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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 1 January 2019 to 31 December 2019.

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)

1.2 The Japan Civil Aviation Bureau (JCAB) has been conducting replacement of the Air Traffic Control (ATC) systems from legacy systems to new systems adopted the Trajectory Based Operations (TBO).

1.3 The Trajectorized Oceanic Traffic Data Processing System (TOPS), a new Oceanic ATC system of JCAB, has started its operations since 3 February 2019 instead of the Oceanic Data Processing (ODP) which was a legacy Oceanic ATC system of JCAB.

1.4 The trajectory data are created and managed by the Integrated Control Advice Processing System (ICAP) which is one of the new ATC systems of JCAB, and the transfer information is sent, received, and managed by the ATC Data Exchange System (ADEX) which is one of the new ATC systems of JCAB too.

1.5 The JASMA's program to calculate the horizontal risk estimate was upgraded for data from TOPS/ICAP/ADEX and was calculated the risk estimate after the term of starting operation of TOPS because the data to calculate the risk estimate are not compatible between TOPS/ICAP/ADEX and ODP.

2. DISCUSSION

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

Executive Summary

2.2 **Table 1** provides the North Pacific Ocean airspace horizontal risk estimates. **Figure 1** presents the 10 minutes time-based longitudinal collision risk estimate trends for the North Pacific airspace during the period February 2019 to December 2019.

North Pacific Airspace – estimated annual flying hours = 89.318 hours *(note: estimated hours based on Dec 2019 traffic sample data)*			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 24 50NM Lateral Risk	*0.054 x 10^{-9}*	*5.0 x 10^{-9}*	*Below TLS*
RASMAG 24 10MIN Time-based Longitudinal Risk	*0.14 x 10^{-9}*	*5.0 x 10^{-9}*	*Below TLS*
RASMAG 24 30NM Distance-based Longitudinal Risk	*0.001 x 10^{-9}*	*5.0 x 10^{-9}*	*Below TLS*
50NM Lateral Risk	**1.45 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**
10MIN Time-based Longitudinal Risk	**20.1 x 10^{-9}**	5.0 x 10^{-9}	**Above TLS**
30NM Distance-based Longitudinal Risk	**0.015 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**

Table 1: Pacific Airspace Horizontal Risk Estimates

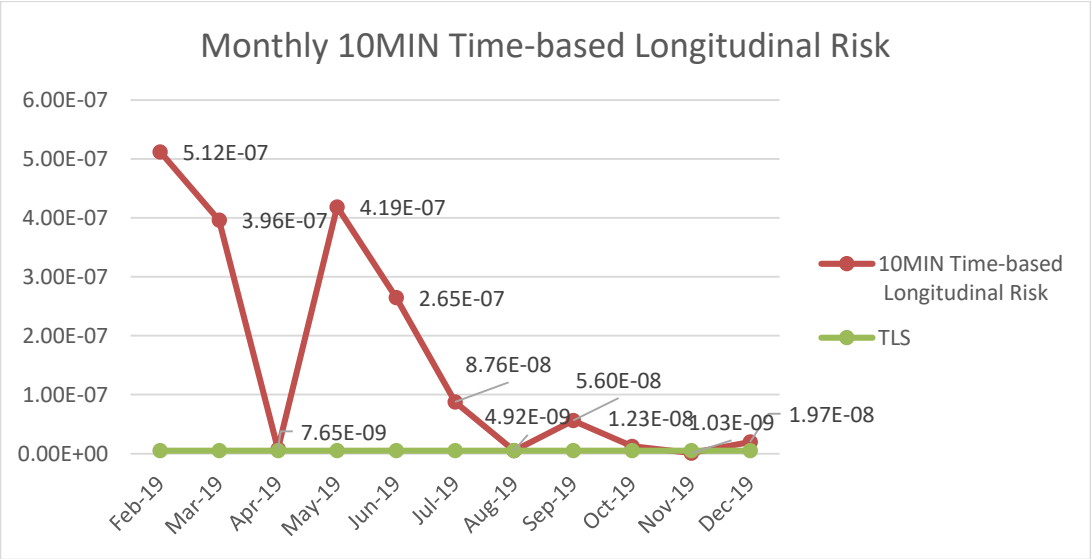

Figure 1: North Pacific Ocean Airspace Horizontal Risk Estimates

2.3 The monthly 10 minutes time-based longitudinal collision risk estimate had been highly unstable and above the TLS between February 2019 and September 2019.

2.4 It is recognized that the trajectory data from ICAP had not been accurate until a major updated program was applied to ICAP in June 2019. The trajectory data from ICAP after October 2019 seem to be accurate, so that 10 minutes time-based longitudinal collision risk estimate will be stable in 2020.

2.5 **Table 2** contains a summary of Large Lateral Deviations (LLD) and Large Longitudinal Errors (LLE) received by JASMA for the Pacific Ocean airspace of the Fukuoka FIR. Category A, flight crew deviating without ATC clearance, and category D, ATC system loop error, were the top contributors during the calendar year 2019.

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	1

	Flight crew waypoint insertion error, due to correct entry of incorrect position or incorrect entry of correct position	1
D	ATC system loop error	4
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	2
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	0
H	Turbulence or other weather related causes (other than approved) leading to a deviation in the horizontal dimension;	0
I	An aircraft was provided with reduced horizontal separation minima but did not meet the RNP/RSP/RCP specification	0
J	Others	1
Total		13

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

2.6 There were four reported LLDs assigned to category D that occurred around GURAG, the Hot spot D at the FIR boundary between Manila FIR and Fukuoka FIR. There were one reported LLD and one reported LLE assigned to category E also occurred around GURAG.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

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Attachment A

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.

	Flight Hours		Passing Frequencies		
Airways	East Bounds	West Bounds	Same East Bounds	Same West Bounds	Opposite Direction
R220	0	37901.7			
			0	2227	0
R580	0	13152.1			
			0	0	6684
A590	33488.8	0			
			55	0	111
R591	4327.5	474.7			

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_{ay} (same)	0.14×10^{-9}
N_{ay} (opposite)	1.31×10^{-9}
N_{ay} (total)	1.45×10^{-9}

Table 2: NOPAC Lateral collision risk estimation

2. Consideration for LLDs and LLEs

2.1 13 cases of the RNP deviation were reported from the Air Traffic Management Center (ATMC) during the calendar year 2019 as shown in **Table 3**.

No.	Date	Time (UTC)	LLD /LLE	Location	ACFT TYPE	Assigned ALT	Deviation (Direction)	Duration	CAT
1	22-Feb-2019	13:21	LLD	34N160E	B763	350B370	10NM (Right)	3 min	C
2	31-Mar-2019	12:30	LLD	SEALS	B788	FL400	100NM (Left)	15 min	B
3	1-Jun-2019	03:19	LLD	NOGAL	B744	FL330	10NM (right)	6 min	A

4	6-Aug-2019	07:45	LLD	GURAG	A21N	FL350	110NM (left)	2 min	D
5	15-Aug-2019	04:52	LLD	GURAG	B789	FL350	80NM (left)	0 min	E
6	16-Aug-2019	08:07	LLD	MDE	A321	FL340	50NM (right)	34 min	A
7	19-Oct-2019	18:00	LLD	TUNTO	B752	FL300	50NM (left)	10 min	A
8	7-Nov-2019	15:42	LLD	GURAG	P8	FL330	50NM (left)	0 min	D
9	5-Dec-2019	19:15	LLD	GURAG	B789	FL350	30NM (left & right)	19 min	D
10	9-Dec-2019	17:37	LLE	PAKDO	B738	FL360	-	13 min	J
11	16-Dec-2019	14:57	LLE	GURAG	B77W	FL310	-	80 min	E
12	18-Dec-2019	03:12	LLD	GURAG	B744	FL360	20NM (left)	4 min	D
13	24-Dec-2019	19:55	LLD	GURAG	A20N	FL310	10NM (left)	5 min	A

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 (2)

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

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	0.828	JASMA (2019)
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	0.0272 nm	JASMA (2019 Dec)
λy	Average aircraft width	0.0247 nm	JASMA(2019 Dec)
λz	Average aircraft height	0.0078 nm	JASMA(2019 Dec)
T	The average time to fly the segment.	0.69 h	FDPS 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:

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

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

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

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
$\overline{\lvert V\rvert}$	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 of 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	0.0272 nm	JASMA (Dec 2019)
λy	Average aircraft width	0.0247 nm	JASMA (Dec 2019)
λz	Average aircraft height	0.0078 nm	JASMA (Dec 2019)
N_x(same)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the same direction traffic	6.31×10^{-3}	FDPS data (NOPAC, Dec 2019)
N_x(opp)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	1.52×10^{-1}	FDPS data (NOPAC, Dec 2019)
$P_z(0)$	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	1.51×10^{-8}	DDE Normal model (2019)

Table 5: Estimates of the parameters in the CRM