International Civil Aviation Organization

Twenty-Eighth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/28)

Bangkok, Thailand, 21 – 24 August 2023

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

JASMA VERTICAL SAFETY REPORT

(Presented by JASMA)

SUMMARY

This paper presents the results of the vertical safety assessment of the Reduced Vertical Separation Minimum (RVSM) airspace in the Fukuoka Flight Information Region (FIR) by the Japan Airspace Safety Monitoring Agency (JASMA) for the period from January to December 2022.

1. INTRODUCTION

1.1 This paper provides the executive summary of the airspace safety oversight assessment undertaken by the Japan Airspace Safety Monitoring Agency (JASMA) for the Reduced Vertical Separation Minimum (RVSM) implementations in the Fukuoka Flight Information Region (FIR), which is a part of the Pacific Ocean Airspace and North-East Asia Airspace. The report is detailed in the **Attachment**.

2. DISCUSSION

2.1 The report shows the estimated risk of RVSM airspace in Fukuoka FIR for the reporting period from 1 January 2022 to 31 December 2022 was 4.92 x 10^{-9}, which was below the Target Level of Safety (TLS) 5.0 x 10^{-9}.

<u>Executive Summary</u>

2.2 **Table 1** summarizes Japanese airspace RVSM technical, operational, and total risks. **Figure 1** presents collision risk estimate trends during the period from January 2022 to December 2022.

Japanese Airspace – estimated annual flying hours = 1,303,077 hours ***(note: estimated hours based on Dec 2022 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 27 Total Risk	*9.52 x 10^{-9}*	*5.0 x 10^{-9}*	*Above TLS*
Technical Risk	0.24 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	4.67 x 10^{-9}	-	-
Total Risk	**4.92 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**

Table 1: Japanese Airspace RVSM Risk Estimates

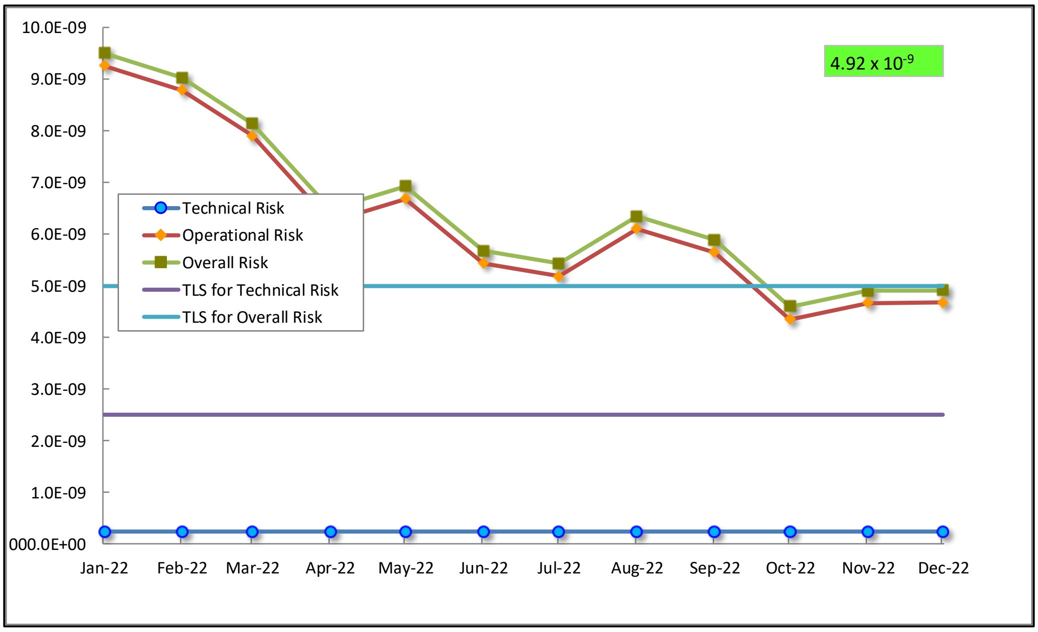

Figure 1: Japanese Airspace RVSM Risk Estimate Trends

2.3 **Table 2** presents a summary of the LHD causes within Japanese airspace from January 2022 until December 2022.

Code	LHD Category Description	No.
A	Flight crew fails to climb or descend the aircraft as cleared	2
B	Flight crew climbing or descending without ATC clearance	3
C	Incorrect operation or interpretation of airborne equipment	6
D	ATC system loop error	3
E	Coordination errors in the ATC -to-ATC transfer of control responsibility as a result of human factors issues	6
F	ATC transfer of control coordination errors due to technical issues	1
G	Aircraft contingency leading to sudden inability to maintain level	3
H	Airborne equipment failure and unintentional or undetected level change	3
I	Turbulence or other weather related cause leading to unintentional or undetected change of flight level	11
J	TCAS resolution advisory; flight crew correctly climb or descend following the resolution advisory	5
K	TCAS resolution advisory; flight crew incorrectly climb or descend following the resolution advisory	0
L	An aircraft being provided with RVSM separation is not RVSM approved	0
M	Others	2
Total		45

Table 2: Summary of LHD Causes within Japanese Airspace

2.4 **Figure 2** provides the geographic location of risk bearing LHD reports within Japanese Airspace, Fukuoka FIR during the assessment period. The filled blue square symbols represent LHD location in the RVSM stratum of Fukuoka FIR. The circle size means an LHD duration of 50 seconds or more.

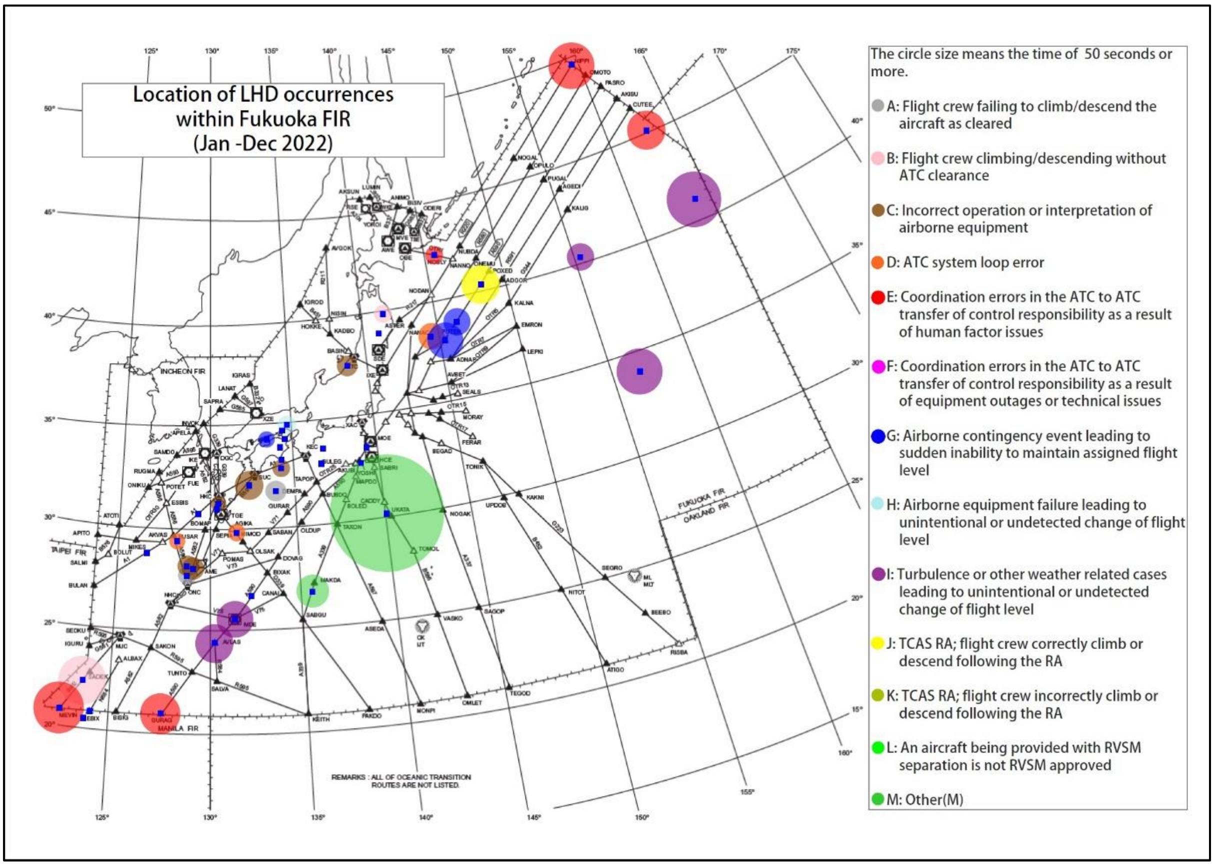

Figure 2: Geographical Location of LHDs within Fukuoka FIR

2.5 **Figure 3** shows the comparing the number of LHDs by category from the calendar year 2018 to 2022. In general, the number of LHDs in 2022 decreased from in 2021, and the total duration time of LHDs in 2022 was shorter than it was in 2021.

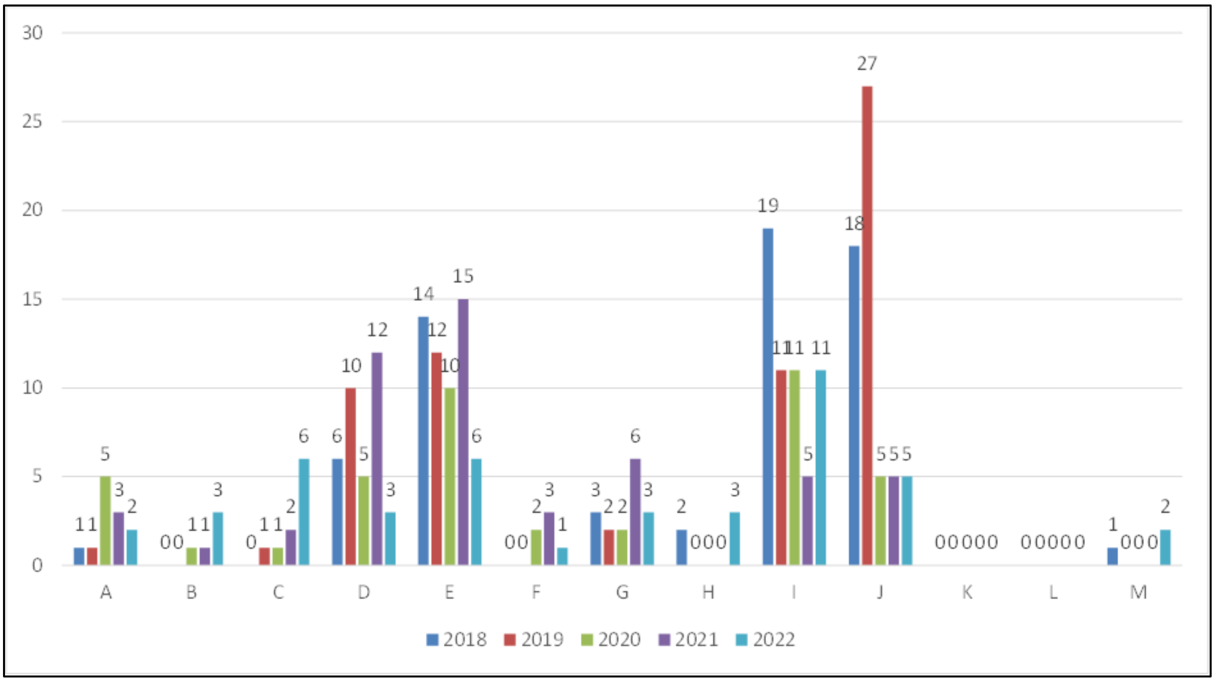

Figure 3: Comparing LHDs by category from 2018 to 2022

2.6 JASMA has analyzed trends and changes in LHDs as follows.

- In Category A LHDs, "Flight crew failing to climb/descend the aircraft as cleared," the number of occurrences slightly decreased to two in 2022 from three in 2021. Since all occurrences were caused by military aircraft, a detailed investigation was stuck and not completed.
- The number of Category B LHDs, "Flight crew climbing/descending without ATC clearance," increased to three in 2022 from one in 2021.
- The noted trend was shown in the number of Category C LHDs, "Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment." The number of the LHDs increased to six in 2022 though it was few from 2018 to 2021, and the primary reason was a wrong input to FMS by pilots.
- It was remarkable and unique that the number of Category D LHDs, "ATC system loop error," was a wide fluctuation. The numbers of the LHDs were over 10 in odd years, 2019 and 2021. However, the numbers of it were at or below six in even years 2018, 2020 and 2022.
- The number of Category E LHDs, "ATC transfer error due to human factors," fell to six in 2022 from 15 in 2021, and the number in 2022 was the lowest in recent five years. The detailed information and analysis of Hot Spots are described in later paragraphs.
- It was reported that the number of Category H LHDs, "Airborne equipment failure," was three in 2022, and it was the highest and the same number in recent five years. One case occurred due to the vulnerable and sensitive ALT knob of airborne equipment of A350-900, and Airbus had already released an Operations Engineering Bulletin (OEB) for the issue.
- In Category I LHDs, "Turbulence or bad weather," the number of occurrences was 11 in 2022, and it was the same in 2019 and 2020.
- The number of Category J LHDs, "TCAS resolution advisory and flight crew correctly following the resolution advisory," was five in 2022, the same as the year before last year and the previous year.
- All five Category J LHDs were caused due to "nuisance TCAS RAs"*1, so "genuine TCAS RAs"*2 were not reported in 2022.

*1 TCAS RAs occurred despite ATC instructed enough vertical separation for the aircraft, and the flight crew responded correctly.

*2 TCAS RAs occurred when ATC did not provide 1,000 ft or more vertical separation.

2.7 At the Tenth Meeting of the Regional Airspace Safety Monitoring Advisory Group Monitoring Agencies Working Group (RASMAG/MAWG/10), which was held virtually from 30 January to 10 February 2023, ICAO proposed that RMAs/EMAs consider the percentage value of traffic volume recovery since 2019 in order to assist RASMAG in the re-examination of current LHD hotspots.

2.8 The RASMAG Chair invited the Asia Pacific RMAs to include this analysis in their safety reports for the RASMAG/28 meeting. **Figure 4** shows the trend of traffic volume in Fukuoka FIR from 2008 to 2022.

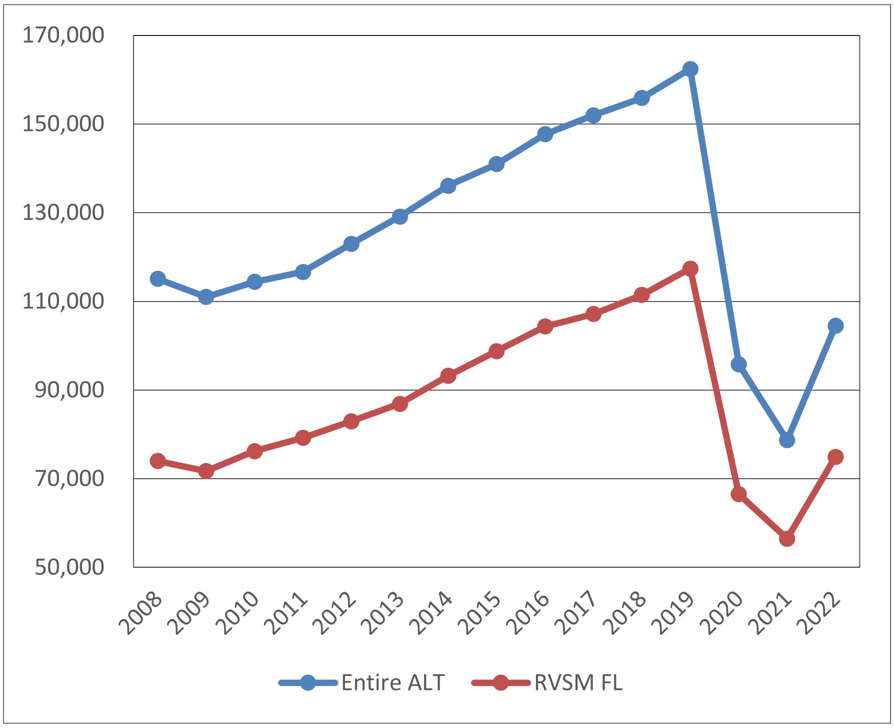

Figure 4: Traffic volume in Fukuoka FIR from 2008 to 2022

2.9 The traffic volume of Fukuoka FIR in 2022 was approximately 64% of it in 2019, which was a peak traffic volume before the COVID-19 pandemic. Additionally, the traffic volume in 2022 was nearly level in 2009 and 2010, which was the beginning of the recovery from the financial crisis of 2007 to 2008.

<u>Hot Spot B (FIR Boundary between Fukuoka and Incheon FIRs in AKARA FUKUE corridor airspace)</u>

2.10 In 2022, there was no LHD reported at a part of Hot Spot, B where the area is the east edge of the AKARA FUKUE corridor airspace and the FIR boundary between Fukuoka and Incheon FIRs.

<u>Hot Spot D (FIR Boundary between Fukuoka and Manila FIRs)</u>

2.11 **Figure 5** presents the number of LHD occurrences at the FIR boundary between Fukuoka FIR and Manila FIR, which is a part of Hot Spot D from 2018 to 2022. A total of six category E LHDs occurred at Hot Spot D in 2022. Four of these LHDs occurred on transfer from the Manila ACC to Fukuoka ACC or the Fukuoka Air Traffic Management Center (ATMC), and the rest of the two LHDs occurred on transfer from Fukuoka ATMC or Fukuoka ACC to Manila ACC.

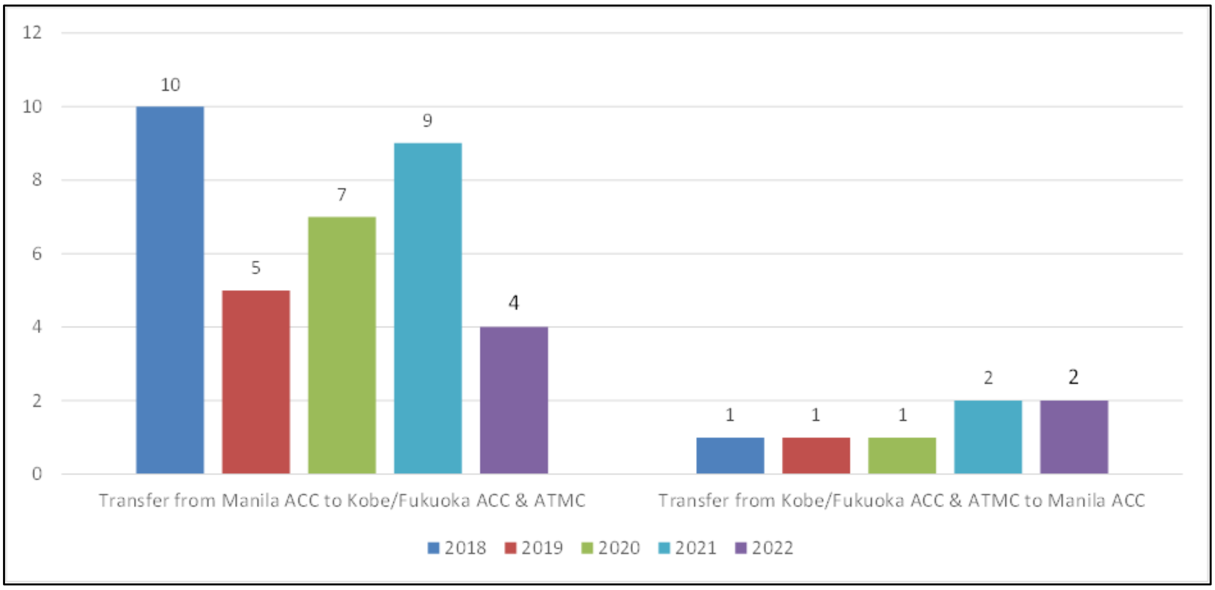

Figure 5: Number of LHDs at Hot spot D between Fukuoka and Manila FIR

2.12 One of the Category E LHDs from Fukuoka ACC to Manila ACC in 2022 occurred due to temporary and unique traffic flow, whose trigger was the sudden airspace restrictions established within Taibei FIR.

2.13 At the Tenth Meeting of the Regional Airspace Safety Monitoring Advisory Group Monitoring Agencies Working Group (RASMAG/MAWG/10), which was held virtually from 30 January to 10 February 2023, JASMA shared that Fukuoka ACC and Manila ACC had a bilateral virtual meeting in December 2022 and proposed to establish a task force to work on improving the issues which were unveiled at the meeting.

2.14 In response to JASMA's proposal, ICAO suggested the formation of the Scrutiny Group comprising JASMA, MAAR, the Civil Aviation Authority (CAA) of the Philippines and the Japan Civil Aviation Bureau (JCAB) to undertake this activity, subject to further discussion.

2.15 Additionally, MAAR shared that MAAR was invited to participate in the bilateral meeting between Bangkok ACC and Kuala Lumpur ACC, and this kind of meeting was utilized well and could be applied to Fukuoka ACC and Manila ACC.

2.16 The bilateral meetings between Fukuoka and Manila ACC were held twice as of July 2023. The detail of the bilateral meetings is submitted and reported by a separate information paper at the RASMAG/28 meeting.

Former Hot Spot L (FIR Boundary between Fukuoka and Khabarovsk FIRs)

2.17 **Figure 6** shows the number of LHDs at the FIR boundary between Fukuoka FIR and Khabarovsk FIR where is the former Hot Spot L for the period from 2018 to 2022. There was no LHD occurrence in the area in 2022. The main reason is the less traffic volume along the FIR boundary between Fukuoka and Khabarovsk FIRs since traffic flow between Japan and European countries have been changed significantly.

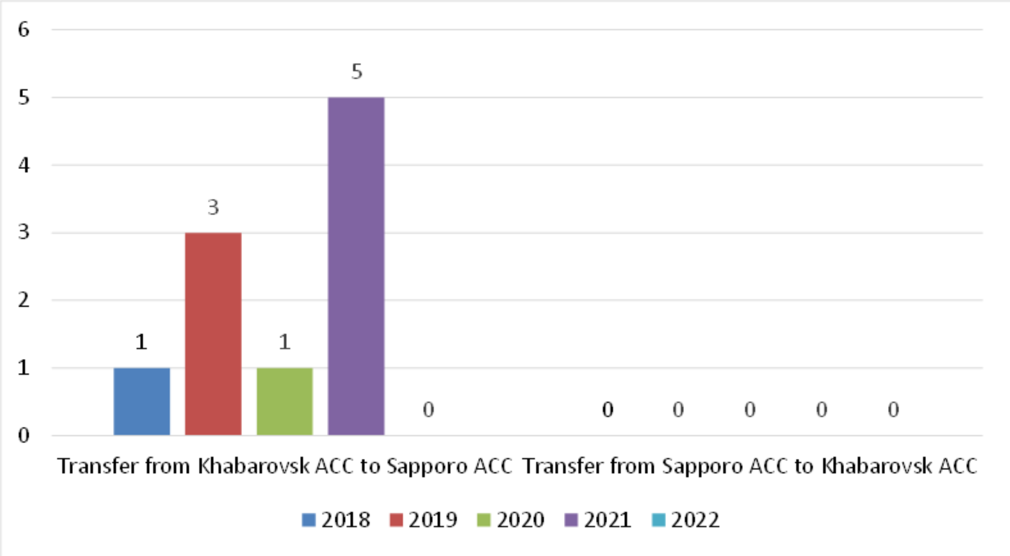

Figure 6: Number of LHDs at former Hot spot L between Fukuoka and Khabarovsk FIRs

2.18 JASMA has participated in the trial of the management process of Hot Spots, which the Monitoring Agency for Asia Region (MAAR) developed and presented at the Ninth meeting of the RASMAG Monitoring Agency Working Group (RASMAG-MAWG/9) in February 2022. The result and process of JASMA's consideration and analysis for Hot Spot B and D and former Hot Spot L are summarized and presented in another working paper.

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

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

January 2022 to December 2022

(Presented by JASMA)

SUMMARY

The purpose of this report is to compare actual performance to safety goals related to the continued use of reduced vertical separation minimum (RVSM) in the Fukuoka Flight Information Region (FIR). This report contains a summary of large height deviation reports received by the Japan Airspace Safety Monitoring Agency (JASMA) and an update on the vertical collision risk for the period from January 2022 to December 2022. There are a total of 42 reported large height deviations that occurred during this period in Fukuoka FIR. The vertical collision risk estimate for the RVSM airspace in Fukuoka FIR was 4.92 x $10^{-9,}$ which was below the target level of safety (TLS).

1. INTRODUCTION

1.1 This attachment presents a summary of the Large Height Deviation (LHD) reports received by the JASMA and an update on the vertical collision risk for the period of 1 January 2022 to 31 December 2022.

2. DISCUSSION

2.1 Traffic Sample Data (TSD)

2.1.1 Traffic Sample data for December 2022 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 LHD reports were used in this safety assessment starting from January 2022 to December 2022.

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

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)
January 2022	4	1.95
February 2022	4	21.0
March 2022	3	76.35
April 2022	3	1.68
May 2022	5	11.1
June 2022	2	2.2
July 2022	2	9.0

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)
August 2022	6	34.1
September 2022	3	10.3
October 2022	2	1.7
November 2022	9	16.3
December 2022	2	3.8
Total	**45**	**189.5**

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

2.2.3 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 in 2021 and 2022. The number of LHD reports in 2022 decreases in 2022.

Code	LHD Category Description	2021	2022
A	Flight crew fails to climb or descend the aircraft as cleared	3	2
B	Flight crew climbing or descending without ATC clearance	1	3
C	Incorrect operation or interpretation of airborne equipment	2	6
D	ATC system loop error	12	3
E	ATC transfer of control coordination errors due to human factors	15	6
F	ATC transfer of control coordination errors due to technical issues	3	1
G	Aircraft contingency leading to sudden inability to maintain level	6	3
H	Airborne equipment failure and unintentional or undetected level change	0	3
I	Turbulence or other weather related cause	5	11
J	TCAS resolution advisory and flight crew correctly responds	9	5
K	TCAS resolution advisory and flight crew incorrectly responds	0	0
L	Non-approved aircraft is provided with RVSM separation	0	0
M	Other	0	2
Total		56	**45**

Table 2: Summary of LHD Causes within Fukuoka FIR.

2.2.4 **Appendix A** contains the details of the 20 LHDs contributed to the operational risk, which was reported to the JASMA during the assessment period.

2.2.5 **Appendix B** contains the details of the 25 LHDs which were not involved in the operational risk and were reported to the JASMA during the assessment period.

2.2.6 **Appendix C** contains the details of the 3 LHDs which occurred outside of Fukuoka FIR and were not involved in the operational risk during the assessment period.

2.2.7 **Appendix D** provides the geographic location of all LHD reports in Fukuoka FIR during the assessment period. The filled blue square symbols represent the LHD location in the RVSM stratum inside of Fukuoka FIR, and the hollow blue square symbols represent the LHD location in the RVSM stratum outside of Fukuoka FIR. The circle size means an LHD duration of 50 seconds or more.

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 aircraft based on the TSD of December 2022 are slightly smaller than that of aircraft based on the TSD of December 2021.

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 2012).
λx	Average aircraft length	0.0276 nm	JASMA (TSD of RVSM flights in Dec 2022)
λy	Average aircraft width	0.0251 nm	
λz	Average aircraft height	0.0079 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	2.26×10^{-2}	CCAW data (Dec 2022)
Nx(opp)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	6.44×10^{-2}	CCAW data (Dec 2022)
$Naz^{technical}$ (cross)	The collision risk for crossing routes (technical dimension)	1.18×10^{-10} [accidents/flight hour]	FO flight data (Dec 2022) is utilized for the calculation of $E_z(\theta)$.
$Naz^{operational}$ (cross)	The collision risk for crossing routes (operational dimension)	4.87×10^{-9} [accidents/flight hour]	By eq. (12).
H	Total flight hours of aircraft flying on the route segments within airspace under consideration	1,303,077 flight hours	Estimated flight hours from Jan 2022 to Dec 2022 *12 times the flight hours in Dec 2022
T(0)	LHD duration in hours	0.79	Total duration hours of 20 operational LHD reports received from Jan 2022 to Dec 2022

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

3.2 Risk Calculation

3.2.1 Based on the TSD for one month of December 2022 extracted from the JCAB's Flight Object Administration Center System (FACE), 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 the average size of the 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

$$K(same) = 1 + \frac{\lambda x}{Vrx(same)}\left(\frac{Vry}{\lambda y} + \frac{Vrz}{\lambda z}\right) \quad (1)$$

$$K(opp) = 1 + \frac{\lambda x}{Vrx(opp)}\left(\frac{Vry}{\lambda y} + \frac{Vrz}{\lambda z}\right) \quad (2)$$

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

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

$$N_x^z(opp) = \frac{2n_p(opp)}{H} \quad (4)$$

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

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respectively.

Technical Risk is estimated by

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

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

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

$P_h(\theta)$ was calculated assuming that the distributions of along-track positions and 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 $\left|\dot{h}(\theta)\right|$ 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,

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

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

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

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 0.24 x 10^{-9} fatal accidents per flight hour. The operational risk estimate is 4.67 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 4.92 x 10^{-9} fatal accidents per flight hour, which is below the globally agreed TLS value of 5.0 x 10^{-9} fatal accidents per flight hour

Japanese Airspace – estimated annual flying hours = 1,303,077 hours *(note: estimated hours based on Dec 2022 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 27 Total Risk	*9.52 x 10^{-9}*	*5.0 x 10^{-9}*	*Above TLS*
Technical Risk	0.24 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	4.67 x 10^{-9}	-	-
Total Risk	**4.92 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**

Table 4: Fukuoka FIR RVSM Risk Estimates

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 2022 to December 2022.

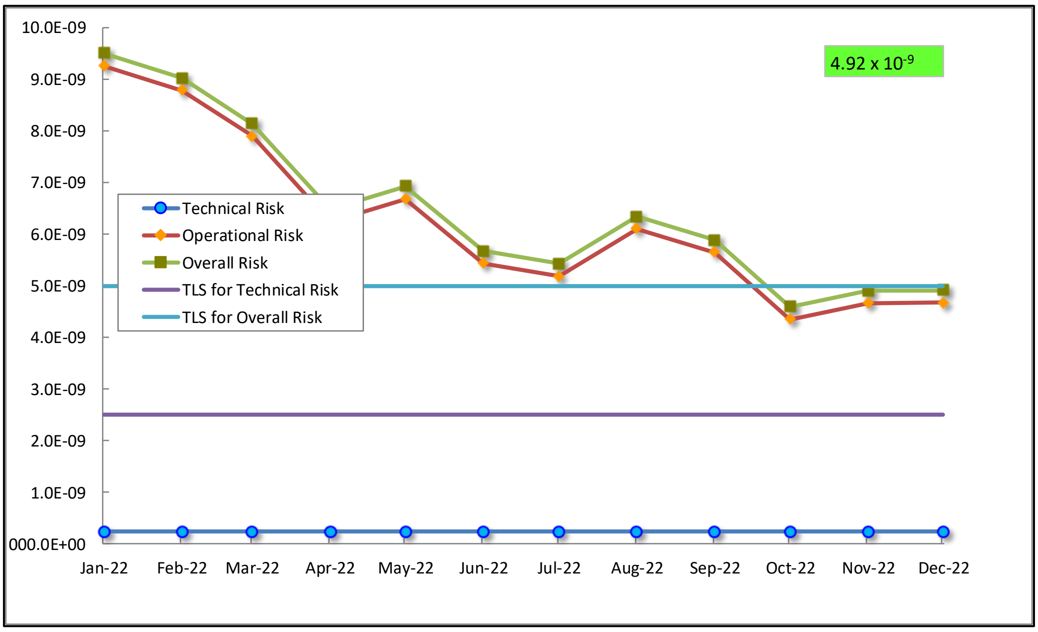

Figure 2: Fukuoka FIR RVSM Risk Estimate Trends

3.3.3 The estimated overall risk was below the TLS. The risk value is lower than the previous year.

Appendix A

LHDs contributed to Operational Risk within the RVSM airspace in Fukuoka FIR reported to the JASMA during the assessment period

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
1	18 Feb 2022	Kobe ACC	MEVIN	B78X	390	40,000	11	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	D
2	19 Feb 2022	Fukuoka ATMC	4508N 16319E	B77W	360	37,000	5	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	
3	21 Feb 2022	Sapporo ACC	NOSLY	B789	400	39,000	1	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	
4	29 Mar 2022	Fukuoka ACC	AWE	B738	350	33,000	0.88	ATC system loop error	D	
5	2 Apr 2022	Fukuoka ACC	LEBIX	A20N	350	37,000	0	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	D
6	12 Apr 2022	Fukuoka ACC	PRIUS	B738	380	40,000	1.35	Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment	C	
7	3 May 2022	Fukuoka ATMC	GURAG	B789	350	39,000	6	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	D
8	28 May 2022	Operator	HPE	CRJ7	320	31,000	1	Flight crew climbing/descending without ATC clearance	B	
9	23 Jun 2022	Fukuoka ACC	ONC	B788	340	29,900	1.15	Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment	C	
10	31 Jun 2022	Fukuoka ACC	ONC	K35R	320	30,600	1.02	Flight crew failing to climb/descend the aircraft as cleared	A	
11	8 Aug 2022	Fukuoka ACC	SUC	MQ4	340	32,000	1.13	Flight crew failing to climb/descend the aircraft as cleared	A	
12	30 Aug 2022	Fukuoka ACC	MEVIN	P8	280	30,000	8.53	Flight crew climbing/descending without ATC clearance	B	D

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
13	30 Aug 2022	Fukuoka ACC	TGE	B738	360	34,000	0.97	ATC system loop error	D	
14	24 Sep 2022	Fukuoka ACC	MEXIR	A321	350	37,000	1.3	Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment	C	
15	8 Oct 2022	Fukuoka ACC	LEBIX	A321	330	37,000	0.38	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	D
16	10 Nov 2022	Kobe ACC	MADOG	E190	330	34,000	2.33	Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment	C	
17	14 Nov 2022	Tokyo ACC	GTC	E170	360	36,900	1.17	Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment	C	
18	16 Nov 2022	Fukuoka ACC	HKC	A333	350	34,300	0.83	Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment	C	
19	22 Nov 2022	Tokyo ACC	HGE	K35R	310	30,000	0.67	Flight crew climbing/descending without ATC clearance	B	
20	14 Dec 2022	Tokyo ACC	OATIS	B78X	360	35,300	1.83	ATC system loop error	D	

Appendix B

LHDs not contributed to Operational Risk in the Fukuoka FIR reported to the JASMA during the assessment period

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
1	10 Jan 2022	Fukuoka ACC	KTE	E170	340	29,000	0.95	Aircraft contingency leading to sudden inability to maintain level	G	
2	16 Jan 2022	Kobe ACC	AWAJI	B788	320	31,200	0.33	TCAS resolution advisory, flight crew correctly climb or descend following the resolution advisory	J	
3	21 Jan 2022	Kobe ACC	SAZMA	B738	320	31,500	0.33	TCAS resolution advisory, flight crew correctly climb or descend following the resolution advisory	J	
4	27 Jan 2022	Tokyo ACC	GLORY	E75L	330	33,400	0.33	TCAS resolution advisory, flight crew correctly climb or descend following the resolution advisory	J	
5	18 Feb 2022	Fukuoka ATMC	PUTER	A124	330	32,000	4	Aircraft contingency leading to sudden inability to maintain level	G	
6	2 Mar 2022	Fukuoka ATMC	3030N 14010E	C5M	360	36,000	75	Others	M	
7	28 Mar 2022	Fukuoka ACC	ONC	K35R	330	33,400	0.47	Airborne equipment failure	H	
8	15 Apr 2022	Operator	ISEBI	A320	350	34,700	0.33	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
9	10 May 2022	Fukuoka ACC	KTE	A21N	350	35,500	0.62	TCAS resolution advisory, flight crew correctly climb or descend following the resolution advisory	J	
10	19 May 2022	Fukuoka ATMC	2845N 13554E	K35R	370	36,600	3	Others	M	
11	27 May 2022	Tokyo ACC	SDE	P8	320	31,700	0.5	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
12	17 Jun 2022	Tokyo ACC	WAKIT	A359	340	33,200	1	Airborne equipment failure	H	

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
13	30 Jul 2022	Fukuoka ATMC	3420N 15730E	K35R	400	42,000	8	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
14	2 Aug 2022	Fukuoka ATMC	AVLAS	B789	380	38,300	5	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
15	11 Aug 2022	Tokyo ACC	BILLY	B788	310	30,200	0.5	Airborne equipment failure	H	
16	19 Aug 2022	Fukuoka ATMC	4138N 16418E	B789	330	33,300	14	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
17	12 Sep 2022	Fukuoka ATMC	PUTER	B77L	330	33,400	5	TCAS resolution advisory, flight crew correctly climb or descend following the resolution advisory	J	
18	21 Sep 2022	Fukuoka ATMC	MDE	B77W	310	30,700	4	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
19	23 Oct 2022	Fukuoka ACC	MDE	B77W	360	36,300	0.32	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
20	9 Nov 2022	Fukuoka ATMC	NIPPI	B77L	360	36,000	8	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues	F	
21	12 Nov 2022	Fukuoka ACC	HKC	A35K	370	36,600	0.45	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
22	13 Nov 2022	Fukuoka ACC	MEXIR	B738	410	40,500	0.3	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
23	13 Nov 2022	Tokyo ACC	GULEG	A320	380	38,400	0.5	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	
24	16 Nov 2022	Fukuoka ATMC	PUTER	B763	310	29,000	2	Aircraft contingency leading to sudden inability to maintain level	G	
25	22 Dec 2022	Fukuoka ATMC	4038N 15638E	B77L	310	31,300	2	Turbulence or other weather related causes leading to unintentional or undetected change of flight level	I	

Appendix C

LHDs occurred outside of Fukuoka FIR

	Occurrence Date	Relevant ATC Unit	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
1	27 Feb 2022	Oakland ARTCC	PAKDO	B738	370	37,000		Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	
2	5 Aug 2022	Manila ACC	BISIG	B738	360	36,000		Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	D
3	12 Oct 2022	Manila ACC	BISIG	A321	320	38,000		Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues	E	D

Appendix D

Geographical Location of all LHDs in Fukuoka FIR