International Civil Aviation Organization

The Nineteenth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/19)

Pattaya, Thailand, 27-30 May 2014

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

JASMA RVSM SAFETY REPORT

(Presented by JASMA)

SUMMARY

This paper presents the results of the airspace safety assessment of the Fukuoka Flight Information Region (FIR) by the Japan Airspace Safety Monitoring Agency (JASMA) for the time period from 1 January 2013 to 31 December 2013.

1. INTRODUCTION

1.1 The paper provides details of the airspace safety oversight assessment undertaken by the Japan Airspace Safety Monitoring Agency (JASMA) for the RVSM implementations in Fukuoka FIR. The report is detailed in **Attachment 1**.

2. DISCUSSION

2.1 The report shows that for the Fukuoka FIR, the target level of Safety (TLS) was met for the reporting period with the assessed risk calculated as 3.66×10^{-9}.

2.2 **Table 1** summarizes Fukuoka FIR RVSM technical, operational and total risks. **Figure 1** presents collision risk estimate trends during the period from 1 January 2013 to December 2013.

Fukuoka FIR – estimated annual flying hours = 1101469 hours *(note: estimated hours based on Dec 2012 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG18 Total Risk (PREVIOUS RASMAG)	*4.34×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
Technical Risk	0.40×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	3.26×10^{-9}	-	-
Total Risk	**3.66×10^{-9}**	5.0×10^{-9}	**Below TLS**

Table 1: Fukuoka FIR RVSM Risk Estimates

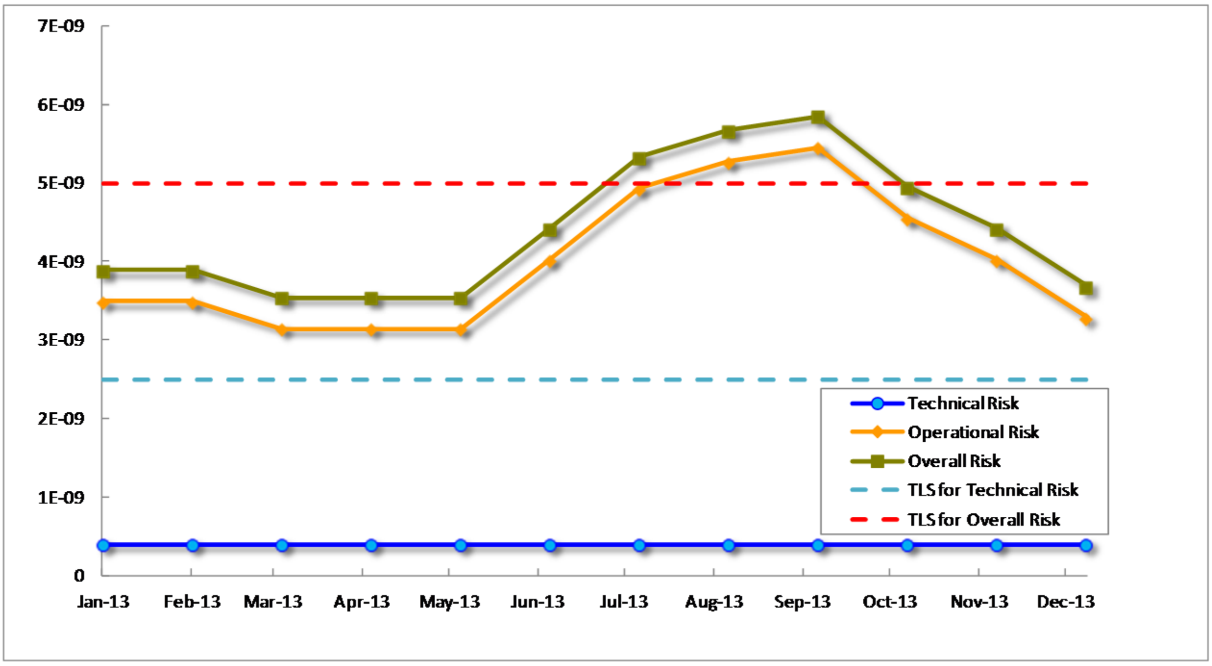

Figure 1: Fukuoka FIR RVSM Risk Estimate Trends

2.3 **Table 2** presents as summary of the LHD causes within Fukuoka FIR from 1 January 2013 to 31 December 2013.

Code	LHD Category Description	No.
A	Flight crew fails to climb or descend the aircraft as cleared	1
B	Flight crew climbing or descending without ATC clearance	2
C	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	2
E	ATC transfer of control coordination errors due to human factors	15
F	ATC transfer of control coordination errors due to technical issues	0
G	Aircraft contingency leading to sudden inability to maintain level	2
H	Airborne equipment failure and unintentional or undetected level change	0
I	Turbulence or other weather related cause	8
J	TCAS resolution advisory and flight crew correctly responds	17
K	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	0
M	Other	1
Total		48

Table 2: Summary of LHD Causes within Fukuoka FIR.

2.4 **Figure 2** provides the geographic location of risk bearing LHD reports within Fukuoka FIR during the assessment period.

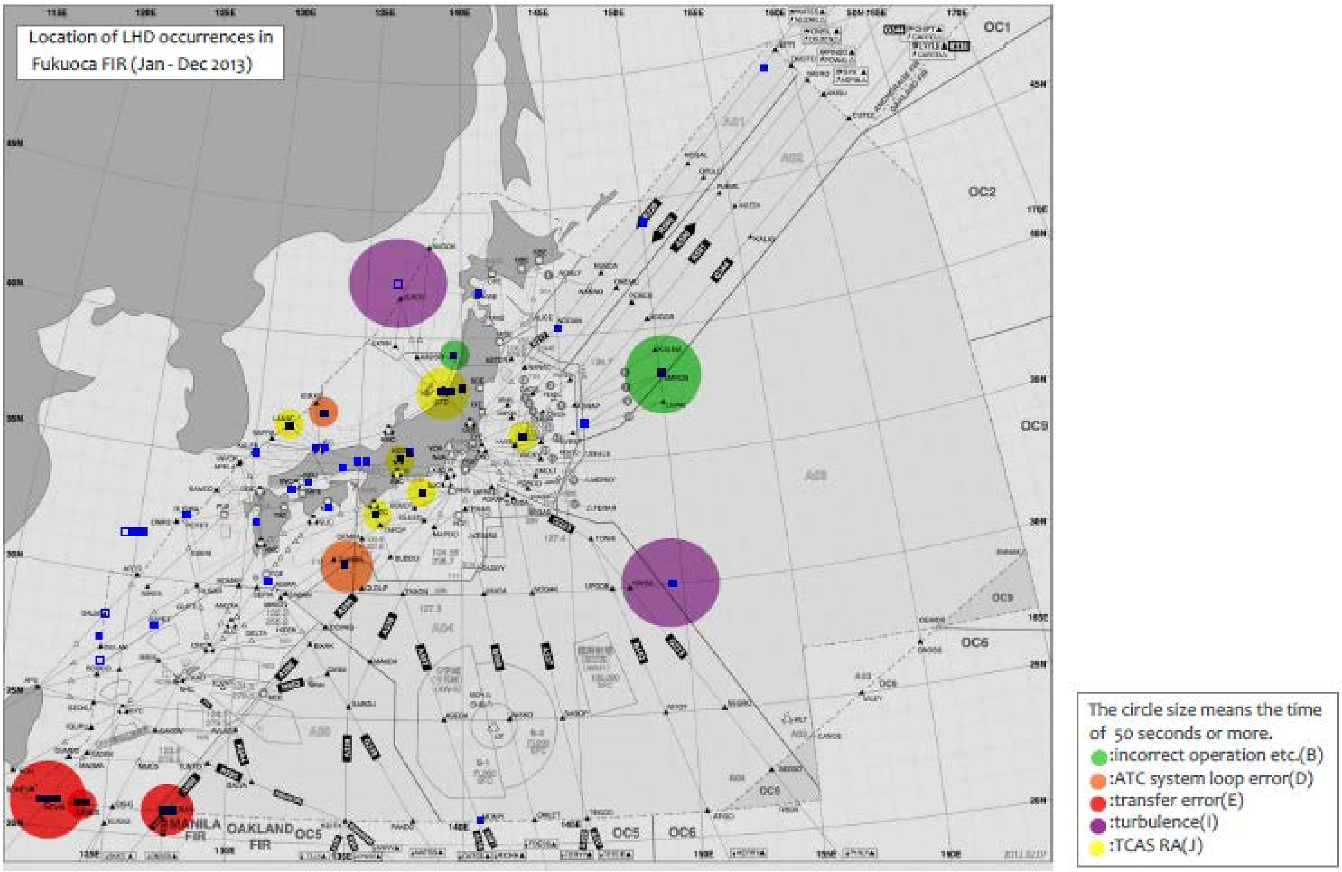

Figure 2: Fukuoka FIR – Risk Bearing LHD

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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AIRSPACE SAFETY REVIEW FOR THE RVSM IMPLEMENTATION IN FUKUOKA FLIGHT INFORMATION REGION

JAN 2013 to DEC 2013

(Presented by JASMA)

SUMMARY

The purpose of this repot is to compare actual performance to safety goals related to continued use of reduced vertical separation minimum (RVSM) in Fukuoka Flight Information Region (FIR). This report contains a summary of large height deviation reports received by the JASMA and an update of the vertical collision risk for the time period of 1 January 2013 to 31 December 2013. There are at total of 48 reported large height deviations that occurred during this period in Fukuoka FIR. The vertical collision risk estimate for the RVSM airspace in Fukuoka FIR is 3.66 x 10^{-9} that meets the target level of safety (TLS).

1. INTRODUCTION

1.1 The Japan Airspace Safety Monitoring Agency (JASMA) has produced a periodic airspace safety assessment for the RVSM implementation in the Fukuoka FIR.

1.2 This paper presents a summary of large height deviation reports received by the JASMA and an update of the vertical collision risk for the time period of 1 January 2013 to 31 December 2013 are reported in the **Attachment 1**. JASMA has received fifty one (51) Large Height Deviation (LHD) reports during this period. The vertical collision risk estimate for the RVSM airspace in the Fukuoka FIR is 3.66 x 10^{-9} that meets the target level of safety (TLS) value of 5.0 x 10^{-9} fatal accidents per flight hour.

2. DISCUSSION

2.1 Traffic Sample Data (TSD)

2.1.1 Traffic Sample data for the month of December 2013 of aircraft operating in the Fukuoka FIR were used to assess the safety of RVSM airspace.

2.2 Large Height Deviation (LHD)

2.2.1 A series of cumulative 12-month of LHD reports were used in this safety assessment starting from January 2013 to December 2013.

2.2.2 Summary of LHD Occurrences in the Fukuoka FIR

2.2.3 **Table 1** summarizes the number of LHD occurrences and associated LHD duration (in minutes) by month in the RVSM airspace of the Fukuoka FIR.

Table 1: Summary of LHD Occurrences and Duration per Month in the Fukuoka FIR

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)
January 2013	4	0.98
February 2013	2	0
March 2013	3	3.75
April 2013	1	0.83
May 2013	4	10.5
June 2013	3	5.37
July 2013	8	6.83
August 2013	8	13.92
September 2013	1	1.0
October 2013	4	0.33
November 2013	6	3.62
December 2013	4	3.0
Total	**48**	**50.13**

2.2.4 The LHD reports are separated by categories based on the details provided for each deviation. **Table 2** presents a summary of the LHD causes within Fukuoka FIR from Jan. 2013 until Dec. 2013. JASMA received two LHD reports of three LHD event from ATC facilities and one aircraft operator, so that the total number is less than three (3) against the total number of LHD mention in paragraph 1.2.

Code	LHD Category Description	No.
A	Flight crew fails to climb or descend the aircraft as cleared	1
B	Flight crew climbing or descending without ATC clearance	2
C	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	2
E	ATC transfer of control coordination errors due to human factors	15
F	ATC transfer of control coordination errors due to technical issues	0
G	Aircraft contingency leading to sudden inability to maintain level	2
H	Airborne equipment failure and unintentional or undetected level change	0
I	Turbulence or other weather related cause	8
J	TCAS resolution advisory and flight crew correctly responds	17
K	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	0
M	Other	1
Total		48

Table 2: Summary of LHD Causes within Fukuoka FIR.

2.2.5 **Appendix A** contains the details of the fourteen (14) LHDs contributed to the operational risk, which were reported to the JASMA during the reporting period.

2.2.6 **Appendix B** contains the details of the twenty six (26) LHDs which were not involved in the operational risk. Two (2) of them was contingency descend due to fire monitoring system and cabin pressure system alerted cases categorized G. Seven (7) were Turbulence or other weather related causes categorized I. Sixteen (16) were TCAS resolution advisory and flight crew correctly responds cases categorized J. Although, One (1) is unknown but there is a possibility of TCAS case.

2.2.7 The JASMA received Eight (8) reported including transfer error, TCAS RA and weather related deviations which were occurred outside of Fukuoka FIR. The details are shown in **Appendix C**.

2.2.8 In addition, JASMA has received fifteen (15) transfer error reports occurred in Taipei and Manila FIR from MAAR. JASMA shared these error reports with the ATC facilities concerned. One of the reasons was a short flight leg of southwest bound over flight within Fukuoka FIR. In case of the wind data was not updated, the gap of estimated time of arrival (ETA) at the entering waypoint to adjacent Taipei FIR made a late AIDC send-message that caused the transfer error event even though AIDC has installed. To prevent this kind of event, if the upper wind data is doubtful, Fukuoka ACC controller requests wind data updating to the person in charge of ATMC where receives Met data. And also Fukuoka ACC controller shall be aware of error message and if necessary, send revised ETA and Flight Level (FL) message via AIDC or voice communication line to Taipei ACC.

2.2.9 **Appendix D**, **Figure 3** provides the geographic location of risk bearing LHD reports within Fukuoka FIR during the assessment period.

3. Risk Assessment and Safety Oversight

3.1 This section updates the results of safety oversight for the RVSM implementation in the Fukuoka FIR. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of the airspace.

3.1.1 Estimate of the Collision Risk Model (CRM) Parameters shown in **Table 3**. The average sizes of aircrafts are a little bit smaller than the December 2012 TSD.

Table 3: Summarizes the value of the parameters used for the risk calculation.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
Pz(1000)	Probability that two aircraft nominally separated by the vertical separation minimum 1000 feet are in vertical overlap	1.7×10^{-8}	Value specified in ICAO Doc. 9574
Pz(0)	Probability that two aircraft at the same nominal level are in vertical overlap	0.54	Value often used (shown in RVSM/TF-9-IP/2)
Py(0)	Probability that two aircraft on the same track are in lateral overlap	0.0711	Using the data of secondary surveillance radar obtained by the Hachinohe Air Route Surveillance radar (domestic RNAV route, 2001-2002) and FDPS data (December 2013).
λx	Average aircraft length	0.0272 nm	FDPS data (December 2013)
λy	Average aircraft width	0.025 nm	
λz	Average aircraft height	0.008 nm	
$\overline{\lvert\Delta V\rvert}$	Average along track speed of aircraft pairs	28.9 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC, Apr. 1994)
$\overline{\lvert V\rvert}$	Individual-aircraft along track speed	480 kt	Value often used

$\overline{\lvert\dot{y}\rvert}$	Average cross track speed of aircraft pairs	11.6 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC, Apr. 1994)
$\overline{\lvert\dot{z}\rvert}$	Average vertical speed of aircraft pairs	1.5 kt	Value often used
Nx(same)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the same direction traffic	3.84×10^{-2}	FDPS data (December 2013)
Nx(opp)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	1.58×10^{-1}	FDPS data (December 2013)
$Naz^{technical}$ (cross)	The collision risk for crossing routes (technical dimension)	1.26×10^{-10} [accidents/flight hour]	FDPS data (December 2013) is utilized for the calculation of $E_z(\theta)$.
$Naz^{operational}$ (cross)	The collision risk for crossing routes (operational dimension)	1.04×10^{-9} [accidents/flight hour]	By eq. (12).
H	Total flight hours of aircraft flying on the route segments within airspace under consideration	1,195,776 flight hours	12 times of December 2013
T(0)	LHD duration in hours	0.31flight hours	48 LHD reports received from Jan. 2013 to Dec. 2013

3.2 Risk Calculation

3.2.1 Based on the TSD for one month of December 2013 extracted from the JCAB Flight Data Processing System (FDPS), the numbers of passing events, n_p(same) and n_p(opp), were calculated for each route segment consisting of two fixes.

3.2.2 Using the CRM parameters, such as average size of aircraft and average relative speed of the aircraft pair, contained in Table 3, kinematical coefficients of passing frequencies for the same and opposite direction traffic can be calculated by

$$K(same) = 1 + \frac{\lambda x}{\overline{|\Delta V|}}\left(\frac{\overline{|\dot{y}|}}{\lambda y} + \frac{\overline{|\dot{z}|}}{\lambda z}\right) \quad (1)$$

$$K(opp) = 1 + \frac{\lambda x}{2\overline{|V|}}\left(\frac{\overline{|\dot{y}|}}{\lambda y} + \frac{\overline{|\dot{z}|}}{\lambda z}\right) \quad (2)$$

Same-direction passing frequency N_x(same), opposite-direction passing frequency N_x(opp) and equivalent opposite-direction passing frequency N_x^z(e) are defined by

$$N_x(same) = \frac{2n_p(same)}{H}, \quad (3)$$

$$N_x(opp) = \frac{2n_p(opp)}{H} \text{ and} \quad (4)$$

$$N_x^z(e) = N_x(opp) + \frac{K(same)}{K(opp)} N_x(same), \quad (5)$$

respectively.

Technical Risk is estimated by

$$N_{az}^{technical} = N_{az}^{technical}(o+s) + N_{az}^{technical}(cross) \quad (6)$$

where,

$$N_{az}^{technical}(o+s) = P_z(1000)P_y(0)N_x^{\,z}(e)K(o) \quad (7)$$

$$N_{az}^{technical}(cross) = P_z(1000)\sum_{\theta} P_h(\theta)E_z^{\,cross}(\theta)\left[\frac{2\left|\overline{\dot{h}(\theta)}\right|}{\pi\lambda_{xy}} + \frac{\left|\overline{\dot{z}}\right|}{2\lambda_z}\right] \quad (8)$$

$P_h(\theta)$ was calculated assuming that the distributions of along-track positions and of cross-track deviations follow normal distributions whose standard deviations are $5/\sqrt{6}$ NM and 0.132, respectively. Remark that 5NM is the radar separation standard and $5/\sqrt{6}$ NM is the standard deviation of the uniform distribution with the domain width = 5NM. The value 0.132 is calculated from the Hachinohe radar data collected from August 2001 till July 2002. $P_h(\theta)$, $E_z^{cross}(\theta)$ and $\left|\overline{\dot{h}(\theta)}\right|$ were calculated every ten degrees.

Operational Risk is given by

$$N_{az}^{operational} = N_{az}^{operational}(o+s) + N_{az}^{operational}(cross) \quad (9)$$

where,

$$N_{az}^{operational}(o+s) = \frac{\sum P_z(z)T(z)}{H} P_y(0)N_x^{\,z}(e)K(opp) \quad (10)$$

$$N_{az}^{operational}(cross) = \frac{\Sigma P_z(z)T(z)}{H}\sum_{\theta} P_h(\theta)E_z^{\,cross}(\theta)\left[\frac{2\left|\overline{\dot{h}(\theta)}\right|}{\pi\lambda_{xy}} + \frac{\left|\overline{\dot{z}}\right|}{2\lambda_z}\right] \quad (11)$$

equivalently,

$$N_{az}^{operational}(cross) = \frac{\Sigma P_z(z)T(z)}{H} \cdot \frac{N_{az}^{technical}(cross)}{P_z(1000)} \quad (12)$$

Executive Summary

3.3 Safety Oversight for the RVSM implementation in the Fukuoka FIR

3.3.1 **Table 4** presents the estimates of vertical collision risk for the RVSM airspace of the Fukuoka FIR. The technical risk is estimated to be 0.40 x 10^{-9} fatal accidents per flight hour. The operational risk estimate is 3.26 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 3.66 x 10^{-9} fatal accidents per flight hour, which satisfies the globally agreed TLS value of 5.0 x 10^{-9} fatal accidents per flight hour.

3.3.2 **Figure 2** presents collision risk estimate trends by type (technical, operational, and total) for each month using the appropriate cumulative during the period from January 2013 to December 2013.

Fukuoka FIR – estimated annual flying hours = 1101469 hours *(note: estimated hours based on Dec 2012 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG17 Total Risk (PREVIOUS RASMAG)	*4.34×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
Technical Risk	0.40×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	3.26×10^{-9}	-	-
Total Risk	**3.66×10^{-9}**	5.0×10^{-9}	**Below TLS**

Table 4: Fukuoka FIR RVSM Risk Estimates

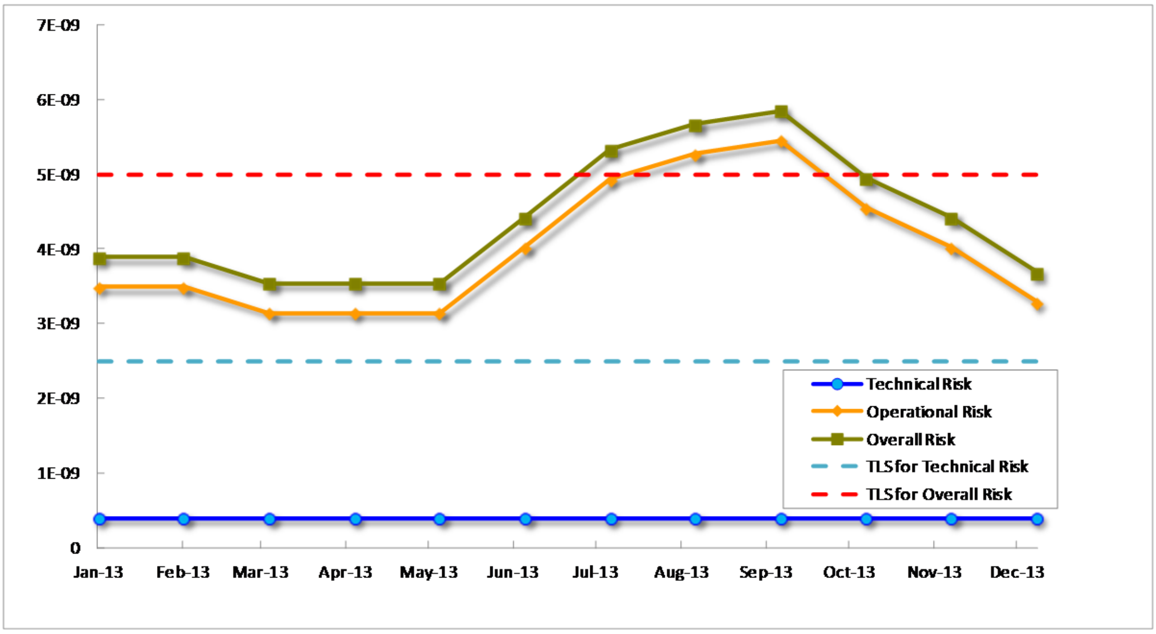

Figure 2: Fukuoka FIR RVSM Risk Estimate Trends

3.3.3 Even the estimated one year Overall risk has met the TLS some of the human errors are above the TLS between July and September 2013. It is reported that the ATC facilities and aircraft operator concerned are discussing these events to mitigate this kind of human errors.

4. ACTION BY THE MEETING

4.1 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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Appendix A

Height Deviations contributed to Operational Risk in the Fukuoka FIR Reported to the JASMA during the Reporting Period

Event date	Source	Location of deviation	Duration of LHD (min)	Cause	code
13 Mar 13	Naha ACC	MEVIN (B462)	1.6	ATC transfer of control coordination errors due to human factors	E
26 Mar 13	Tokyo ACC	30NM Southeast of YULIA	2	ATC system loop error	D
13 May 13	Fukuoka ACC	20NM West of SADLI (A593)	0	ATC transfer of control coordination errors due to human factors	E
24 May 13	Fukuoka ACC	20NM West of SADLI (A593)	0	ATC transfer of control coordination errors due to human factors	E
14 Jun 13	Naha ACC	MEVIN (B462)	5	ATC transfer of control coordination errors due to human factors	E
5 Jul 13	A/C Operator	35NM South of RJOK	0.2	Flight crew fails to climb the aircraft as cleared	A
10 Jul 13	Naha ACC	MEVIN (B462)	0	ATC transfer of control coordination errors due to human factors	E
16 Jul 13	ATMC	EMRON (OTR9)	5	Flight crew climbing without ATC clearance	B
30 Jul 13	Fukuoka ACC	20NM Northwest of KALEK (G203)	0	ATC transfer of control coordination errors due to human factors	E
12 Aug 13	Fukuoka ACC	20NM North of RUGMA (A586)	0	ATC transfer of control coordination errors due to human factors	E
22 Aug 13	Naha ACC, ATMC	20NM Northwest of GURAG (A590)	1.9	ATC transfer of control coordination errors due to human factors	E
1 Sep 13	Sapporo ACC	50NM Southeast of OBAKO	1	Flight crew climbing without ATC clearance	B
14 Nov 13	Naha ACC	LEBIX (N884)	1.1	ATC transfer of control coordination errors due to human factors	E
10 Dec 13	Tokyo ACC	OTARI (Y517)	0.8	ATC system loop error	D

Appendix B

Height Deviations which did not contribute to Operational Risk in the Fukuoka FIR Reported to the JASMA during the Reporting Period

Event date	Source	Duration of LHD (min)	Assigned FL	Observed / Reported ft	Cause	Code
14 Jan 13	A/C operator	0.3	340	34600	Turbulence or other weather related cause	I
24 Jan 13	Tokyo ACC, Fukuoka ACC	0.5	340	33400	TCAS resolution advisory and flight crew correctly responds	J
24 Jan 13	Tokyo ACC	0.2	290	34700	TCAS resolution advisory and flight crew correctly responds	J
15 Apr 13	Tokyo ACC	0.8	310	30700	TCAS resolution advisory and flight crew correctly responds	J
1 May 13	A/C Operator	0.5	300	30600	TCAS resolution advisory and flight crew correctly responds	J
16 Jun 13	A/C Operator	2	400	40300	Turbulence or other weather related cause	I
22 Jun 13	Tokyo ACC	0.3	330	32600	TCAS resolution advisory and flight crew correctly responds	J
4 Jul 13	Tokyo ACC	0.7	400	40600	TCAS resolution advisory and flight crew correctly responds	J
18 Jul 13	Fukuoka ACC	0.7	370	36600	TCAS resolution advisory and flight crew correctly responds	J
18 Jul 13	Fukuoka ACC	0.3	310	30700	TCAS resolution advisory and flight crew correctly responds	J
27 Jul 13	ATMC	unknown	340	33600	Turbulence or other weather related cause	I
5 Aug 13	Fukuoka ACC	0.7	310	30500	Turbulence or other weather related cause	I

Event date	Source	Duration of LHD (min)	Assigned FL	Observed / Reported ft	Cause	Code
8 Aug 13	ATMC	9	370	39000	Turbulence or other weather related cause	I
8 Aug 13	Tokyo ACC	0.8	370	36600	TCAS resolution advisory and flight crew correctly responds	J
9 Aug 13	A/C operator, Tokyo ACC	1	310	30600	TCAS resolution advisory and flight crew correctly responds	J
26 Aug 13	Tokyo ACC	0.2	370	37400	TCAS resolution advisory and flight crew correctly responds	J
4 Oct 13	Fukuoka ACC	0.3	390	39300	Turbulence or other weather related cause	I
11 Oct 13	ATMC	unknown	340	25000	Aircraft contingency leading to sudden inability to maintain level	G
21 Oct 13	A/C operator	unknown	310	30500	Turbulence or other weather related cause	I
28 Oct 13	ATMC	unknown	400	36000	Aircraft contingency leading to sudden inability to maintain level	G
24 Nov 13	Tokyo ACC	0.8	300	29500	TCAS resolution advisory and flight crew correctly responds	J
24 Nov 13	Tokyo ACC	0.8	310	31600	TCAS resolution advisory and flight crew correctly responds	J
30 Nov 13	Tokyo ACC	0.8	400	40900	TCAS resolution advisory and flight crew correctly responds	J
4 Dec 13	Tokyo ACC	0.8	340	34900	TCAS resolution advisory and flight crew correctly responds	J
19 Dec 13	Tokyo ACC	0.7	310	31400	Unknown (possibility of TCAS RA)	
26 Dec 13	Tokyo ACC	0.7	310	33100	TCAS resolution advisory and flight crew correctly responds	J

Appendix C

Height Deviations Occurred Outside of Fukuoka FIR and RVSM airspace during the Reporting Period

Event date	Source	Location of deviation	Expected FL	Observed FL	Cause	Other traffic
14 Jan 13	Fukuoka ACC	20NM Southwest of MOLKA (M750)	390	350	Transfer error	N
3 Feb 13	Fukuoka ACC	20NM West of SADLI (A593)	290	250	Transfer error	N
21 Feb 13	Fukuoka ACC	20NM Southwest of SADLI (A593)	350	370	Transfer error	N
22 Mar 13	A/C operator	10NM South of HGE	240	244	TCAS RA (Out of RVSM airspace)	Y
14 May 13	Sapporo ACC	80NM North of IGROD (B451)	310	270	Turbulence	N
1 Aug 13	PARMO	MONPI (A597)	390B400	400	Transfer error	Y
1 Nov 13	ATMC	GURAG (A590)	380	360	Transfer error	N
16 Nov 13	Naha ACC	LEBIX (N884)	410	410	Transfer error (ETA transfer error)	N

Appendix D

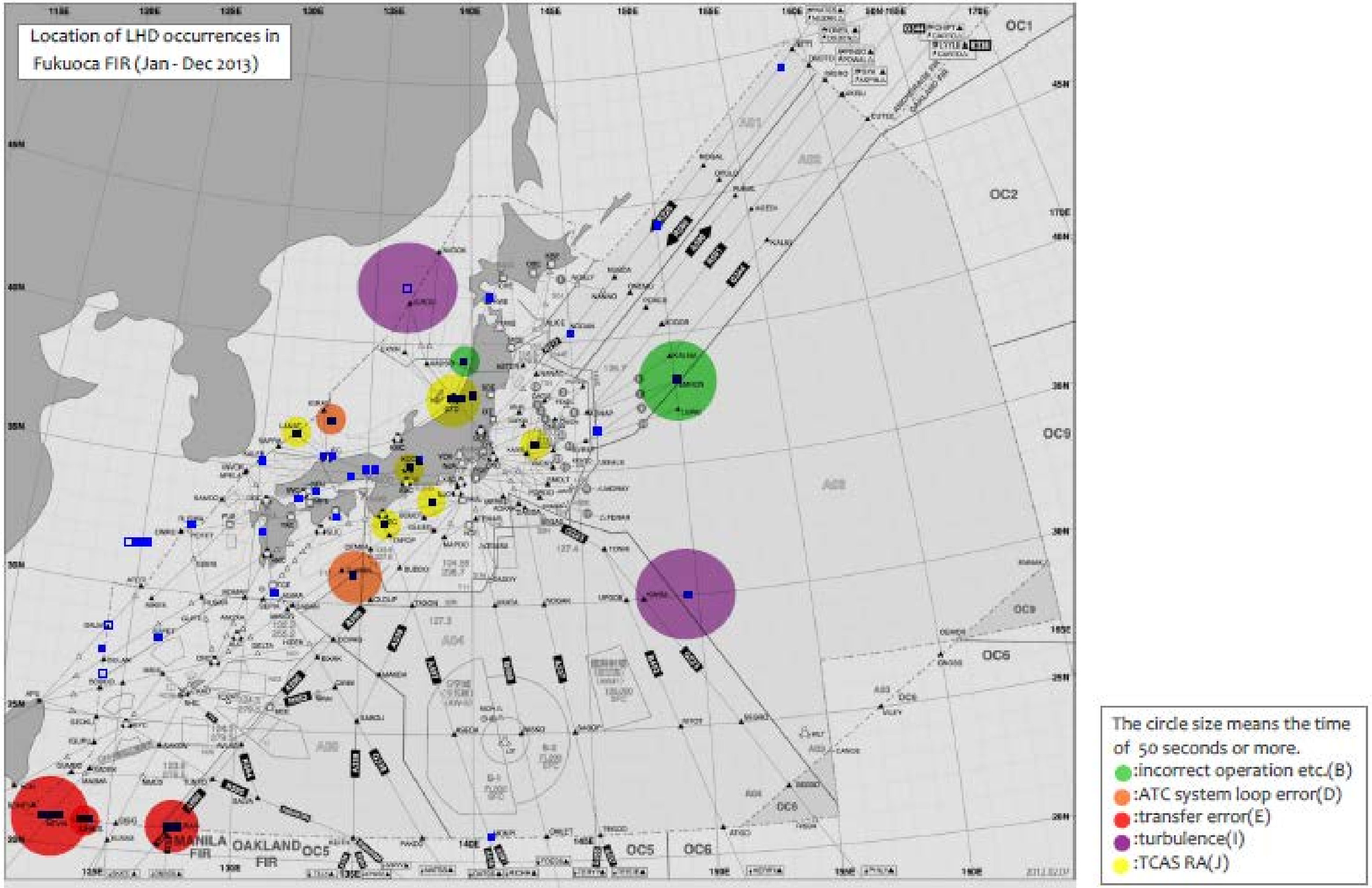

Figure 3: Fukuoka FIR – Risk Bearing LHD position and duration