	Yes	Yes	Yes
May 2011	Yes	Yes	Yes
June 2011	Yes	Yes	Yes
July 2011	Yes	Yes	Yes
August 2011	Yes	Yes	Yes
September 2011	Yes	Yes	Yes
October 2011	Yes	Yes	Yes
November 2011	Yes	Yes	Yes

Table 1: Record of ANSP Reporting by Month for Period December 2010 through November 2011

3.2 *Reported Traffic Counts for December 2010 through November 2011 Monitoring Period*

3.2.1 Table 2 presents the total traffic counts reported by month transiting all South China Sea monitoring fixes for the period December 2010 through November 2011.

<b>Monitoring Month</b>	<b>Total Monthly Traffic Count Reported Over Monitored Fixes</b>	<b>Cumulative 12-Month Count of Traffic Reported Over Monitored Fixes Through Monitoring Month</b>
December 2010	8929	92544
January 2011	8690	94004
February 2011	7937	95086
March 2011	8905	96464
April 2011	8882	97709
May 2011	9331	98770
June 2011	9193	99851
July 2011	9503	101167
August 2011	9717	103078
September 2011	9528	104935
October 2011	9051	106045
November 2011	9848	107713

Table 2: Monthly Count of Monitored Flights Operating on South China Sea RNAV Routes for the period December 2010 through November 2011

### 3.3 *Reports of Large Lateral Deviations (LLDs) and Large Longitudinal Errors (LLEs) for the Monitoring Period December 2010 through November 2011*

3.3.1 Table 3 presents the cumulative totals of LLDs and LLEs.

<b>Monitoring Month</b>	<b>Monthly Count of LLDs Reported Over</b>	<b>Cumulative 12-Month Count of LLDs Reported Over Monitored Fixes</b>	<b>Monthly Count of LLEs Reported Over Monitored Fixes</b>	<b>Cumulative 12-Month Count of LLEs Reported Over Monitored Fixes</b>
December 2010	0	3	0	0
January 2011	0	3	0	0
February 2011	0	3	0	0
March 2011	0	3	0	0
April 2011	0	2	0	0
May 2011	0	2	0	0
June 2011	1	1	0	0
July 2011	0	1	0	0
August 2011	0	1	0	0
September 2011	0	1	0	0
October 2011	0	1	0	0
November 2011	1	2	0	0

Table 3: Monthly Count of LLDs and LLEs Reported on South China Sea RNAV Routes for the period December 2010 through November 2011

3.3.2 Table 4 presents the cause of deviation in the LLD report received for the period December 2010 through November 2011.

<b>Deviation Code</b>	<b>Cause of Deviation</b>	<b>No of Occurrences</b>
A	Flight crew deviate without ATC Clearance	1
D	ATC system loop error	1

Table 4: Cause of deviation in the LLD report

#### 4. Risk Assessment and Safety Oversight

4.1 This section presents the results of safety oversight to the lateral and longitudinal separations standards applied in the South China Sea RNAV route structure. Analysis techniques used are in conformance with the internationally applied collision risk methodology.

##### 4.2 Estimate of the CRM Parameters

4.2.1 The lateral separation standard between the six RNAV routes is 50NM. The form of the lateral collision risk model used in assessing the safety of operations on the South China Sea RNAV routes is:

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

4.2.2 The longitudinal separation standard for co-altitude aircraft on RNAV routes L642 and M771 is 50NM; for the other four RNAV routes, the longitudinal separation standard is either 10 minutes with Mach Number Technique (MNT) or 80NM RNAV.

4.2.3 The form of the longitudinal collision risk model used in assessing the safety of operations on the South China Sea RNAV routes is:

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

4.2.4 Table 5 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	Definition	Value Used in TLS Compliance Assessment	Source for Value
<b>For Lateral Collision Risk Model</b>			
$N_{ay}$	Risk of collision between two aircraft with planned 50NM lateral separation	$5.0 \times 10^{-9}$ fatal accidents per flight hour	TLS adopted by APANPIRG for changes in separation minima
$S_y$	Lateral separation minimum	50NM	Current lateral separation minimum in the South China Sea
$P_y(50)$	Probability that two aircraft assigned to parallel routes with 50NM lateral separation will lose all planned lateral separation	$2.69 \times 10^{-9}$	Value required to meet exactly the APANPIRG-agreed TLS value using equation (1), given other parameter values shown in this table.
$\lambda_x$	Aircraft length	0.0399NM	Based on December 2010 TSD operations on L642/M771
$\lambda_y$	Aircraft wingspan	0.0329NM	
$\lambda_z$	Aircraft height	0.0099NM	
$P_z(0)$	Probability of vertical overlap for airplanes assigned to the same flight level	0.538	Commonly used in safety assessments
$S_x$	Length of half the interval, in NM, used to count proximate aircraft at adjacent fix for occupancy estimates	120NM, equivalent to the +/- 15-minute pairing criterion	Arbitrary criterion which does not affect the estimated value of lateral collision risk
$E_y(\text{same})$	Same-direction lateral occupancy	0.0	Result of direction of traffic flows on each pair of RNAV routes
$E_y(\text{opp})$	Opposite-direction lateral occupancy	0.174	Based on December 2010 TSD
$\bar{V}$	Individual-aircraft along-track speed	492 knots	Combined December 2010 TSD
$ \dot{y}(S_y) $	Average relative lateral speed of aircraft pair at loss of planned lateral separation of $S_y$	75 knots	Conservative value based on assumption of waypoint insertion error
$ \dot{z} $	Average relative vertical speed of a co altitude aircraft pair assigned to the same route	1.5 knots	Conservative value commonly used in safety assessments

Model Parameter	Definition	Value Used in TLS Compliance Assessment	Source for Value
<b>For Longitudinal Collision Risk Model</b>			
$N_{ax}$	Risk of collision between two co-altitude aircraft with planned longitudinal separation equal to at least the applicable minimum longitudinal separation standard	$5.0 \times 10^{-9}$ 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	Based on December 2010 TSD
$ \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	Based on December 2010 TSD
$ \dot{y}(0) $	Relative across-track speed of same-route aircraft pair	1 knot	Based on December 2010 TSD
$m$	Longitudinal separation minimum in NM	50NM	Current preferred longitudinal separation minimum on RNAV routes L642 and M771; used for all RNAV routes in TLS compliance assessment
$N$	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	Based on December 2010 TSD
$Q(k)$	Proportion of aircraft pairs with initial longitudinal separation $k$	Initial distribution of longitudinal separation for RNAV routes L642 and M771 used in RASMAG/9 safety assessment	Based on December 2010 TSD

Model Parameter	Definition	Value Used in TLS Compliance Assessment	Source for Value
<b>For Longitudinal Collision Risk Model</b>			
$P(K > k)$	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	Based on December 2010 TSD

Table 5: Summary of Risk Model Parameters Used in the CRM

4.3 Safety Oversight

4.3.1 Table 6 summarizes the results of the airspace oversight, as of November 2011.

Type of Risk	Risk Estimation	TLS	Remarks
Lateral Risk	$0.68 \times 10^{-9}$	$5 \times 10^{-9}$	Below TLS
Longitudinal Risk	$1.18 \times 10^{-9}$	$5 \times 10^{-9}$	Below TLS

Table 6: Lateral and Longitudinal Risk Estimation

4.3.2 Figure 1 presents the results of the collision risk estimates for each month using the cumulative 12-month LLD and LLE reports since December 2010.

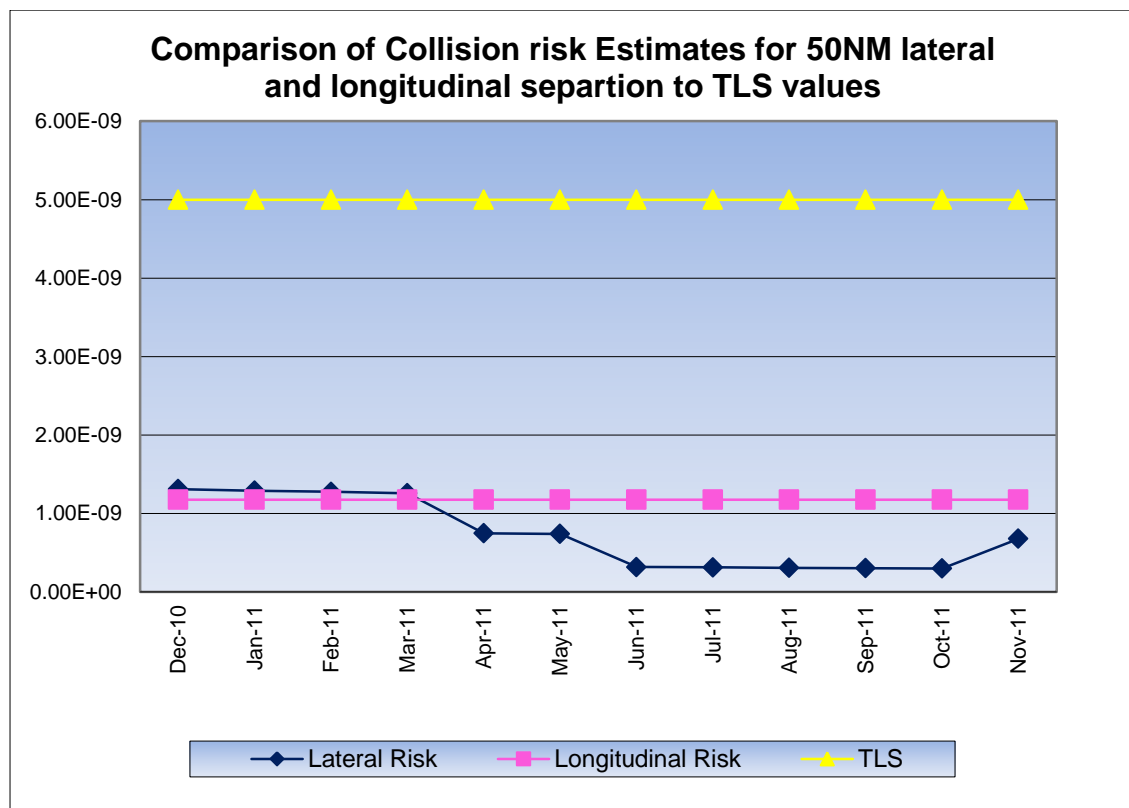


Figure 1 - Assessment of Compliance with Lateral and Longitudinal TLS Values Based on Navigational Performance Observed During South China Monitoring Program



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

**5. Action by the Meeting**

5.1 The Meeting is invited to note the SEASMA findings that:

- a) performance on the South China Sea RNAV routes is compliant with the APANPIRG-agreed lateral TLS
- b) performance on the South China Sea RNAV routes is compliant with the APANPIRG-agreed longitudinal TLS.

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