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Monitoring Advisory Group (RASMAG/26)

Video Teleconference, 20 – 23 September 2021

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 2020.

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 **Attachment**.

2. DISCUSSION

2.1 The report shows that for the Fukuoka FIR, the level of risk for the reporting period from 1 January 2020 to 31 December 2020 was 11.57×10^{-9} , which exceeds the target level of Safety 5.0×10^{-9} (TLS).

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 2020 to December 2020.

Japanese Airspace – estimated annual flying hours = 891,099 hours (note: estimated hours based on Dec 2020 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
<i>RASMAG 25 Total Risk</i>	11.57×10^{-9}	5.0×10^{-9}	<i>Above TLS</i>
Technical Risk	0.19×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	11.38×10^{-9}	-	-
Total Risk	11.57×10^{-9}	5.0×10^{-9}	Above TLS

Table 1: Japanese Airspace RVSM Risk Estimates

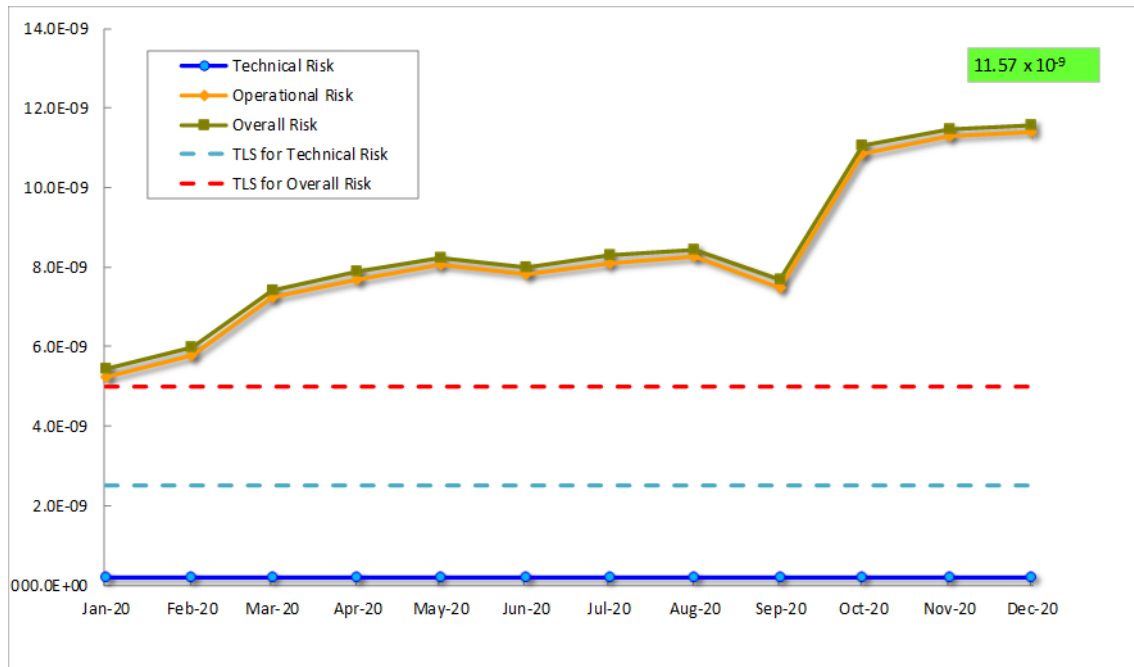


Figure 1: Japanese Airspace RVSM Risk Estimate Trends

2.3 **Table 2** presents a summary of the LHD causes within Japanese airspace from January 2020 until December 2020.

Cod e	LHD Category Description	No.
A	Flight crew fails to climb or descend the aircraft as cleared	5
B	Flight crew climbing or descending without ATC clearance	1
C	Incorrect operation or interpretation of airborne equipment	1
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	10
F	ATC transfer of control coordination errors due to technical issues	2
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 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	0
Total		42

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 during the assessment period. The filled blue square symbols represent LHD location in the RVSM stratum of Fukuoka FIR, and the hollow blue square symbols represent LHD location in the RVSM stratum outside of Fukuoka FIR. The circle size means an LHD duration of 50 seconds or more.

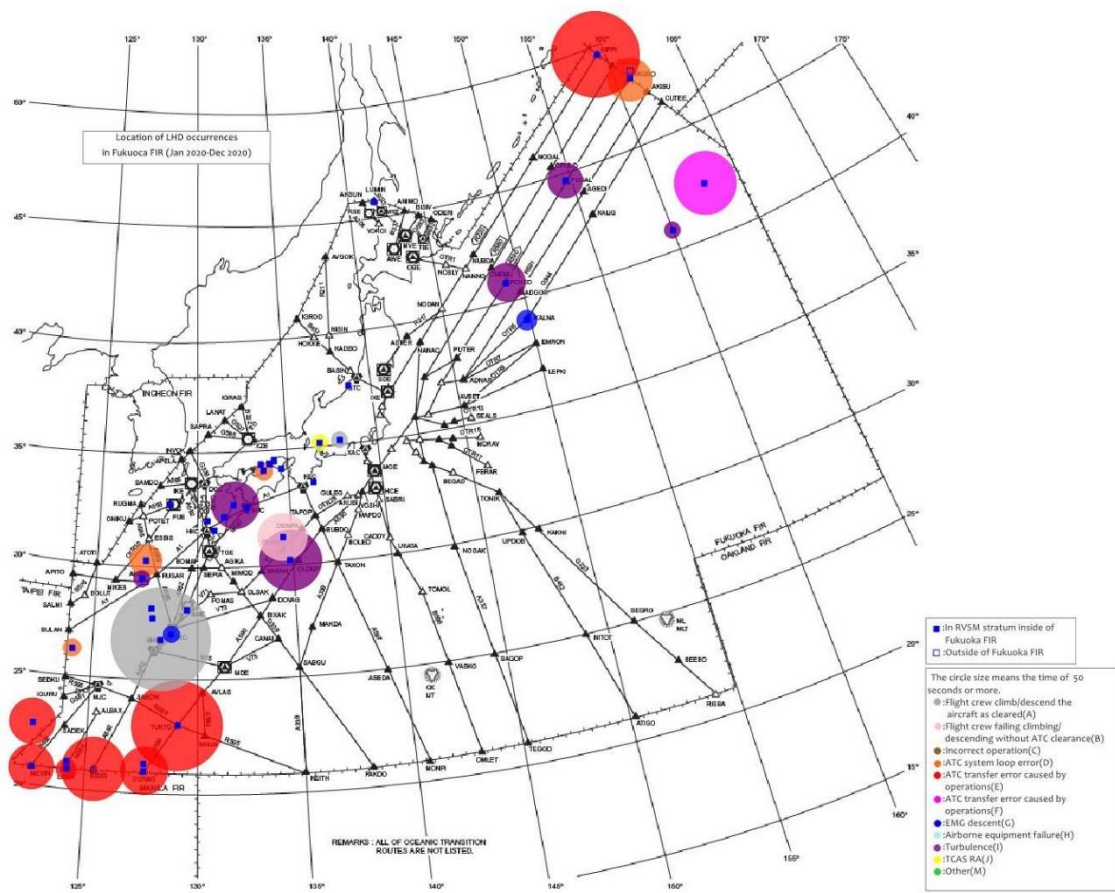


Figure 2: Japanese Airspace – Risk Bearing LHD

2.5 The estimated overall risk in 2020 exceeds the TLS. However, the risk value is the same as the previous year.

2.6 **Figure 3** presents the comparing the number of LHDs by category from the calendar year 2018 to 2020.

- In general, the number of LHDs in 2020 decreased compared with 2018 and 2019.
- The number of category D LHDs, ATC system loop error, fell to 5, half of the previous year.
- The number of category J LHDs, TCAS resolution advisory and flight crew correctly responds, significantly dropped to 5.
- All five category J LHDs were caused due to "nuisance TCAS RAs"*1, so "genuine TCAS RAs"*2 were not reported in 2020.

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

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

- On the other hand, category A LHDs, Flight crew fails to climb or descend the aircraft as cleared, increased to 5.

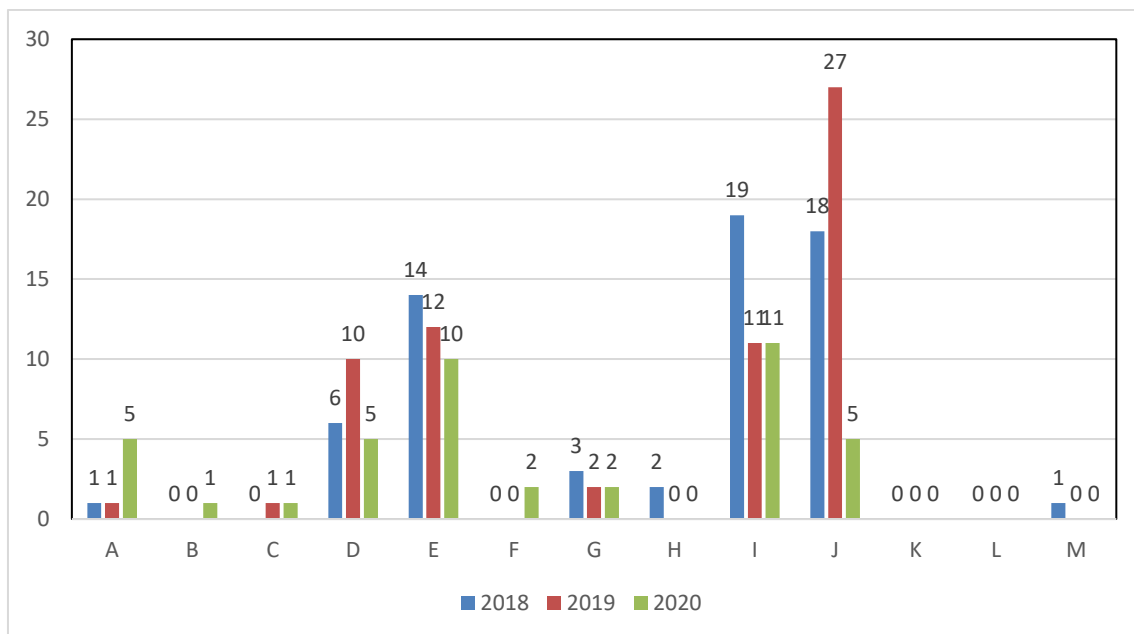


Figure 3: Comparing LHDs from 2018 to 2020

2.7 JASMA has been analyzing trends and changes of LHDs due to the impact of COVID-19.

- Increase of category A LHDs might have been caused by the decreasing opportunities that pilots could operate aircraft.
- The number of category J LHDs might be in proportion to air traffic volumes and flight hours.
- The number of category E LHDs might not be in proportion to air traffic volumes and flight hours, so implementing technical mitigation measures (e.g. AIDC) might be most effective.

2.8 **Figure 4** presents LHDs that occurred at the Hot spot D, the FIR boundary between Manila FIR and Fukuoka FIR. A total of eight category E LHDs occurred at Hot spot D in 2020. Seven of these LHDs occurred on transfer from Manila ACC to Kobe ACC or Fukuoka ATMC, and the rest of one LHD occurred on transfer from Kobe ACC to Manila ACC.

2.9 Two of these LHDs occurred due to no transfer information from Manila ACC, and three LHDs occurred due to no revised transfer information of altitude change from Manila ACC. One LHD occurred due to no revised transfer information of estimated time of over (ETO) at the FIR boundary from Manila ACC, and the aircraft passed at the FIR boundary 14 minutes prior to the ETO.

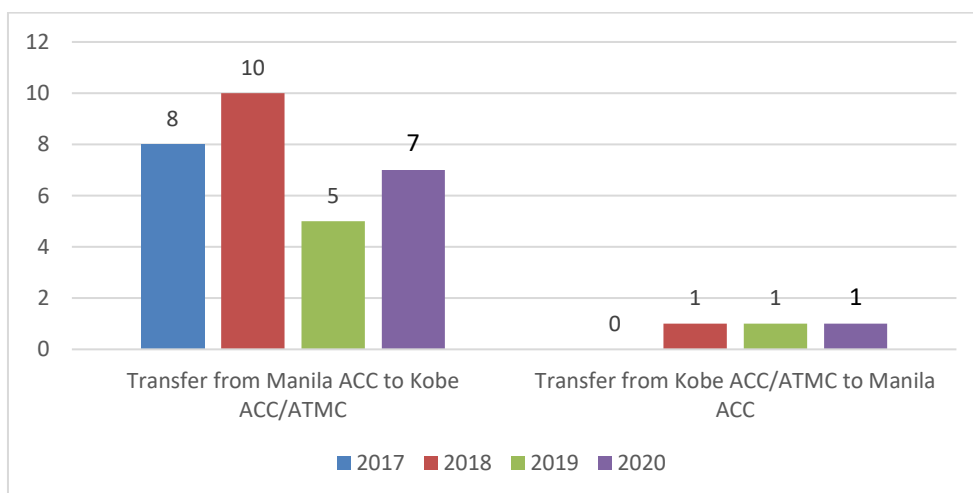


Figure 4: Number of LHDs at Hot spot D between Manila FIR and Fukuoka FIR

2.10 On the basis of the **Decision RASMAG/25-4: Safety Reporting Assessments**, RMAs and EMAs is required to describe an assessment of the safety reporting culture of the States concerned (including ‘Just Culture’), and specifically. JASMA has prepared and submitted another working paper to show the safety reporting culture of Fukuoka FIR in Japan.

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**

JAN 2020 to DEC 2020

(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 of the vertical collision risk for the period from January 2020 to December 2020. 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 11.57×10^{-9} that exceeds the target level of safety (TLS).

1. INTRODUCTION

1.1 This attachment presents a summary of large height deviation reports received by the JASMA and an update of the vertical collision risk for the period of 1 January 2020 to 31 December 2020.

2. DISCUSSION

2.1 Traffic Sample Data (TSD)

2.1.1 Traffic Sample data for December 2020 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 2020 to December 2020.

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.

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)
January 2020	7	24.0
February 2020	4	7.6
March 2020	3	31.0
April 2020	4	2.4
May 2020	2	5.3

June 2020	3	3.6
July 2020	2	2.0
August 2020	4	14.0
September 2020	3	15.3
October 2020	3	30.0
November 2020	3	9.6
December 2020	4	8.0
Total	42	152.8

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

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 in 2019 and 2020. The number of LHD reports in 2020 decreases what in 2019.

Code	LHD Category Description	2019	2020
A	Flight crew fails to climb or descend the aircraft as cleared	1	5
B	Flight crew climbing or descending without ATC clearance	0	1
C	Incorrect operation or interpretation of airborne equipment	1	1
D	ATC system loop error	10	5
E	ATC transfer of control coordination errors due to human factors	12	10
F	ATC transfer of control coordination errors due to technical issues	0	2
G	Aircraft contingency leading to sudden inability to maintain level	2	2
H	Airborne equipment failure and unintentional or undetected level change	0	0
I	Turbulence or other weather related cause	11	11
J	TCAS resolution advisory and flight crew correctly responds	27	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	0
Total		64	42

Table 2: Summary of LHD Causes within Fukuoka FIR.

2.2.5 **Table 3** presents the details of the 22 LHDs that contributed to the operational risk, which were reported to the JASMA during the reporting period.

No.	Date	Time (UTC)	Reporting ACC	Location	ACFT TYPE	Deviation (Levels Crossed)	Duration (min)	CAT
1	3-Jan-2020	20:19	Fukuoka ACC	ESBIS	A333	1	2.32	D
2	13-Jan-2020	2:09	Fukuoka ACC	KTE	A333	0	0.3	A
3	18-Jan-2020	20:45	ATMC	TUNTO	B789	0	20	E
4	30-Jan-2020	15:26	ATMC	GURAG	B77W	0	0	E
5	5-Feb-2020	3:16	ATMC	GURAG	B763	2	6	E
6	5-Feb-2020	13:04	Sapporo ACC	LUMIN	DH8C	5	0	E
7	24-Mar-2020	9:24	ATMC	PASRO	B744	2	4	D
8	26-Mar-2020	20:36	ATMC	NIPPI	MD1	0	17	E
9	5-Apr-2020	0:33	Tokyo ACC	KIDAX	B763	0	1.12	A
10	13-Apr-2020	5:51	Fukuoka ACC	OYE	B738	0	0.48	A
11	24-Apr-2020	6:37	Tokyo ACC	WASYU	B738	1	0.5	A
12	24-Jun-2020	2:01	Kobe ACC	MEVIN	K35R	1	3	E
13	17-Jul-2020	14:20	Tokyo ACC	HABAR	B77W	3	1	D
14	17-Aug-2020	2:31	Fukuoka ACC	HKC	B737	0	0.45	D
15	28-Aug-2020	3:30	Kobe ACC	LEBIX	B788	4	1	E

16	27-Sep-2020	8:52	Kobe ACC	BISIG	A321	4	11	E
17	19-Oct-2020	0:41	Fukuoka ACC	FUE	B752	0	0.43	C
18	31-Oct-2020	7:35	Kobe ACC	AZAMA	B748	2	29	A
19	13-Nov-2020	2:27	ATMC	OLDUP	K35R	1	8	B
20	18-Dec-2020	3:40	Kobe ACC	MEVIN	B789	0	3	E
21	25-Dec-2020	7:52	Fukuoka ACC	BULAN	B789	2	2	D
22	30-Dec-2020	13:07	Kobe ACC	LEBIX	A359	4	1	E

Table 3: Summary of LHD reports contributed to Operational Risk

2.2.6 **Table 4** contains the details of the 20 LHDs which were not involved in the operational risk.

No.	Date	Time (UTC)	Reporting ACC	Location	ACFT TYPE	Deviation (Levels Crossed)	Duration (min)	CAT
1	1-Jan-2020	9:39	Tokyo ACC	OLIVE	B738	0	0.33	J
2	3-Jan-2020	0:46	Tokyo ACC	KCC	B772	0	1.08	J
3	22-Jan-2020	17:08	ATMC	PASRO	MD11	0	0	F
4	6-Feb-2020	7:01	Fukuoka ACC	HKC	A320	0	0.6	I
5	20-Feb-2020	18:05	Kobe ACC	ONC	GLEX	3	1	G
6	13-Mar-2020	6:11	ATMC	OLDUP	K35R	3	10n	I
7	7-Apr-2020	3:11	Tokyo ACC	SIOMI	A20N	0	0.33	J
8	1-May-2020	9:50	ATMC	POXED	B744	0	5	I
9	16-May-2020	4:06	Fukuoka ACC	HKC	A320	0	0.28	I
10	9-Jun-2020	12:39	Fukuoka ACC	RUSAR	A333	0	0.28	I
11	21-Jun-2020	2:40	Kobe ACC	ONC	A320	0	0.33	I
12	3-Jul-2020	21:25	Fukuoka ACC	ATOTI	A321	0	0.97	I
13	20-Aug-2020	10:30	ATMC	4455531N16 32646E	B744	0	10	F
14	31-Aug-2020	14:50	Tokyo ACC	GAKKI	B744	2	2.5	I
15	9-Sep-2020	4:08	Kobe ACC	AME	A320	0	0.33	I
16	10-Sep-2020	16:53	ATMC	PUGAL	B748	0	4	I
17	10-Oct-2020	3:28	Tokyo ACC	GTC	E170	0	0.63	J
18	20-Nov-2020	5:39	Fukuoka ACC	SUC	B738	0	0.62	J
19	28-Nov-2020	11:28	ATMC	42N160E	B789	0	1	I
20	2-Dec-2020	9:45	ATMC	KALNA	A339	5	2	G

Table 4: Summary of LHD reports not contributed to Operational Risk

2.2.7 **Figure 1** provides the geographic location of LHD reports during the assessment period. The blue square symbols represent LHD location in the RVSM stratum inside of Fukuoka FIR. The circle size means an LHD duration of 50 seconds or more.

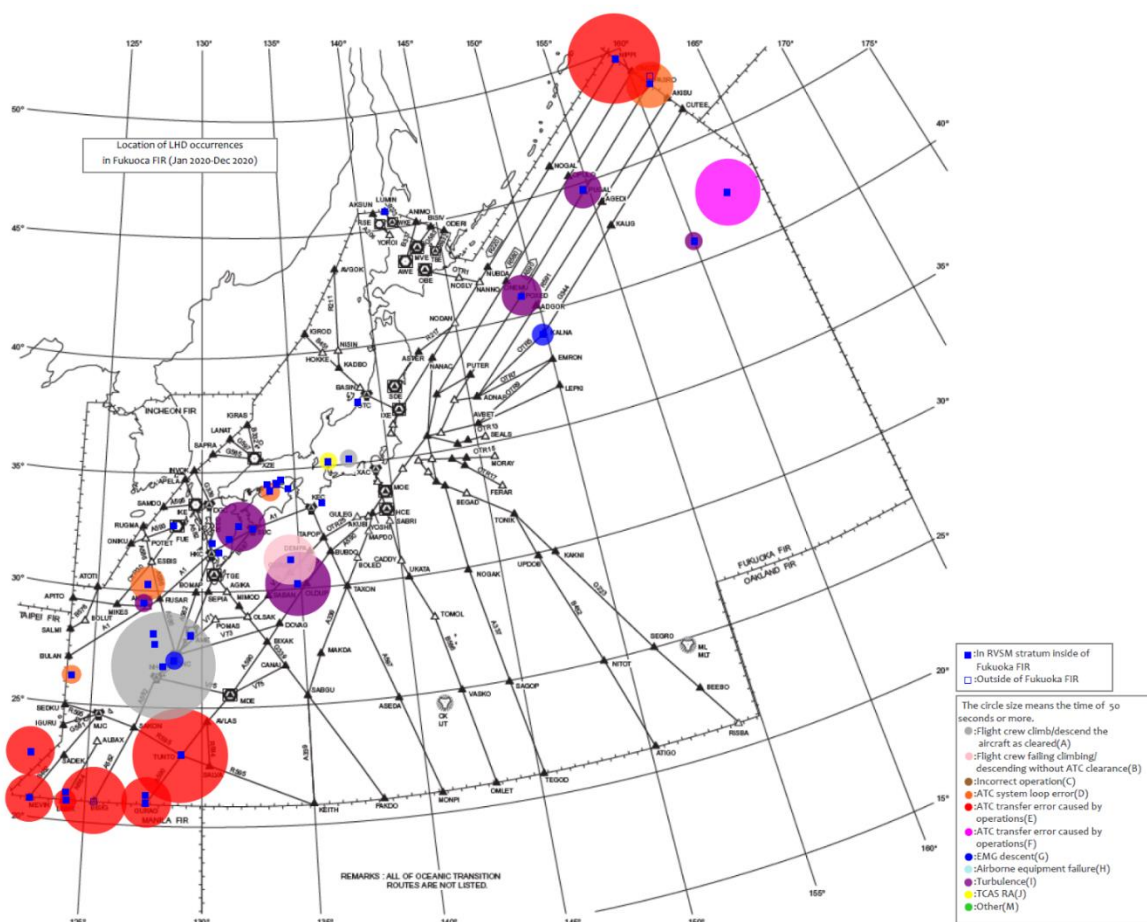


Figure 1: Fukuoka FIR Airspace – None-Zero-Duration LHD

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 5**. The average sizes of aircraft are slightly larger than the TSD of December 2019.

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)

$P_y(0)$	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).
λ_x	Average aircraft length	0.0282 nm	JASMA(December 2020)
λ_y	Average aircraft width	0.0260 nm	
λ_z	Average aircraft height	0.0082 nm	
$ \overline{\Delta V} $	Average along track speed of aircraft pairs	28.9 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC, Apr. 1994)
$ \overline{V} $	Individual-aircraft along track speed	480 kt	Value often used
$ \overline{\dot{y}} $	Average cross track speed of aircraft pairs	11.6 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC, Apr. 1994)
$ \overline{\dot{z}} $	Average vertical speed of aircraft pairs	1.5 kt	Value often used
$N_x(\text{same})$	The passing frequency of aircraft pair assigned to the adjacent flight levels under the same direction traffic	3.88×10^{-6}	ICAP data (2020)
$N_x(\text{opp})$	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	1.54×10^{-5}	ICAP data (2020)
$N_{az}^{\text{technical}}(\text{cross})$	The collision risk for crossing routes (technical dimension)	9.48×10^{-11} [accidents/flight hour]	FO data (December 2020) is utilized for the calculation of $E_z(\theta)$.
$N_{az}^{\text{operational}}(\text{cross})$	The collision risk for crossing routes (operational dimension)	3.13×10^{-9} [accidents/flight hour]	By eq. (12).
H	Total flight hours of aircraft flying on the route segments within airspace under consideration	74258 flight hours	Jan. 2020 to Dec. 2020
T(0)	LHD duration in hours	1.68 flight hours	42 LHD reports received from Jan. 2020 to Dec. 2020

Table 5: Summarizes the value of the parameters used for the risk calculation.

3.2 Risk Calculation

3.2.1 Based on the TSD for one month of December 2019 extracted from the JCAB Flight Data Processing System (FDPS), the numbers of passing events, $n_p(\text{same})$ and $n_p(\text{opp})$, were calculated for each route segment consisting of two fixes.

3.2.2 Using the CRM parameters, such as the 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

$$K(\text{same}) = 1 + \frac{\lambda_x}{V_{rx}(\text{same})} \left(\frac{V_{ry}}{\lambda_y} + \frac{V_{rz}}{\lambda_z} \right) \quad (1)$$

$$K(\text{opp}) = 1 + \frac{\lambda_x}{V_{rx}(\text{opp})} \left(\frac{V_{ry}}{\lambda_y} + \frac{V_{rz}}{\lambda_z} \right) \quad (2)$$

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

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

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

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

respectively.

Technical Risk is estimated by

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

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

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

$P_h(\theta)$ 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. $P_h(\theta)$, $E_z^{\text{cross}}(\theta)$ and $\overline{|\dot{h}(\theta)|}$ were calculated every ten degrees.

Operational Risk is given by

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

where,

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

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

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

Executive Summary

3.3 Safety Oversight for the RVSM implementation in the Fukuoka FIR

3.3.1 **Table 6** presents the estimates of vertical collision risk for the RVSM airspace of the Fukuoka FIR. The technical risk is estimated to be 0.53×10^{-9} fatal accidents per flight hour. The operational risk estimate is 11.04×10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 11.57×10^{-9} fatal accidents per flight hour, which exceeds the globally agreed TLS value of 5.0×10^{-9} fatal accidents per flight hour.

Japanese Airspace – estimated annual flying hours = 891,099 hours (note: estimated hours based on Dec 2019 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 25 Total Risk	11.57×10^{-9}	5.0×10^{-9}	Above TLS
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Operational Risk	11.38×10^{-9}	-	-
Total Risk	11.57×10^{-9}	5.0×10^{-9}	Above TLS

Table 6: 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 2020 to December 2020.

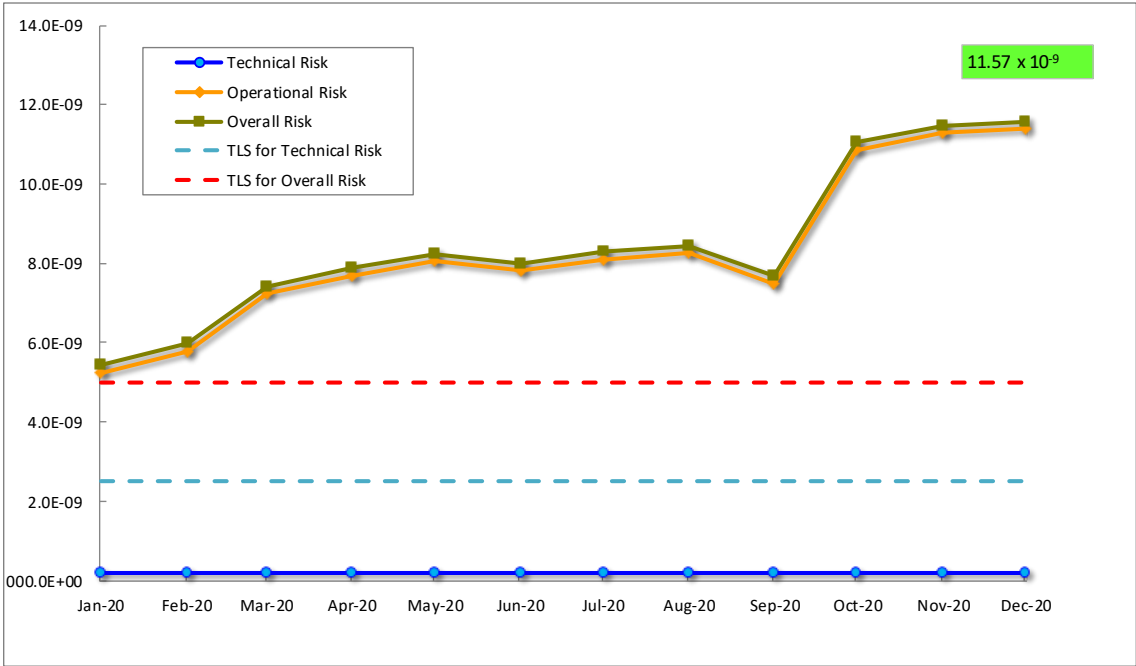


Figure 2: Fukuoka FIR RVSM Risk Estimate Trends

3.3.3 The estimated overall risk exceeded the TLS. The risk value is as same as the previous year.