International Civil Aviation Organization

The Twenty-First Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/21)

Bangkok, Thailand, 14-17 June 2016

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

JASMA HORIZONTAL SAFETY ASSESSMENT

(Presented by JASMA)

SUMMARY

This paper presents the results of the horizontal airspace safety assessment of the oceanic airspace of the Fukuoka Flight Information Region (FIR) for the year 2015(1st Jan.2015-31st Dec.2015.)

1. INTRODUCTION

This paper provides the horizontal risk assessment results of Fukuoka FIR oceanic airspace carried out by JASMA. In this paper we report the risk results of three ATC separations, namely;

a) Time based longitudinal separation. (10 minutes without Mach number technique)

b) Distance based longitudinal separation. (RNP4)

c) 50NM lateral separation.

For the calculation methods and parameters used, please refer to the Attachment A to this paper.

2. ESTIMATED RISK VALUES

2.1 The calculation results of our report for RASMAG/20-WP20 was 9.33×10^{-9} and it was “Above TLS”. As we reported at MAWG/3 at Canberra, we recalculated using the amended data and got 2.76×10^{-9} and it was “Below TLS” by ENRI proposed automatic data screening process. It was based on the observed fact that between the aberrant data and initial separation of the pair of aircrafts has positive correlation. We used the same method and got the risk value 3.96×10^{-9}.

10 MINUTES SEPARATION

2.1

Table 1 shows calculation results of 10 minutes time based longitudinal separation without Mach number technique. Risk estimations are below TLS.

NOPAC Routes – estimated annual flying hours = 82040 hours *(note: estimated hours based on 2015 traffic sample data)*			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 21 Longitudinal Time Risk	$\boldsymbol{3.96\times10^{-9}}$	5.0×10^{-9}	*Below TLS*
RASMAG 20 Longitudinal Time Risk	9.33×10^{-9}	5.0×10^{-9}	*Above TLS*

Table 1: NOPAC time separation Risk Estimates

30NM SEPARATION FOR RNP4 AIRCRAFT

2.2 **Table 2** shows calculation results of 30NM distance based longitudinal separation collision risk estimates. Risk estimations are below TLS.

NOPAC Routes ADS-C aircraft – estimated annual flying hours = 82040 hours *(note: estimated hours based on 2015 traffic sample data)*			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 21 Longitudinal 30NM Risk	$\boldsymbol{3.86\times10^{-11}}$	5.0×10^{-9}	*Below TLS*
RASMAG20 Longitudinal 30NM Risk	5.7×10^{-10}	5.0×10^{-9}	*Below TLS*

Table 2: Risk Estimates for RNP4 aircraft with 30NM distance based separation

50NM LATERAL SEPARATION

2.3 **Table 3** shows collision risk for laterally separated aircraft in the NOPAC system. The risk value might increase as the traffic volume increases, but for the time being we believe the values will remain below TLS.

NOPAC Routes(EXCEPT G344) – estimated annual flying hours = 82040 hours *(note: estimated hours based on 2015 traffic sample data)*			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 21 Lateral Risk	$\boldsymbol{4.89\times10^{-10}}$	2.5×10^{-9}	*Below TLS*
RASMAG 20 Lateral Risk	0.75×10^{-9}	2.5×10^{-9}	*Below TLS*

Table 3: Lateral separation Risk Estimates for NOPAC

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) Discuss the results of the airspace safety oversight presented in this working paper and the attached documentation.

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References

1) R Mori., “Safety Assessment for Reduced Time-based Separation Minima on Oceanic Routes” IEICE Technical Report 20011 May

Attachment A

This appendix provides the calculation methods and parameters used.

1) Using the longitudinal overlapping probability, the collision risk is estimated by the following formula (2)

$$N_{ax} = P_y(0) \cdot P_z(0) \cdot \frac{2\lambda_x}{|\dot{x}|T}\left(\frac{\overline{|\dot{x}|}}{2\lambda_x} + \frac{\overline{|\dot{y}(0)|}}{2\lambda_y} + \frac{\overline{|z(0)|}}{2\lambda_z}\right)\sum E_x(t)P_x(t) \qquad (1)$$

The individual parameters for the equation (1) and their definitions are given in **Table 1**.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
Py(0)	Probability that two aircraft on the same track are in lateral overlap	0.669	SASP-WG/WHL/13-IP/08
Pz(0)	Probability of vertical overlap in operational risk estimation for the aircraft flying as a same flight level	0.5380	ICAO SASP safety assessment
$\overline{\lvert\dot{y}(0)\rvert}$	The average relative speed between two aircraft, across track.	1 kt	EMA handbook
$\overline{\lvert\dot{z}(0)\rvert}$	Average vertical speed of aircraft pairs	1.5 kt	ICAO SASP safety assessment
λx	Average aircraft length	0.0267 nm	JASMA(2015Dec)
λy	Average aircraft width	0.00245 nm	JASMA(2015Dec)
λz	Average aircraft height	0.0078nm	JASMA(2015Dec)
T	The average time to fly the segment.	0.69h	FDPS data (NOPAC)
$E_x(t)$	The proportion of aircraft initial separation		
$P_x(t)$	The probability of the loss of longitudinal separation.		

Table 1：parameters in Equation

2) The formulas of the lateral collision risk model used in assessing the safety of operation on NOPAC routes are:

$$N_{ay}(same) = P_z(0)P_y(S_y)\frac{2\lambda_x}{\overline{|\Delta V|}}N_x^y(same)\left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] \qquad (2)$$

$$N_{ay}(opposite) = P_z(0)P_y(S_y)\frac{2\lambda_x}{2\overline{|V|}}N_x^y(opp)\left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] \qquad (3)$$

$$N_{ay} = N_{ay}(same) + N_{ay}(opposite) \qquad (4)$$

3) **Table 2** summarizes the value and source material for estimating the parameter values of the following Collision Risk Model (CRM) used to conduct safety oversight for the RNP-10 based 50NM lateral separation minimum of NOPAC routes.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value

$\overline{\lvert V \rvert}$	Individual-aircraft along track speed	480 kt	Value often used
$\overline{\lvert \Delta V \rvert}$	Average along track speed of aircraft pairs	28.9 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC,Apr. 1994)
$\overline{\lvert \dot{y} \rvert}$	Average cross track speed of aircraft pairs	42.22 kt	Doc.9689 1st eds. Appendix 13
$\overline{\lvert \dot{z} \rvert}$	Average vertical speed of aircraft pairs	1.5 kt	Value often used
λx	Average aircraft length	0.0267 nm	JASMA(2015Dec)
λy	Average aircraft width	0.0245nm	JASMA(2015Dec)
λz	Average aircraft height	0.0078nm	JASMA(2015Dec)
N_x(same)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the same direction traffic	1.18×10^{-2}	FDPS data (NOPAC, Dec, 2015)
N_x(opp)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	1.10×10^{-1}	FDPS data (NOPAC, Dec, 2015)
$P_z(0)$	Probability of vertical overlap in operational risk estimation for the aircraft flying as a same flight level	0.54	Value often used (shown in RVSM/TF-9-IP/2)
$P_y(50)$	Probability that two aircraft on the same track are in lateral overlap	6.07×10^{-9}	DDE Normal model

Table 2: Estimates of the parameters in the CRM

4) Collision risk for 50NM ATC lateral separation

The total number of Flight hours and Passing frequencies are shown in **Table 3**. Note that passing frequencies between airway R220 and R580 is relatively small. Because R220 and R580 are both westbound only for all the time. So passing occurs only when catching up occurs. On the other hand passing frequencies between R580 and A590 is larger because R580 is used for westbound while A590 is used east bound. The R591 is eastbound only unless designated as westbound PACOTS track.

	Flight Hours		Passing Frequencies		
	East Bounds	West Bounds	Same E-Bounds	Same W-Bounds	Opposite Direction
R220	0	3689.7			
			0	31	0
R580	0	950.3			
			0	0	377.5
A590	1863.3	0			
			9.5	0	0
R591	333.4	0			
			0	0	0

Table 3: Flight Hours and Passing Frequencies

Table 4 shows lateral collision risk estimation on NOPAC routes. Total risk estimation is below TSL.

Source of Risk	Risk Estimation

N_{ay} (same)	1.07×10^{-10}
N_{ay} (opposite)	3.81×10^{-10}
N_{ay} (total)	4.89×10^{-10}

Table 4：NOPAC Lateral collision risk estimation