



ICAO

International Civil Aviation Organization

Twenty-Sixth Meeting of the Regional Airspace Safety  
Monitoring Advisory Group (RASMAG/26)

Video Teleconference, 20 – 23 September 2021

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

**JASMA HORIZONTAL SAFETY REPORT**

(Presented by JASMA)

**SUMMARY**

This paper presents the results of the horizontal safety assessment of the Pacific Ocean airspace in the Fukuoka Flight Information Region (FIR) for the period January 2020 to December 2020.

**1. INTRODUCTION**

1.1 This paper provides the horizontal risk assessment results of the Pacific Ocean airspace of the Fukuoka Flight Information Region (FIR) carried out by the Japan Airspace Safety Monitoring Agency (JASMA). In this paper, we report the risk estimation results of the following three horizontal separation standards.

- a) 50NM lateral separation
- b) 10 minutes Time-based longitudinal separation (without Mach number technique)
- c) 30NM Distance-based longitudinal separation (PBCS and RNP4)

**2. DISCUSSION**

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

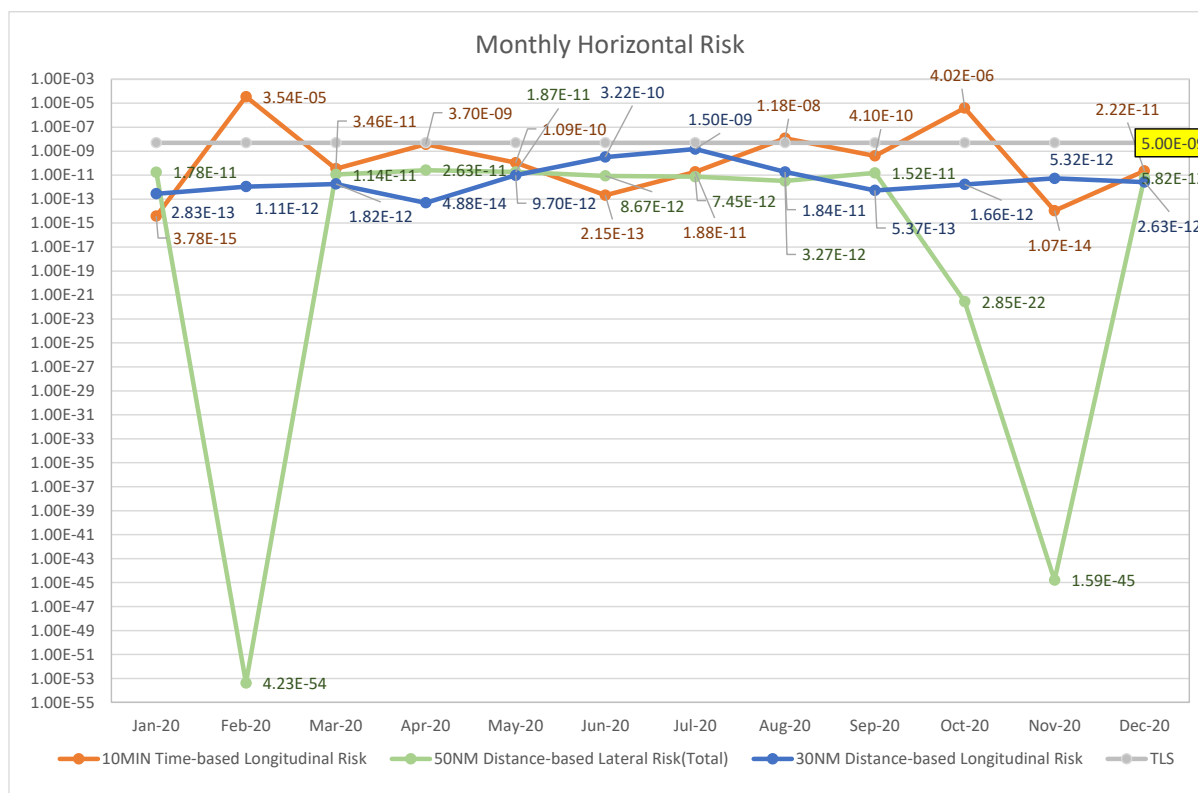
Executive Summary

2.2 **Table 1** provides the North Pacific Ocean airspace horizontal risk estimates. **Figure 1** presents the lateral and longitudinal collision risk estimate trends for the North Pacific Ocean airspace during the period January 2020 to December 2020.

<b>North Pacific Ocean Airspace – estimated annual flying hours = 81,549 hours</b> <i>(note: estimated hours based on Dec 2020 traffic sample data)</i>			
<b>Risk</b>	<b>Risk Estimation</b>	<b>TLS</b>	<b>Remarks</b>
<i>RASMAG 25 50NM Lateral Risk</i>	$1.45 \times 10^{-9}$	$5.0 \times 10^{-9}$	<i>Below TLS</i>
<i>RASMAG 25 10MIN Time-based Longitudinal Risk</i>	$20.1 \times 10^{-9}$	$5.0 \times 10^{-9}$	<i>Above TLS</i>
<i>RASMAG 25 30MN Distance-based Longitudinal Risk</i>	$0.015 \times 10^{-9}$	$5.0 \times 10^{-9}$	<i>Below TLS</i>
50NM Lateral Risk	<b><math>0.65 \times 10^{-9}</math></b>	$5.0 \times 10^{-9}$	<b>Below TLS</b>
10MIN Time-based Longitudinal Risk	<b><math>0.25 \times 10^{-9}</math></b>	$5.0 \times 10^{-9}$	<b>Below TLS</b>

30NM Distance-based Longitudinal Risk	<b>0.015 x 10<sup>-9</sup></b>	5.0 x 10 <sup>-9</sup>	<b>Below TLS</b>
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**Table 1:** North Pacific Ocean Airspace Horizontal Risk Estimates



**Figure 1:** North Pacific Ocean Airspace Horizontal Risk Estimates

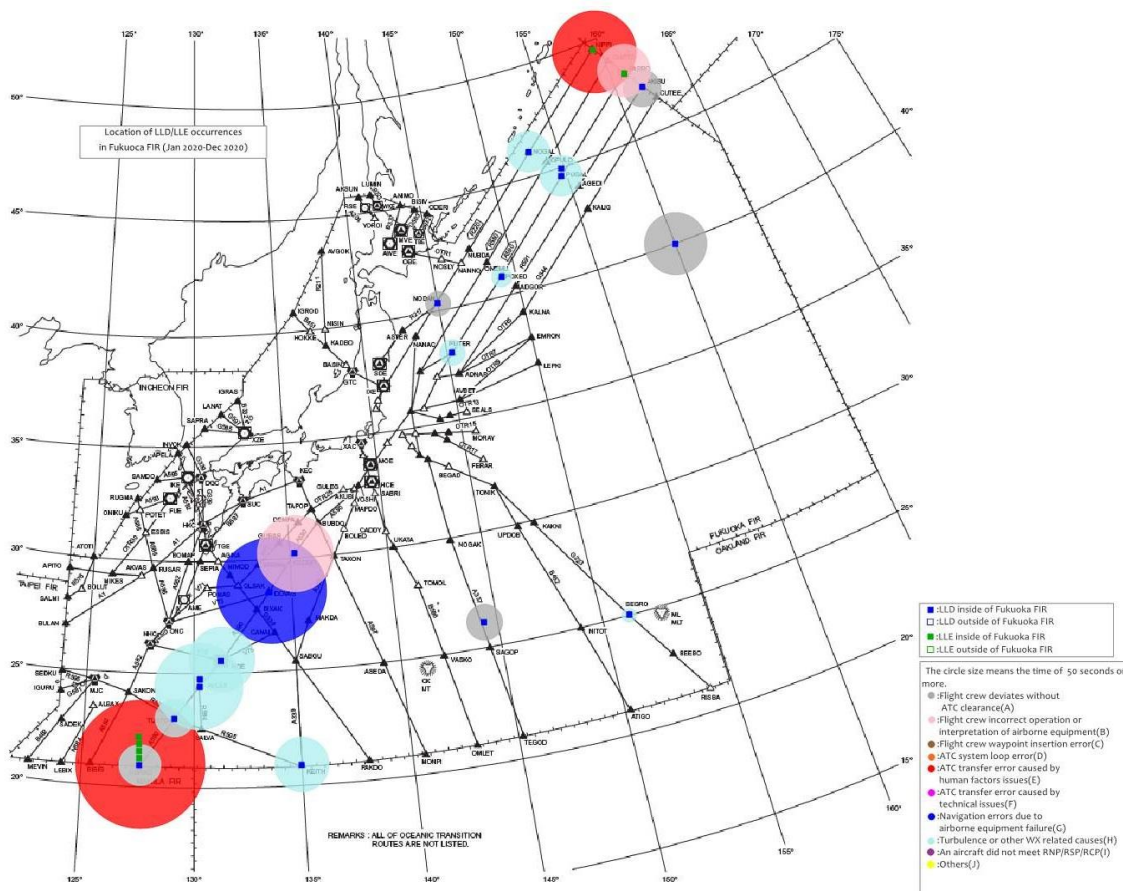
2.3 **Table 2** contains a summary of Large Lateral Deviations (LLD) and Large Longitudinal Errors (LLE) received by JASMA for the Pacific Ocean airspace.

Code	Deviation Description	No.
A	Flight crew deviates without ATC clearance in the horizontal dimension	4
B	Flight crew incorrect operation or interpretation of airborne equipment	2
C	Flight crew waypoint insertion error, due to correct entry of incorrect position or incorrect entry of correct position	0
D	ATC system loop error	0
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	5
F	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues	0
G	Navigation errors due to airborne equipment failure leading to a deviation in the horizontal dimension of which notification was not received by ATC or notified too late for action	1
H	Turbulence or other weather related causes (other than approved) leading to a deviation in the horizontal dimension;	12
I	An aircraft was provided with reduced horizontal separation minima but did not meet the RNP/RSP/RCP specification	0
J	Others	0
Total		24

**Table 2:** Summary of Pacific Ocean Airspace LLD and LLE Reports

2.4 Category H, Turbulence or other weather related causes, was the top contributors during the calendar year 2020.

2.5 **Figure 2** provides the geographic location of LLD and LLE reports within Pacific Ocean Airspace during the assessment period. The filled blue square symbols represent LLD location in Fukuoka FIR, and the hollow blue square symbols represent LLD location outside of Fukuoka FIR. The filled green square symbols represent LLE location in Fukuoka FIR, and the hollow green square symbols represent LLE location outside of Fukuoka FIR. The circle size means an LLD or LLE duration of 50 seconds or more.



**Figure 2:** Pacific Ocean Airspace –LLD & LLE

2.6 The restructure of the North Pacific (NOPAC) Route System with implementing 23 NM lateral separation for aircraft approved PBCS and RNP4 have been started to consider and discuss by the Federal Aviation Administration (FAA) and JCAB.

2.7 The restructure will be conducted with a phased approach. JASMA is keeping up with the consideration and discussion to update procedures and software for the safety assessment as an EMA.

### 3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- note the information contained in this paper; and
- discuss any relevant matters as appropriate.

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**Attachment**

**1. COLLISION RISK FOR 50NM ATC LATERAL SEPARATION**

1.1 The North Pacific (NOPAC) Route System is comprised of five Air Traffic Service (ATS) routes which transit the North Pacific between Alaska and Japan.

1.2 The two northern routes, R220 and R580 are used for westbound traffic. The center route, A590 is used for eastbound traffic. The southern two routes, R591 and G344 are used for eastbound traffic that aircraft crossing the FIR boundary between Anchorage FIR and Fukuoka FIR between 0900UTC and 2100UTC and used for westbound traffic that aircraft crossing the FIR boundary between 0000UTC and 0600UTC.

1.3 NOPAC Passing Frequencies are shown in **Table 1**. Note that passing frequencies between airway R220 and R580 is relatively small because R220 and R580 are both westbound only for all the time, passing occurs only when catching up occurs. On the other hand, passing frequency between R580 and A590 is large, because R580 is used for westbound while A590 is used for eastbound. The passing frequency between A590 and R591 is small because the flight hours of R591 is small.

Airways	Flight Hours		Passing Frequencies		
	East Bounds	West Bounds	Same East Bounds	Same West Bounds	Opposite Direction
R220	0	38407.1	0	79.5	0
R580	0	9146.34	0	0	2704
A590	27345.8	0	30.5	0	11
R591	2924.31	50.0464	0	0	4
R344	3408.01	267.709			

**Table 1:** Flight Hours and Passing Frequencies

1.4 **Table 2** shows the estimated lateral collision risk on NOPAC routes. The total risk estimation is below TSL.

Source of Risk	Risk Estimation
N <sub>ay</sub> (same)	0.06 × 10 <sup>-9</sup>
N <sub>ay</sub> (opposite)	0.59 × 10 <sup>-9</sup>
N <sub>ay</sub> (total)	0.65 × 10 <sup>-9</sup>

**Table 2:** NOPAC Lateral collision risk estimation

**2. Consideration for LLDs and LLEs**

2.1 24 cases of the RNP deviation were reported from the Fukuoka Air Traffic Management Center (ATMC) during the calendar year 2020 as shown in **Table 3**.

No.	Date	Time (UTC)	LLD /LLE	Location	ACFT TYPE	Assigned ALT	Deviation (Direction)	Duration	CAT
1	19-Jan-2020	10:01	LLD	40N160E	A332	FL350	13NM (right)	10 min	A

2	30-Jan-2020	15:26	LLE	GURAG	B77W	FL310	-	14 min	E
3	11-Mar-2020	11:01	LLD	AKISU	B77W	FL330	10NM (left)	5 min	A
4	26-Mar-2020	20:36	LLE	NIPPI	MD11	FL310	-	17 min	E
5	31-Mar-2020	2:31	LLD	SAGOP	C17	FL320	10NM (right)	4 min	A
6	26-Apr-2020	5:25	LLD	DOVAG	K35R	FL370	100NM (south east)	25 min	G
7	1-May-2020	9:48	LLD	POXED	B744	FL330	15NM (left)	2 min	H
8	1-May-2020	10:53	LLD	OLDUP	B1	FL210	15NM (right)	14 min	B
9	4-May-2020	4:03	LLD	AVLAS	B788	FL410	11NM (right)	10 min	H
10	1-Jun-2020	3:19	LLD	NOGAL	B744	FL330	20NM (right)	6 min	H
11	7-Jun-2020	5:11	LLD	AVLAS	A333	FL380	10NM (right)	5 min	H
12	4-Jul-2020	17:19	LLD	NODAN	B748	FL360	10NM (left)	3 min	A
13	26-Jul-2020	6:14	LLD	MDE	B744	FL400	10NM (left)	11 min	H
14	8-Aug-2020	17:53	LLD	SEGRO	B763	FL330	15NM (right)	1 min	H
15	13-Aug-2020	12:38	LLD	TUNTO	B77W	FL330	5NM (left)	5 min	H
16	10-Sep-2020	16:00	LLD	PUGAL	B77W	FL330	50NM (right)	2 min	H
17	10-Sep-2020	16:53	LLD	PUGAL	B748	FL320	40NM (left)	4 min	H
18	10-Sep-2020	19:20	LLD	PUTER	B77W	FL330	15NM (right)	3 min	H
19	15-Sep-2020	20:38	LLE	GURAG	B78X	FL390	-	8 min	E
20	20-Sep-2020	1:56	LLD	KEITH	B744	FL410	15NM (right)	7 min	H
21	14-Nov-2020	0:50	LLE	PASRO	D328	FL290	-	7 min	B
22	7-Dec-2020	14:30	LLE	GURAG	A359	FL370	-	4 min	E
23	7-Dec-2020	15:26	LLE	GURAG	A359	FL370	-	6 min	E
24	9-Dec-2020	13:50	LLD	GURAG	B1	FL280	30NM (right)	6 min	H

**Table 3:** Summary of LLD and LLE reports

### 3. Risk Assessment

3.1 The calculation methods and parameters used are following;

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

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

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

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
$P_y(0)$	Probability that two aircraft on the same track are in lateral overlap	0.815	JASMA (2020)
$P_z(0)$	Probability of vertical overlap in operational risk estimation for the aircraft flying as a same flight level	0.55	Doc 10063 Appendix F Table F-5
$\overline{ \dot{y}(0) }$	The average relative speed between two aircraft, across track.	1 kt	EMA handbook
$\overline{ \dot{z}(0) }$	Average vertical speed of aircraft pairs	1.5 kt	ICAO SASP safety assessment
$\lambda_x$	Average aircraft length	0.0371 nm	JASMA (TSD of NOPAC in 2020/12)
$\lambda_y$	Average aircraft width	0.0340 nm	JASMA (TSD of NOPAC in 2020/12)
$\lambda_z$	Average aircraft height	0.0098 nm	JASMA (TSD of NOPAC in 2020/12)
$T$	The average time to fly the segment.	0.69 h	ICAP data (NOPAC)
$E_x(t)$	The proportion of aircraft initial separation		
$P_x(t)$	The probability of the loss of longitudinal separation.		

**Table 4:** parameters in Equation

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

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

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

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

3) **Table 5** 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
$\overline{ V }$	Individual-aircraft along track speed	480 kt	Doc 10063 Appendix F Table F-5
$\overline{ \Delta V }$	Average along track speed of aircraft pairs	28.9 kt	Kushiro Air Route Surveillance Radar data (R220 of NOPAC, Apr. 1994)

$\overline{ \dot{y} }$	Average cross track speed of aircraft pairs	36 kt	Doc 10063 Appendix F F.2.4
$\overline{ \dot{z} }$	Average vertical speed of aircraft pairs	1.5 kt	Doc 10063 Appendix F Table F-5
$\lambda x$	Average aircraft length	0.0371 nm	JASMA (TSD of NOPAC in 2020/12)
$\lambda y$	Average aircraft width	0.0340 nm	JASMA (TSD of NOPAC in 2020/12)
$\lambda z$	Average aircraft height	0.0098 nm	JASMA (TSD of NOPAC in 2020/12)
$N_x(\text{same})$	The passing frequency of aircraft pair assigned to the adjacent flight levels under the same direction traffic	$2.70 \times 10^{-3}$	ICAP data (NOPAC, 2020)
$N_x(\text{opp})$	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	$6.67 \times 10^{-2}$	ICAP data (NOPAC, 2020)
$P_z(0)$	Probability of vertical overlap in operational risk estimation for the aircraft flying as a same flight level	0.55	Doc 10063 Appendix F Table F-5
$P_y(50)$	Probability that two aircraft on the same track are in lateral overlap	$1.55 \times 10^{-8}$	DDE Normal model (2020)

**Table 5:** Estimates of the parameters in the CRM