International Civil Aviation Organization

Twenty-Ninth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/29)

Bangkok, Thailand, 19 – 22 August 2024

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 2023.

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 2023 to 31 December 2023 was 2.36 x 10^{-9}, which was below the Target Level of Safety (TLS) 5.0 x 10^{-9}.

Executive Summary

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 2023 to December 2023.

Table 1: Japanese Airspace RVSM Risk Estimates

Japanese Airspace – estimated annual flying hours = 1,688,572 hours ***(note: estimated hours based on Dec 2023 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 28 Total Risk	*4.92 x 10^{-9}*	*5.0 x 10^{-9}*	*Below TLS*
Technical Risk	0.27 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	2.09 x 10^{-9}	-	-
Total Risk	**2.36 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**

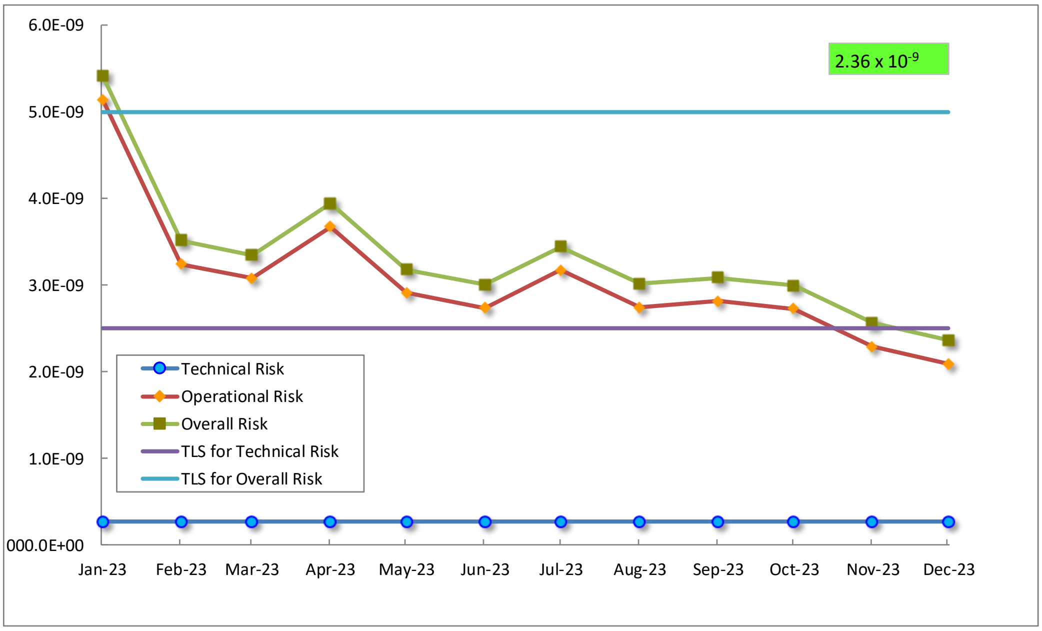

Figure 1: Japanese Airspace RVSM Risk Estimate Trends

2.3 **Table 2** presents a summary of the LHD causes within Japanese airspace from January 2023 until December 2023.

Table 2: Summary of LHD Causes within Japanese Airspace

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	2
C	Incorrect operation or interpretation of airborne equipment	3
D	ATC system loop error	5
E	Coordination errors in the ATC -to-ATC transfer of control responsibility as a result of human factors issues	3
F	ATC transfer of control coordination errors due to technical issues	1
G	Aircraft contingency leading to sudden inability to maintain level	0
H	Airborne equipment failure and unintentional or undetected level change	0
I	Turbulence or other weather related cause leading to unintentional or undetected change of flight level	17
J	TCAS resolution advisory; flight crew correctly climb or descend following the resolution advisory	16
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	0
Total		49

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.

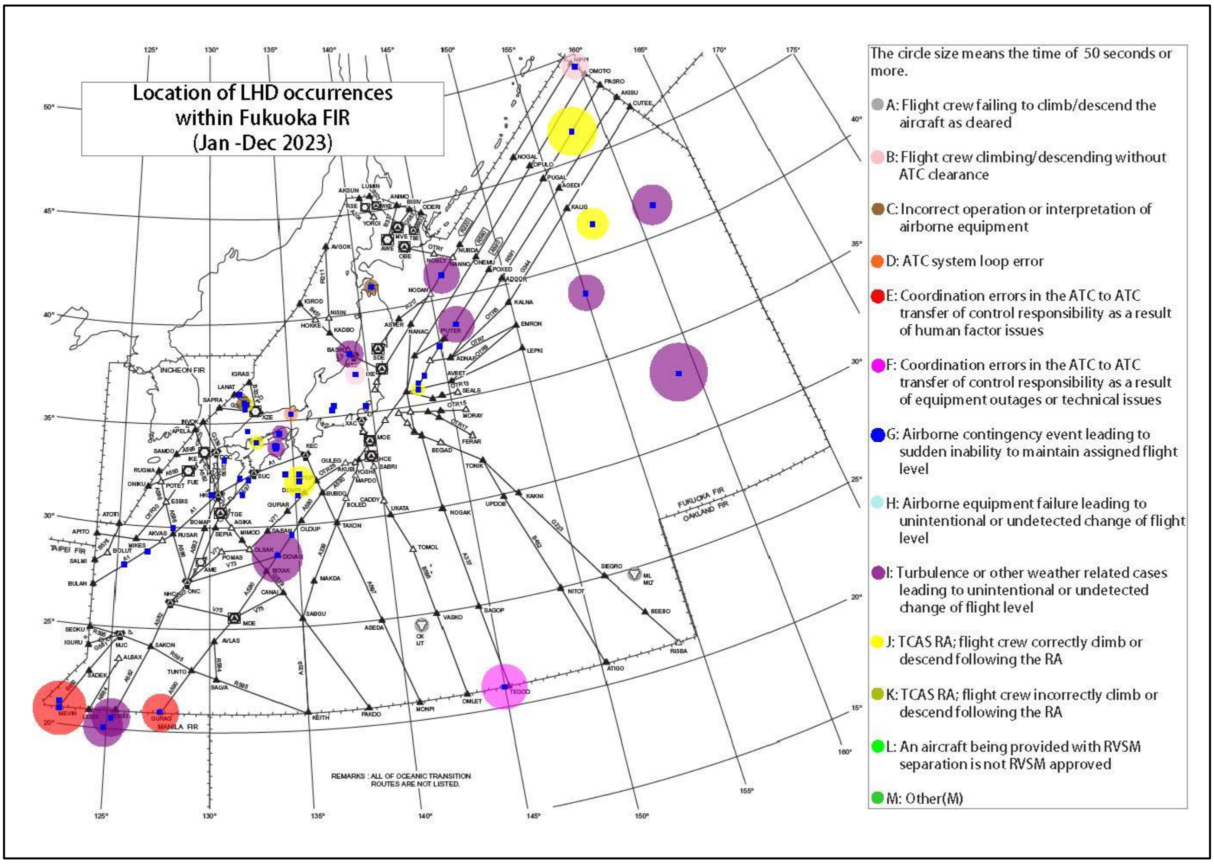

Figure 2: Geographical Location of LHDs within Fukuoka FIR

2.5 **Figure 3** shows the comparing the number of LHDs by category from the calendar year 2019 to 2023. In general, the number of LHDs in 2023 increased from in 2022, however, the total duration time of LHDs in 2023 was shorter than it was in 2022.

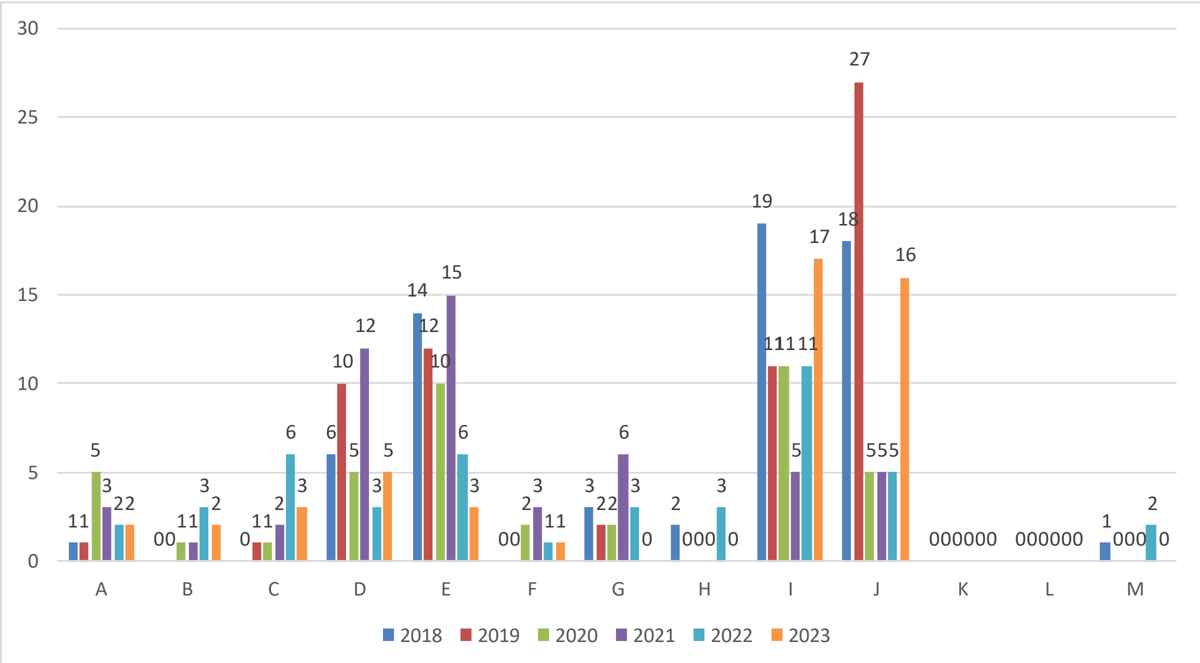

Figure 3: Comparing LHDs by category from 2019 to 2023

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

a) In Category A LHDs, "Flight crew failing to climb/descend the aircraft as cleared," there were two occurrences in 2023, the same as in 2022.

b) The number of Category B LHDs, "Flight crew climbing/descending without ATC clearance," decreased from three in 2022 to two in 2023.

c) It was shown in the number of Category C LHDs, "Incorrect flight level provided due to incorrect operation or interpretation of airborne equipment," decreased from six in 2022 to three in 2023.

d) The number of Category D LHDs, "ATC system loop error," slightly increased to five in 2023 from three in 2022. The trend from 2018 to 2022 was remarkable, unique and wide fluctuation observed, however, the Category D LHD occurrences in the recent two years are not significant although traffic volumes in Fukuoka FIR show a strong recovery trend.

e) The number of Category E LHDs, "ATC transfer error due to human factors," plummeted from 15 in 2021 to 6 in 2022, and further declined to 3 in 2023, the smallest number in the last five years.

f) In Category I LHDs, "Turbulence or bad weather," there were 17 occurrences in 2023, approximately 1.5 times of 11 in 2022. Approximately half of Category I LHD occurrences were in the Pacific Ocean airspace of Fukuoka FIR, and the duration times are longer than those in the continental airspace covered with the Air Traffic Service (ATS) surveillance.

g) The number of Category J LHDs, "TCAS resolution advisory and flight crew correctly following the resolution advisory," showed 16 occurrences in 2023, which significantly increased from 5 in 2022 and marked three times the number of occurrences.

h) In the 16 occurrences of Category J LHD, 14 were "nuisance TCAS RAs" *1, and the rest of the two events were reported as "genuine TCAS RAs" *2. The genuine TCAS RAs were counted and treated as an operational error.

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

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

i) The significant increase of Category J LHDs might correspond with the increase of traffic volume in Fukuoka FIR, however, further detailed analysis would be needed because some cases occurred due to traffic that seemed to fly by the Visual Flight Rules (VFR) in the RVSM altitude stratum. Additionally, in a few cases, relevant traffic was not observed by ATS surveillance and pilots' visual contact.

2.7 According to the ICAO's proposal and the RASMAG Chair's invitation, "RMAs/EMAs consider the percentage value of traffic volume recovery since 2019 and include the analysis in their safety reports in order to assist RASMAG in the re-examination of current LHD Hot Spots," at the Tenth Meeting of the RASMAG Monitoring Agencies Working Group (RASMAG/MAWG/10), **Figure 4** shows the trend of traffic volume in Fukuoka FIR from 2008 to 2023.

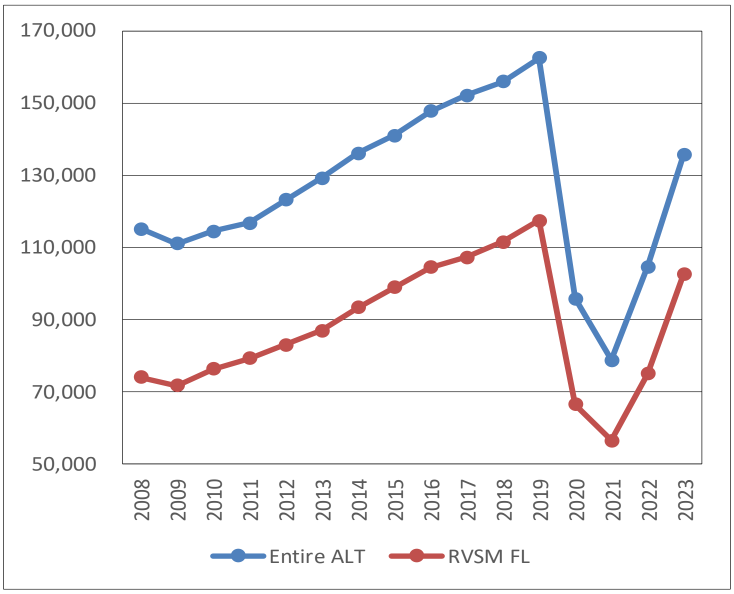

Figure 4: Traffic volume in Fukuoka FIR from 2008 to 2023

2.8 The traffic volume of Fukuoka FIR in 2023 was approximately 83% of it in 2019, which was a peak traffic volume before the COVID-19 pandemic. The traffic volume of Fukuoka FIR shows a solid recovery trend, and it is estimated that the traffic volumes of the RVSM altitude stratum in 2024 will exceed them in 2019.

Hot Spot B3 (FIR Boundary between Fukuoka and Incheon FIRs in AKARA FUKUE corridor airspace)

2.9 In 2023, 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.

2.10 At the RASMAG/MAWG/11 meeting held from January to February 2024, JASMA proposed to split Hot Spots at each FIR boundary by contributing factors, mitigation measures and future risks to manage and monitor Hot Spots more precisely.

2.11 The subdivision of Hot Spot B was discussed and agreed at the meeting. The area, along and around the FIR interface between Fukuoka and Incheon FIRs was redefined as Hot Spot B3. Hot Spot B3 will be removed from the Hot Spot list during this RASMAG/29 meeting since there has been no LHD report in the area for over two years.

Hot Spot D1 (FIR Boundary between Fukuoka and Manila FIRs)

2.12 **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 2023. Hot Spot D was also split into D1 to D9, and the FIR boundary between Fukuoka and Manila FIRs was renamed D1.

2.13 A total of five category E LHDs occurred at Hot Spot D1 in 2023. Three 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.

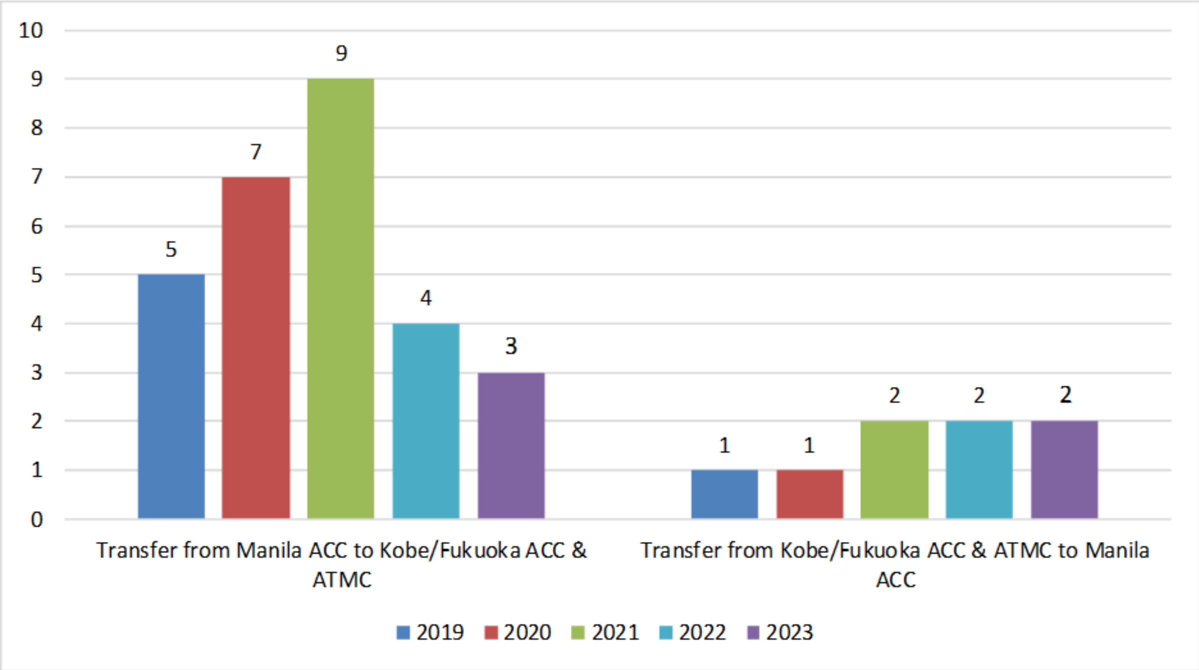

Figure 5: Number of LHDs at Hot spot D between Fukuoka and Manila FIR

2.14 To mitigate transfer error due to human factors at Hot Spot D1, the bilateral meetings between Fukuoka and Manila ACC have regularly been held since December 2022. The details and efforts of the bilateral meetings are provided by a separate information paper at the RASMAG/29 meeting.

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 2023 to December 2023

(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 2023 to December 2023. There are a total of 49 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 2.36 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 2023 to 31 December 2023.

2. DISCUSSION

2.1 Traffic Sample Data (TSD)

2.1.1 Traffic Sample data for December 2023 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 2023 to December 2023.

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 2023	2	2.5
February 2023	0	0
March 2023	0	0
April 2023	5	9.7
May 2023	5	23.5
June 2023	6	22.6
July 2023	5	12.1

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)
August 2023	11	19.9
September 2023	9	17.9
October 2023	1	0.4
November 2023	5	3.7
December 2023	0	0
Total	**49**	**112.3**

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 2022 and 2023. The number of LHDs reported in 2023 is increased from 2022.

Code	LHD Category Description	2022	2023
A	Flight crew fails to climb or descend the aircraft as cleared	2	2
B	Flight crew climbing or descending without ATC clearance	3	2
C	Incorrect operation or interpretation of airborne equipment	6	3
D	ATC system loop error	3	5
E	ATC transfer of control coordination errors due to human factors	6	3
F	ATC transfer of control coordination errors due to technical issues	1	1
G	Aircraft contingency leading to sudden inability to maintain level	3	0
H	Airborne equipment failure and unintentional or undetected level change	3	0
I	Turbulence or other weather related cause	11	17
J	TCAS resolution advisory and flight crew correctly responds	5	16
K	TCAS resolution advisory and flight crew incorrectly responds	0	0
L	Non-approved aircraft is provided with RVSM separation	0	0
M	Other	2	0
Total		**45**	**49**

Table 2: Summary of LHD Causes within Fukuoka FIR.

2.2.4 **Appendix A** contains the details of the 14 LHDs that 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 34 LHDs that 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 2 LHDs that 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 2023 are slightly smaller than that of aircraft based on the TSD of December 2022.

Table 3: Summarizes the value of the parameters used for the vertical 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 2012).
λx	Average aircraft length	0.0276 nm	JASMA (TSD of RVSM flights in Dec 2023)
λy	Average aircraft width	0.0249 nm	
λz	Average aircraft height	0.0078 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	3.01×10^{-2}	CCAW data (Dec 2023)
Nx(opp)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	7.30×10^{-2}	CCAW data (Dec 2023)
$Naz^{technical}$ (cross)	The collision risk for crossing routes (technical dimension)	1.21×10^{-10} [accidents/flight hour]	FO flight data (Dec 2023) is utilized for the calculation of $E_z(\theta)$.
$Naz^{operational}$ (cross)	The collision risk for crossing routes (operational dimension)	3.86×10^{-9} [accidents/flight hour]	By eq. (12).
H	Total flight hours of aircraft flying on the route segments within airspace under consideration	1,688,572 flight hours	Estimated flight hours from Jan 2023 to Dec 2023 *12 times the flight hours in Dec 2022
T(0)	LHD duration in hours	0.41	Total duration hours of 20

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
			operational LHD reports received from Jan 2023 to Dec 2023

3.2 Risk Calculation

3.2.1 Based on the TSD for one month of December 2023 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

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

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

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

$P_h(\theta)$ was calculated assuming that the distributions of along-track positions and 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,

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

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

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

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 0.27 x 10^{-9} fatal accidents per flight hour. The operational risk estimate is 2.09 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 2.36 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 = 1,688,572 hours ***(note: estimated hours based on Dec 2023 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 28 Total Risk	*4.92 x 10^{-9}*	*5.0 x 10^{-9}*	*Below TLS*
Technical Risk	0.27 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	2.09 x 10^{-9}	-	-
Total Risk	**2.36 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 2023 to December 2023.

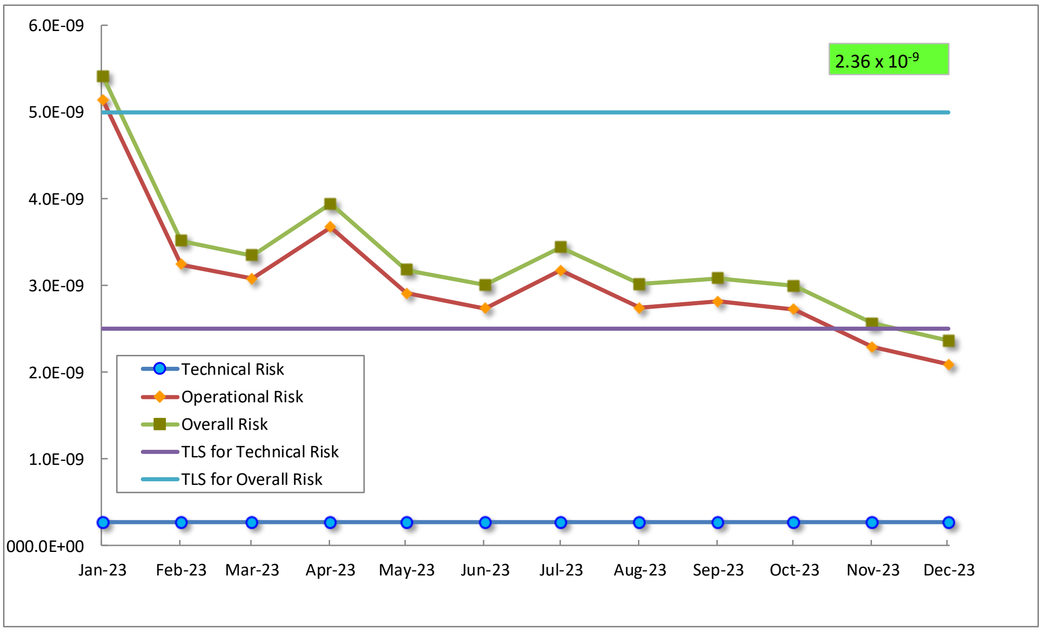

Figure 2: Fukuoka FIR RVSM Risk Estimate Trends

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	11-Jan-2023	Fukuoka ACC	NHC	A20N	370	36,400	0.45	ATC system loop error	D	
2	19-Apr-2023	Fukuoka ACC	HKC	A321	340	32,500	0.33	ATC system loop error	D	
3	21-Apr-2023	Fukuoka ACC	KEC	A21N	310	29,600	0.75	Flight crew fails to climb or descend the aircraft as cleared	A	
4	29-Apr-2023	Fukuoka ACC	MEVIN	A359	370	36,000	6.92	ATC transfer of control coordination errors due to human factors	E	D1
5	06-Jul-2023	Fukuoka ATMC	NIPPI	K35R	320	32,700	2.00	Flight crew climbing or descending without ATC clearance	B	
6	07-Jul-2023	Fukuoka ATMC	GURAG	A359	390	37,000	4.00	ATC transfer of control coordination errors due to human factors	E	D1
7	24-Jul-2023	Fukuoka ACC	SUNPI	A359	340	33,500	0.30	Incorrect operation or interpretation of airborne equipment	C	
8	03-Aug-2023	Tokyo ACC	POROT	B788	320	31,700	0.50	ATC system loop error	D	
9	03-Aug-2023	Tokyo ACC	POROT	B77L	310	30,500	0.97	TCAS resolution advisory and flight crew correctly responds	J	
10	11-Aug-2023	Fukuoka ACC	MEVIN	B77L	350	36,000	3.88	ATC transfer of control coordination errors due to human factors	E	D1
11	12-Aug-23	Tokyo ACC	KABKI	B744	360	35,700	0.10	TCAS resolution advisory and flight crew correctly responds	J	
12	24-Aug-2023	Tokyo ACC	DANDY	B744	310	31,600	1.22	Flight crew climbing or descending without ATC clearance	B	

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
13	15-Sep-2023	Fukuoka ACC	KABKI	A333	330	31,500	0.83	Incorrect operation or interpretation of airborne equipment	C	
14	22-Sep-2023	Fukuoka ACC	YME	B77W	370	36,000	0.87	ATC system loop error	D	
15	28-Sep-2023	Operator	OHMAR	B737	370	37,800	1.00	Incorrect operation or interpretation of airborne equipment	C	
16	02-Nov-2023	Fukuoka ACC	KRE	B77L	380	38,600	0.35	ATC system loop error	D	
17	17-Nov-2023	Fukuoka ACC	TGE	A20N	350	36,300	0.23	Flight crew fails to climb or descend the aircraft as cleared	A	

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	08-Jan-2023	Tokyo ACC	GTC	A320	390	37,900	2.00	Turbulence or other weather related cause	I	
2	01-Apr-2023	Kobe ACC	SUC	GLF6	290	29,700	0.50	TCAS resolution advisory and flight crew correctly responds	J	
3	19-Apr-2023	Tokyo ACC	SHION	MD11	340	34,900	1.17	Turbulence or other weather related cause	I	
4	09-May-2023	ATMC	PASRO	B789	350	35,300	9.00	TCAS resolution advisory and flight crew correctly responds	J	
5	14-May-2023	Tokyo ACC	SUGAL	B77L	310	31,400	0.52	TCAS resolution advisory and flight crew correctly responds	J	
6	19-May-2023	ATMC	BIXAK	A320	360	35,700	6.00	Turbulence or other weather related cause	I	
7	19-May-2023	ATMC	4211N 15730E	A339	350	35,400	3.00	TCAS resolution advisory and flight crew correctly responds	J	
8	24-May-2023	ATMC	4239N 16138E	B77W	310	31,300	5.00	Turbulence or other weather related cause	I	
9	02-Jun-2023	Tokyo ACC	KABKI	B738	370	36,700	0.83	TCAS resolution advisory and flight crew correctly responds	J	
10	13-Jun-2023	ATMC	3823N 14616E	A359	350	34,700	4.00	Turbulence or other weather related cause	I	
11	23-Jun-2023	Kobe ACC	KRE	B738	290	29,400	0.50	TCAS resolution advisory and flight crew correctly responds	J	
12	28-Jun-2023	Fukuoka ACC	RUSAR	B738	320	32,400	0.27	Turbulence or other weather related cause	I	

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
13	29-Jun-2023	Kobe ACC	HGE	B738	300	30,600	1.00	TCAS resolution advisory and flight crew correctly responds	J	
14	30-Jun-2023	Fukuoka ATMC	3340N 15904E	B744	360	35,700	16.00	Turbulence or other weather related cause	I	
15	03-Jul-2023	Tokyo ACC	PUTER	B789	370	37,500	0.80	Turbulence or other weather related cause	I	
16	26-Jul-2023	ATMC	BIXAK	A321	330	32,500	5.00	Turbulence or other weather related cause	I	
17	05-Aug-2023	Fukuoka ACC	BUBDO	A20N	370	36,700	0.05	Turbulence or other weather related cause	I	
18	18-Aug-2023	Fukuoka ACC	HKC	A321	350	34,600	0.50	Turbulence or other weather related cause	I	
19	21-Aug-2023	Tokyo ACC	VESET	B77L	360	35,600	0.70	TCAS resolution advisory and flight crew correctly responds	J	
20	22-Aug-2023	Fukuoka ATMC	DOVAG	A320	370	36,700	10.00	Turbulence or other weather related cause	I	
21	23-Aug-2023	Fukuoka ACC	TARBY	A320	350	35,300 /34,200	1.48	Turbulence or other weather related cause	I	
22	25-Aug-2023	Operator	YULIA	A320	380	37,600	0.50	Turbulence or other weather related cause	I	
23	06-Sep-2023	Operator	SZE	A320	350	34,600	0.17	Turbulence or other weather related cause	I	

	Occurrence Date	Reporter	Location	ACFT Type	Assigned FL	Observed/ Reported ALT (ft)	Duration of LHD (min.)	Cause	CAT code	Hot Spot
24	06-Sep-2023	Tokyo ACC	IGNOT	B77L	300	29,400	0.27	TCAS resolution advisory and flight crew correctly responds	J	
25	09-Sep-2023	Fukuoka ATMC	21N145E	B788	400	40,000	7.00	ATC transfer of control coordination errors due to technical issues	F	
26	21-Sep-2023	Fukuoka ATMC	4112N 14557E	B744	340	34,500	3.00	Turbulence or other weather related cause	I	
27	24-Sep-2023	Fukuoka ATMC	3801N 15505E	B787	380	38,300	4.00	Turbulence or other weather related cause	I	
28	27-Sep-2023	Fukuoka ACC	LANAT	B748	390	36,900	0.73	TCAS resolution advisory and flight crew correctly responds	J	
29	28-Oct-2023	Fukuoka ACC	ONC	B77W	290	29,300 /28,800	0.40	TCAS resolution advisory and flight crew correctly responds	J	
30	05-Nov-2023	Fukuoka ACC	NAKTU	A320	350	34,700	0.57	TCAS resolution advisory and flight crew correctly responds	J	
31	30-Nov-2023	Fukuoka ACC	NOBEP	A320	310	31,300	1.00	TCAS resolution advisory and flight crew correctly responds	J	
32	30-Nov-2023	Fukuoka ACC	NOBEP	B763	300	29,600	1.55	TCAS resolution advisory and flight crew correctly responds	J	

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	11-May-2023	Manila ACC	BISIG	P8	320	32,000		ATC transfer of control coordination errors due to human factors	E	D1
2	07-Sep-2023	Manila ACC	BISIG	B77W	360	34,000		ATC transfer of control coordination errors due to human factors	E	D1

Appendix D

Geographical Location of all LHDs in Fukuoka FIR