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

CHINA RMA VERTICAL SAFETY REPORT

(Presented by China RMA)

SUMMARY

This paper presents the results of the airspace safety oversight for the RVSM operation in the airspace of 9 Chinese FIRs and Pyongyang FIR for 2022. The report updates vertical collision risk of the above-mentioned airspace and summarizes the LHD reports as received.

1. INTRODUCTION

1.1 China Regional Monitoring Agency (China RMA) is assigned with annual report reflecting the status of compliance for RVSM (Reduced Vertical Separation Minimum) safety requirements in the Shenyang FIR, Beijing FIR, Shanghai FIR, Guangzhou FIR, Kunming FIR, Wuhan FIR, Lanzhou FIR, Urumqi FIR, Sanya FIR and Pyongyang FIR.

2. DISCUSSION

2.1 From late 2014, China RMA started to conduct monthly risk assessments and analyzed the contribution of operational risk for each non-nil event to the total risk. This paper provides the results of the airspace safety oversight for the RVSM operation in the airspace of Chinese FIRs for the time of January 2022 to December 2022, as given in Attachment A. The analysis conducted for the 9 Chinese FIRs is based on one-month traffic sample data (TSD) collected in December 2022 and the latest 12-month Large Height Deviation (LHD) reports until December 2022. Attachment B presents the risk assessment for Pyongyang FIR of DPR Korea based on one-month TSD collected in December 2022.

Executive Summary-RVSM airspace of Chines FIRs

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

The RVSM Airspace of Chinese FIRs – estimated annual flying hours = 1296204.4 hours *(note: estimated hours based on Dec 2022 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 27 Total Risk	*2.17 x 10^{-9}*	*5.0 x 10^{-9}*	*Below TLS*
Technical Risk	0.10 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	0.09 x 10^{-9}	-	-
Total Risk	**0.19 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**

Table 1: Risk Estimates for the RVSM airspace of Chinese FIRs

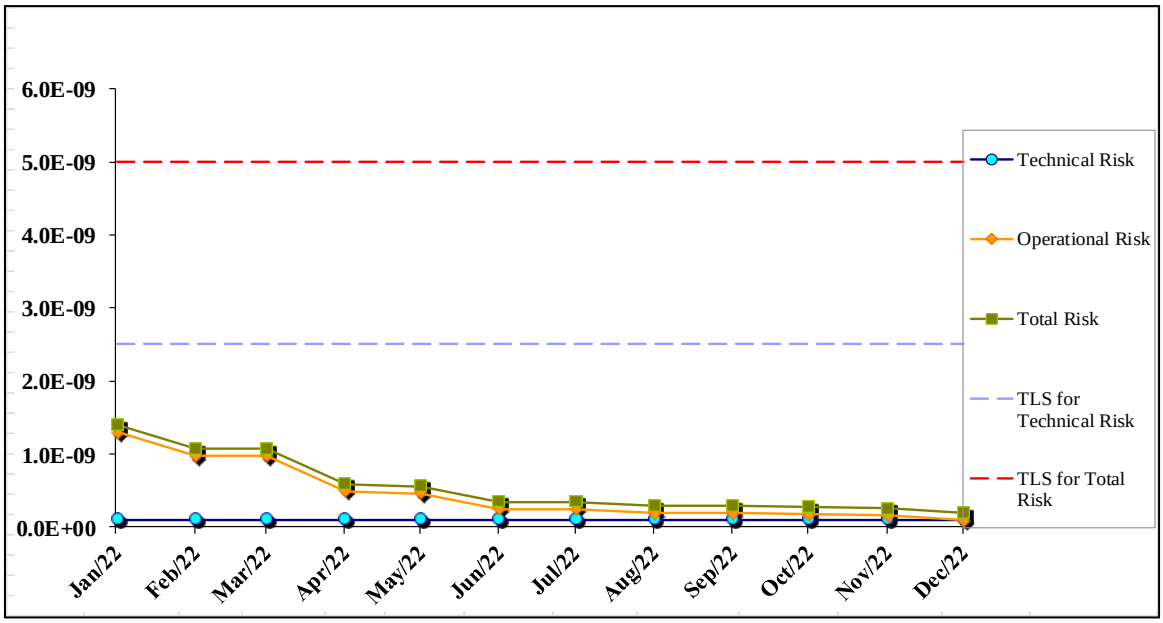

Figure 1: Chinese FIRs RVSM Risk Estimate Trends

2.3 **Table 2** presents a summary of the LHD causes within airspace of Chinese FIRs from January 2022 to 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	1
C	Incorrect operation or interpretation of airborne equipment	1
D	ATC system loop error	0
E	Coordination errors in the ATC -to-ATC transfer of control responsibility as a result of human factors issues	5
F	ATC transfer of control coordination errors due to technical issues	6
G	Aircraft contingency leading to sudden inability to maintain level	0
H	Airborne equipment failure and unintentional or undetected level change	1
I	Turbulence or other weather-related cause leading to unintentional or undetected change of flight level	41
J	TCAS resolution advisory; flight crew correctly climb or descend following the resolution advisory	0
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	15
Total		72

Table 2: Summary of LHD Causes within Airspace of Chinese FIRs

2.4 **Figure 2** provides the geographic location of risk bearing LHD reports within Airspace of Chinese FIRs during the assessment period.

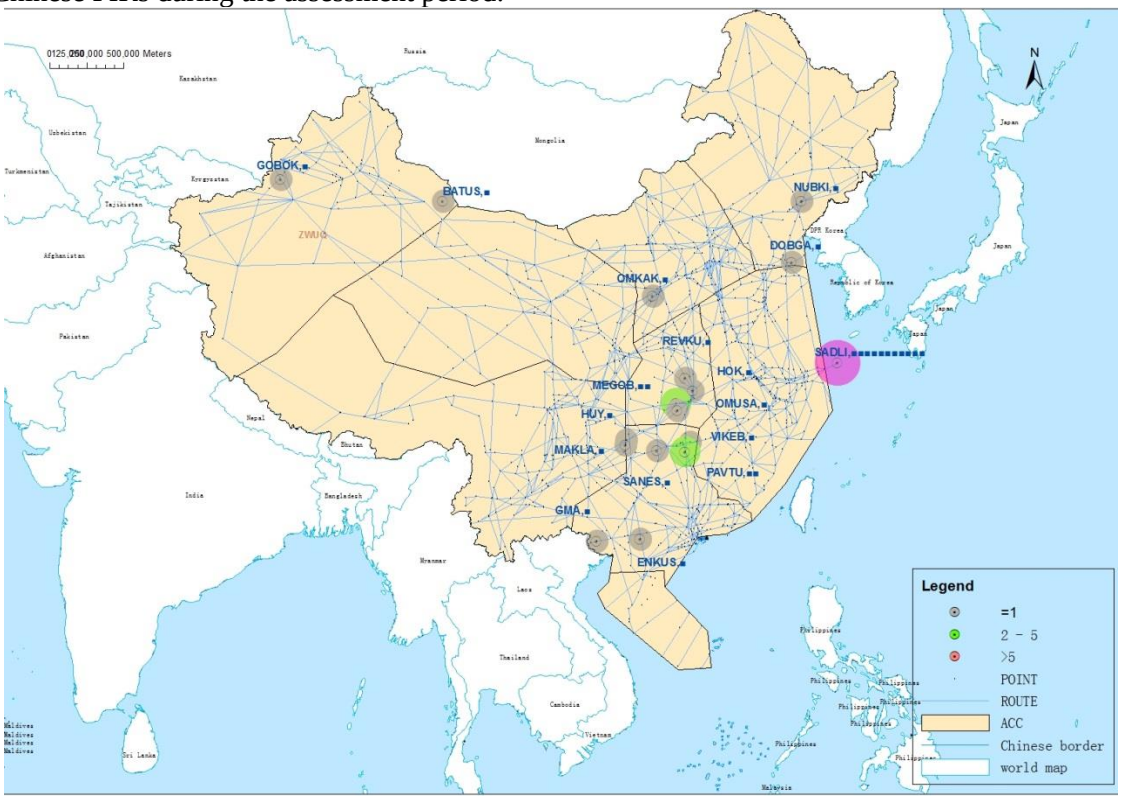

Figure 2: Airspace of Chinese FIRs – Risk Bearing LHD

Executive Summary-RVSM airspace of Pyongyang FIR

2.5 **Table 3** provides the Pyongyang FIR RVSM technical, operational, and total risk estimates. **Figure 3** presents the collision risk estimate trends during the period from January 2022 to December 2022. Since there was no LHD event occurred and few flying hours, the operational risk, the technical risk and the total risk are all 0 in 2022.

RVSM Airspace of DPR Korea – estimated annual flying hours = 10.2 hours *(note: estimated hours based on Dec 2022 traffic sample data)*			
Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 27 Total Risk	*1.08×10^{-9}*	*5.0×10^{-9}*	*Below TLS*
Technical Risk	0	2.5×10^{-9}	Below Technical TLS
Operational Risk	0	--	--
Total Risk	**0**	5.0×10^{-9}	**Below TLS**

Table 3: Airspace of Pyongyang FIR RVSM Risk Estimates

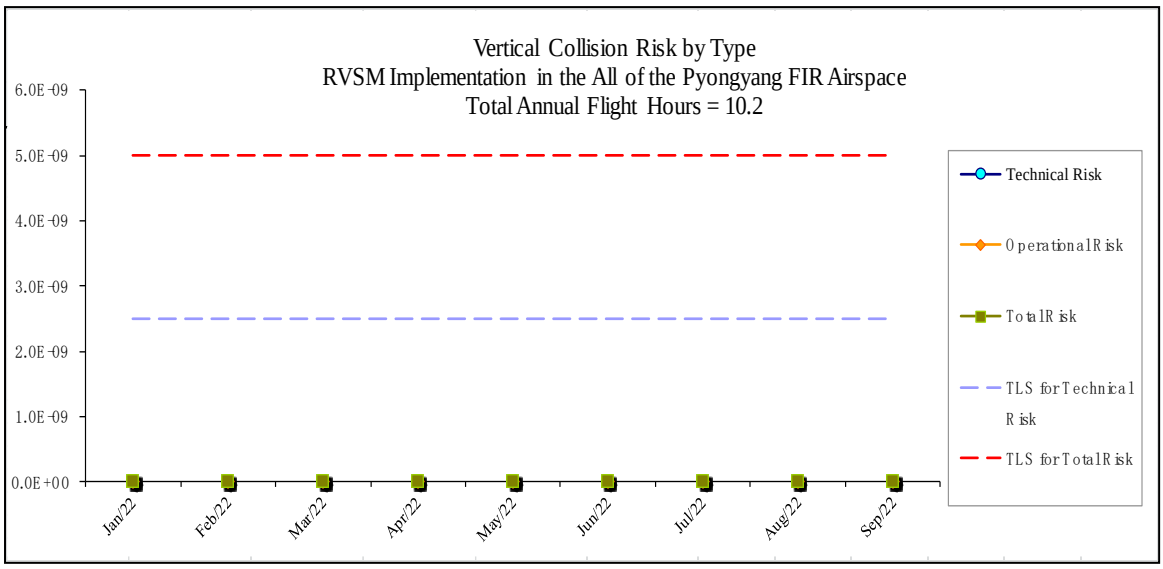

Figure 3: Airspace of Pyongyang FIR RVSM Risk Estimate Trends

2.6 There was no LHD report from Pyongyang FIR in 2022.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.

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ATTACHMENT A

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE Nine CHINESE FLIGHT INFORMATION REGIONS JANUARY 2022 – DECEMBER 2022

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

August 2023

SUMMARY

This report presents the airspace safety oversight from China Regional Monitoring Agency (China RMA) for the reporting time from January to December 2022. The purpose of the report is to compare actual performance to safety goals related to the continued use of Reduced Vertical Separation Minimum (RVSM) in the Chinese FIRs. This report contains a summary of Large Height Deviation Reports received by the China RMA for the most recent reporting period of January 2022 -December 2022. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Chinese FIRs RVSM airspace in December 2022 is below the target level of safety (TLS) value of 5.0 x 10^{-9} fapfh.

1. Introduction

1.1 The report covers the reporting period from January to December 2022 in the China RMA's responsible FIRs. Each year, China RMA produces one report requested by the Regional Airspace Safety Monitoring Advisory Group (RASMAG).

1.2 It summarizes the airspace safety oversight for the China domestic FIRs, including the Large Height Deviation (LHD) reports analysis and an update of the vertical collision risk estimate for the China Domestic Airspace.

2. Data Submissions

2.1. China RMA requests an annual one-month traffic movement sample and monthly large height deviation reports from the ATS providers in Chinese RVSM airspace. The second and third column of **Table 1** lists the Flight Information Regions (FIRs) and relevant Area Control Centers in China.

2.2. Traffic Sample Data (TSD)

2.2.1. Traffic sample data for December 2022 for the airspace of Chinese FIRs were used in the assessment of risk for the RVSM airspace. **Table 1** contains a summary of the traffic sample data received by China RMA for each FIR. Traffic sample data were received from all of the FIRs.

FIR Name	FIR Code	Data Collected in ACCs	Collecting Method	Status	Remarks
Shenyang	ZYSH	Shenyang	Automatic system	Received	Data completed
		Dalian	Automatic system	Received	Data completed
		Harbin	Automatic system	Received	Data completed
		Hailar	Automatic system	Received	Data completed
Beijing	ZBPE	Beijing	Automatic system	Received	Data completed
Shanghai	ZSHA	Shanghai	Automatic system	Received	Data completed
		Qingdao	Automatic system	Received	Data completed
Guangzhou	ZGZU	Guangzhou	Automatic system	Received	Data completed
		Nanning	Automatic system	Received	Data completed
Kunming	ZPKM	Kunming	Automatic system	Received	Data completed
		Chengdu	Automatic system	Received	Data completed
		Lhasa	Automatic system	Received	Data completed
Wuhan	ZHWH	Included in Beijing and Guangzhou	--	--	Data completed
Lanzhou	ZLHW	Lanzhou	Automatic system	Received	Data completed
		Xi’an	Automatic system	Received	Data completed
Urumqi	ZWUQ	Urumqi	Automatic system	Received	Data completed
Sanya	ZJSA	Sanya	Automatic system	Received	Data completed

Table 1. Summary of Traffic Sample Data of December 2022 in the Airspace of Chinese FIRs

2.3. **Large Height Deviation (LHD)**

2.3.1. Series of cumulative 12-month of LHD reports were used in this safety assessment starting from January 2022 to December 2022. **Table 2** provides the summary of LHD reports submitted by each FIR.

FIR Name	Beijing	Shanghai	Guangzhou	Wuhan	Shenyang	Lanzhou	Urumqi	Kunming	Sanya
Jan-22	X	X	X	X	X	X	X	X	X
Feb-22	X	X	X	X	X	X	X	X	X
Mar-22	X	X	X	X	X	X	X	X	X
Apr-22	X	X	X	X	X	X	X	X	X
May-22	X	X	X	X	X	X	X	X	X
Jun-22	X	X	X	X	X	X	X	X	X
Jul-22	X	X	X	X	X	X	X	X	X
Aug-22	X	X	X	X	X	X	X	X	X
Sep-22	X	X	X	X	X	X	X	X	X
Oct-22	X	X	X	X	X	X	X	X	X
Nov-22	X	X	X	X	X	X	X	X	X
Dec-22	X	X	X	X	X	X	X	X	X

Table 2. Summary of LHD Reports collected from Chinese FIRs

X = Large Height Deviation Report was received for the specified month (including reports indicating "NIL" events)

3. Summary of LHD Occurrences

3.1. Based on the LHD reports in **Table 2**, the LHD occurrences in 2022 are summarized as below.

3.2. **Table 3** and **Figure 1** summarize the number of LHD occurrences, associated LHD duration (in minutes) and the number of flight levels crossed without clearance by month in Chinese FIRs in the reporting period:

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)	No. of flight levels transitioned without clearance
Jan-22	8	0	5
Feb-22	5	0	1
Mar-22	6	0	4
Apr-22	6	0	4
May-22	5	0	3
Jun-22	11	0	7
Jul-22	7	0	3
Aug-22	5	0	3
Sep-22	1	0	1
Oct-22	14	0	5
Nov-22	1	0	0
Dec-22	3	0	0
Total	72	0	36

Table 3. Summary of non-nil LHDs in Chinese FIRs in 2022

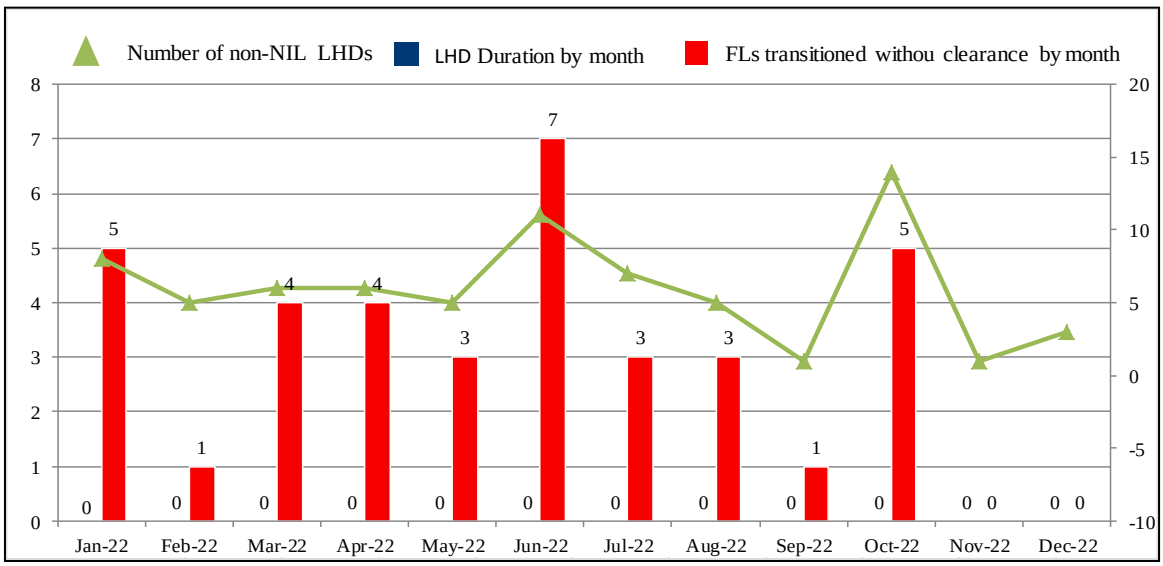

Figure 1. Illustrations of reported LHDs in Chinese FIRs between January 2022 and December 2022

3.3. The LHD reports are categorized by the description of the event. **Table 4**, **Figure 2**, **Figure 3** and **Figure 4** summarize the number of LHD occurrences inside Chinese airspace by the cause of the deviation.

LHD Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. of flight levels transitioned without clearance
A	Flight crew failing to climb/descend the aircraft as cleared	2	0	1
B	Flight crew climbing/descending without Air Traffic Control (ATC) Clearance	1	0	1
C	Incorrect operation or interpretation of airborne equipment	1	0	1
D	ATC system loop error	0	0	0
E	ATC transfer of control coordination errors due to human factors	5	0	0
F	ATC transfer of control coordination errors due to technical issues	6	0	0
G	Aircraft contingency leading to sudden inability to maintain level	0	0	0
H	Airborne equipment failure and unintentional or undetected level change	1	0	1
I	Turbulence or other weather related cause	41	0	32
J	TCAS resolution advisory and flight crew correctly responds	0	0	0
K	TCAS resolution advisory and flight crew incorrectly responds	0	0	0
L	Non-approved aircraft is provided with RVSM separation	0	0	0
M	Other	15	0	0
Total		72	0	36

Table 4. Summary of LHD Categories during the reporting period

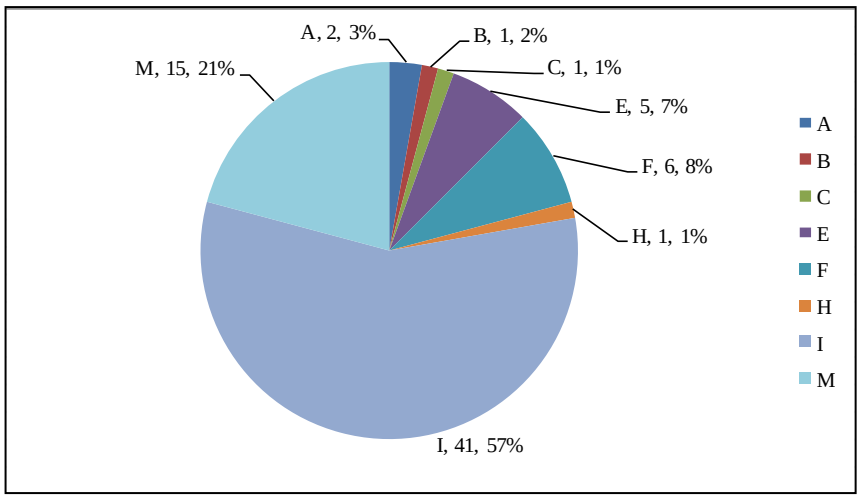

Figure 2. The LHD Events Sorted by Category

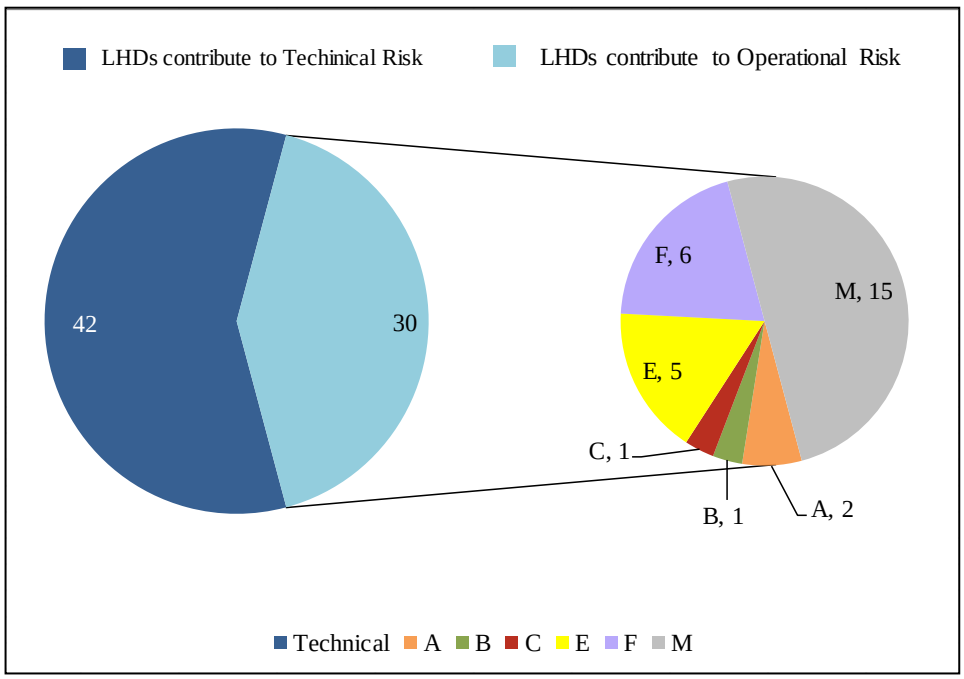

Figure 3. Breakdown of Operation Risk Contributors (Category and Number of Events)

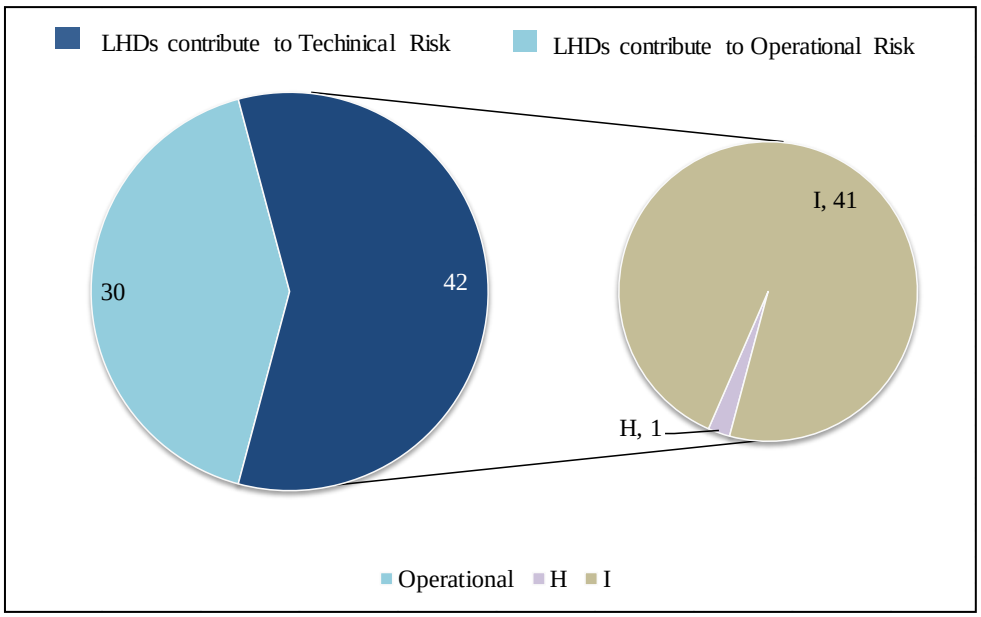

Figure 4. Breakdown of Technical Risk Contributors (Categories and Number of Events)

3.4. **Figure 5** demonstrates the monthly operational risk assessment and the individual event contribution, while **Figure 6** presents the operational risk estimate by categories visualizing the individual event contribution.

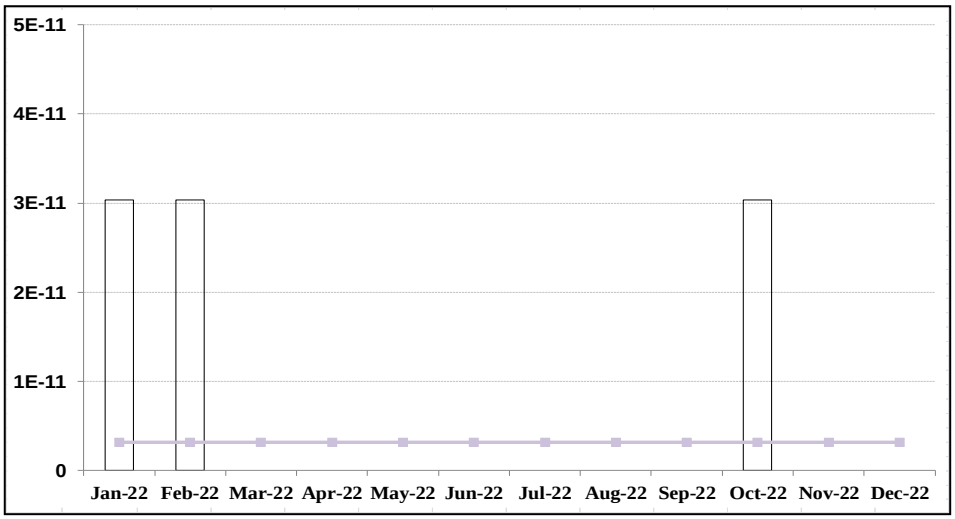

Figure 5. Monthly Assessed Risk Demonstrating the Individual Event Contribution

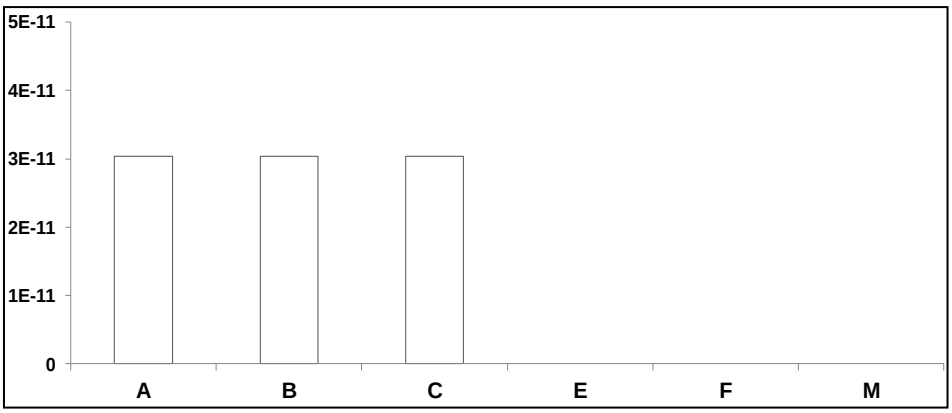

Figure 6. Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

3.5. LHD Analysis and Safety Treatment of Identified LHDs

3.5.1. 77 LHD events were received during the reporting period. 72 events occurred inside Chinese ATS area, and 5 events occurred outside Chinese ATS area. With the decrease of air traffic flow, fewer LHD events occurred compared with 2021.

3.5.2. All the LHD events were received from Chinese ATC units and there was 0 LHD event from Chinese operators. China RMA has made great efforts to improve the reporting mechanism of Chinese operators, including conducting training and research in 2022. Some Chinese operators could report "NIL" events every month, and have established reporting internal mechanism. With our efforts, 6 LHD events had been reported by Chinese operators in 2023.

3.5.3. There were 5 category E and 6 category F events in 2022.8 events occurred in AKARA Corridor between Shanghai ACC and Incheon ACC, 1 event occurred between Urumqi ACC and Islamabad ACC, and 2 event occurred between Urumqi ACC and Alma-Ata ACC. All events were transfer events, and receiving ACC could confirm the transfer information before the aircraft passing the transfer point, so there was no operational risk during these events.

3.5.4. There were 30 operational risk events occurred in 2022, and only 3 events affected operational risk, one for each of category A, B and C. The largest quantity of operational risk event is category M event, which is 15 in the whole year. All the category M events were result from the aircraft lost RVSM capability during the flight because of the on-board equipment failure (most was TCAS failure events). China RMA has investigated these events for years and will submit another report in the next RMACG meeting to provide more analysis for discussion.

3.6. Hot spot identification in trial

3.6.1. As is required by RASMAG/MAWG/9 Action 9/6, all the RMA should try to identify Hot Spots using the method proposed in MAWG/9 WP07 in RASMAG/27 meeting. China RMA conducted the trial and identified 2 clusters as showed in **Figure 7** and **Figure 8**. The cluster 1 is the transfer point SADLI between Shanghai ACC and Incheon ACC in AKARA Corridor. The cluster 2 is at the junction of Wuhan FIR, Shanghai FIR and Guangzhou FIR.

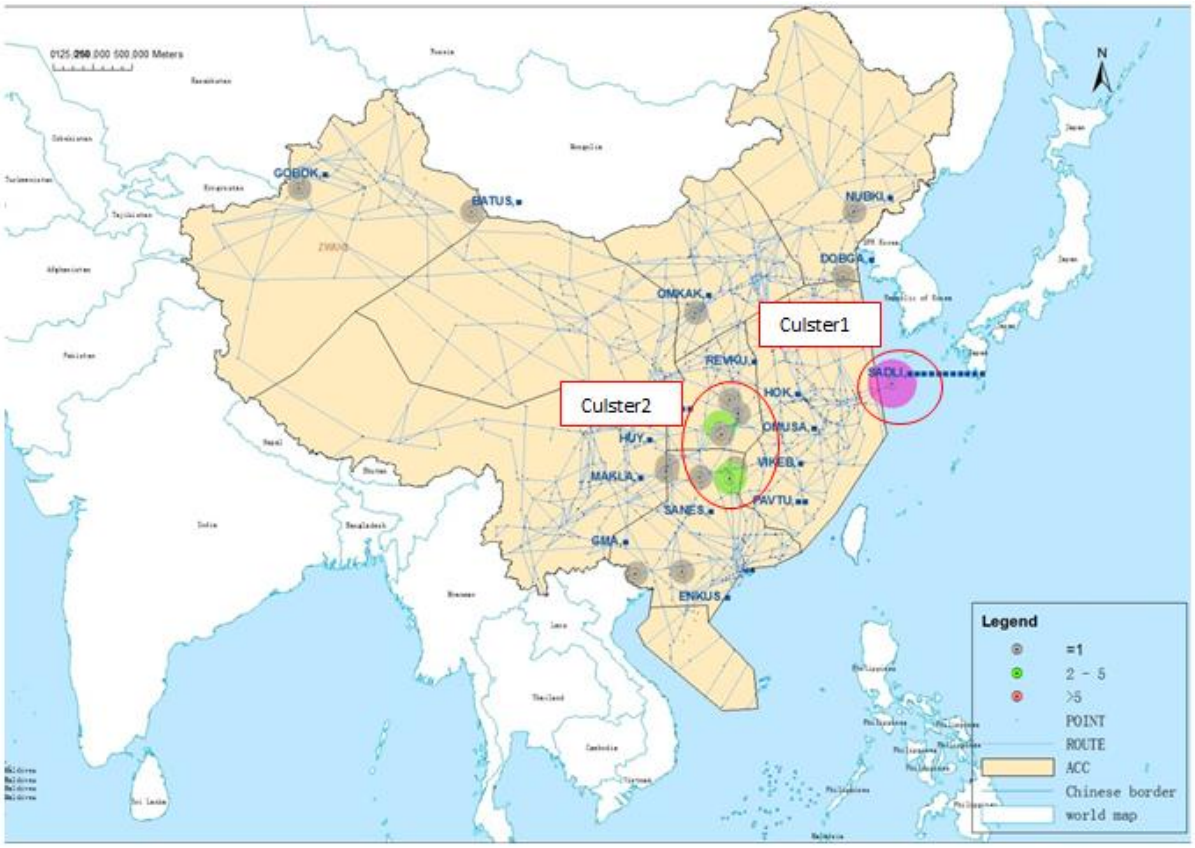

Figure 7. Cluster identification in Chinese airspace for 2022

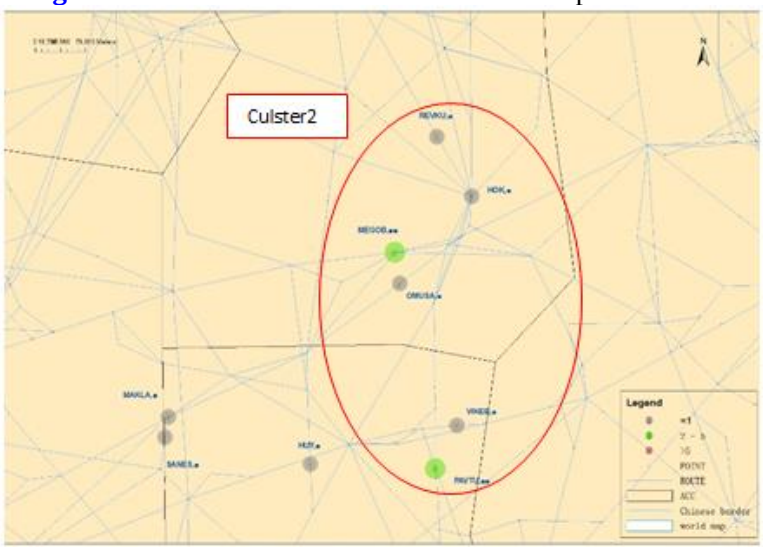

Figure 8. Cluster 2 area zoomed in

3.6.2. **Table 5** and **Table 6** show the Hot Spot criteria and **Table 6** shows the result against the criteria.

	2022
Number of Clusters	2
Number of Operational LHD Events	30
Operational Risk ($x10^{-9}$)	0.09
Criteria: Number	10
Criteria: Risk	0.03

Table 5. The Hot Spot criteria in 2022

	Cluster 1	Cluster 2
Number of Operational LHDs	11	8
Check Criteria: Number	Positive	Negative
Risk	0	0
Check Criteria: Risk	Negative	Negative
Check Criteria: TLS	Negative	Negative

Table 6. The results of checking against the criteria

3.6.3. According to the result of cluster identification, there was no Hot Spot in Chinese airspace and the Cluster 1 belongs to the Hot Spot B in AKARA Corridor. The total risk of 2022 is 0.19 x 10^{-9}, which is below TLS, and there was also no high risk event occurred in this year.

4. Estimate of Vertical Collision Risk for Chinese RVSM Airspace

4.1. The vertical collision risk estimate is to determine whether the Target Level of Safety (TLS) continued to be met in China Domestic airspace, thus supporting the ongoing safe application of RVSM.

4.2. This section updates the results of safety oversight for the RVSM implementation in the monitored airspace. Accordingly, the internationally accepted collision risk methodology is applied in the safety of the RVSM implementation assessment in the airspace.

4.3. The TSD of December 2022, the continuous LHD reports in the airspace of Chinese domestic airspace between January 2022 and December 2022 were adopted to produce the risk estimates presented in this report.

4.4. Collision Risk Model (CRM) parameters Estimate

4.4.1. **Table 7** summarizes the value and source material for values estimation of the empirical parameters of the CRM. The CRM is adopted for the risk assessment and the safety oversight for the RVSM implementation in the China domestic airspace.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
S_x	Longitudinal separation standard for a region, or Length of longitudinal window used to calculate occupancy	80Nm	Standard value used in overall airspace
S_h	Planned Horizontal Separation	80Nm	Standard value used in overall airspace
$P_z(0)$	Probability of vertical overlap (with planned vertical separation equal to zero)	0.4026	Estimated based on the radar data form from Upper Control Area of Beijing, Guangzhou, Shanghai, August 2008
$P_z(S_z)$	Prob. that 2 aircraft nominally separated by the vertical separation minimum S_z are in vertical overlap.	5.604 x 10^{-9}	
$P_y(0)$	Probability of Lateral Overlap	0.025	Estimated by FAA Technical Center based on the proportion of GPS operations observed in the TSD data collected in China
$P_h(\theta)$	Probability of Horizontal	6.88 x 10^{-7}	Value used in the Western

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
	Overlap		Pacific/South China Sea safety assessment
$\overline{\lvert \dot{h}(\theta) \rvert}$	Average relative horizontal speed during overlap for aircraft pairs on routes with crossing angle θ (let θ=45°)	367.4 knots	Value used in Western Pacific/South China Sea safety assessment (corresponds to an average aircraft speed of 480 knots)
$\lvert \bar{\dot{y}} \rvert$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	2.8 knots	Estimated by FAA Technical Center based on the proportion of GPS operations observed in the TSD data collected in China
$\lvert \bar{\dot{z}} \rvert$	Average absolute relative vertical speed of an aircraft pair that has lost all vertical separation	1.5 knots	Value used in NAT RVSM safety assessment
λ_x	Average aircraft length	0.02345Nm	Estimated based on the collected TSD
λ_y	Average aircraft wingspan	0.02073Nm	
λ_z	Average aircraft height	0.0070 Nm	
λ_h	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.02345Nm	

Table 7. Estimate of the empirical Parameters in the CRM

4.4.2. **Table 8** summarizes the value and source material for values estimate of the empirical parameters of the TSD. The TSD is adopted for the risk assessment and the safety oversight for the RVSM implementation in the airspace.

Parameter Symbol	Parameter	Parameter Definition
T	1296204.4	Annual flight hours
E_z(same)	0.0754	Same-direction vertical occupancies
E_z(opposite)	0.0677	Opposite-direction vertical occupancies
Crossing pairs	2015328	Annual estimate of crossing pairs in crossing route
$\overline{\lvert \Delta V \rvert}$	35.8705	Average relative along-track speed between aircraft on same direction routes
$\overline{\lvert V \rvert}$	447.8068	Average absolute aircraft ground speed

Table 8. Estimate of the Parameters Based on the Collected TSD

4.5. **Estimate of Vertical Collision Risk for Chinese RVSM Airspace**

4.5.1. This section summarizes the results of the safety assessment for the airspace of Chinese FIRs. **Figure 9** presents the Technical Risk computed by the TSD collected in December 2022.

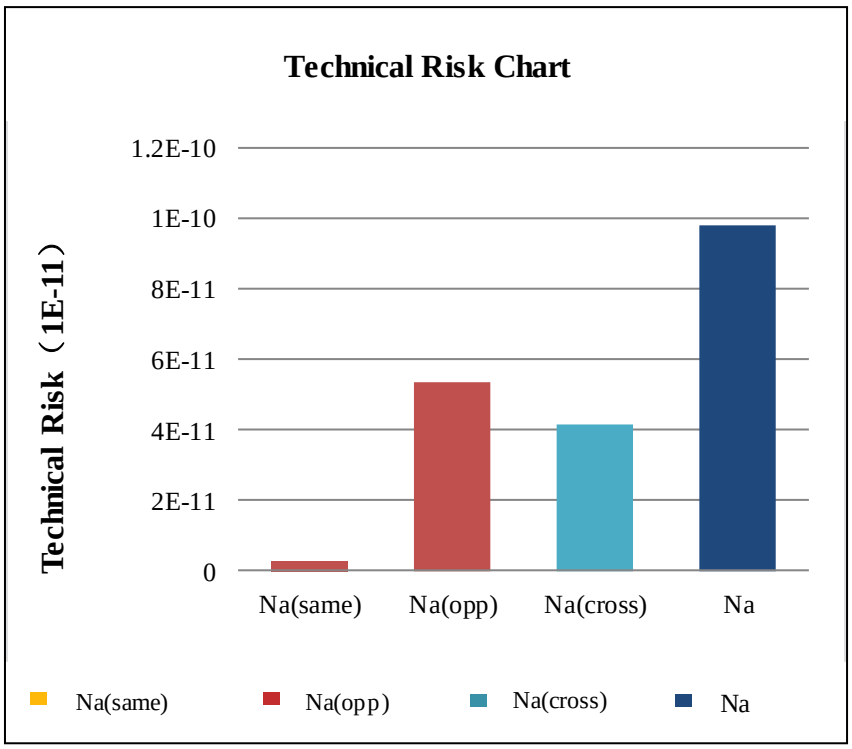

Figure 9. Technical Risk Bar Chart Computed by the TSD Collected in December 2022

4.5.2. **Table 9** presents the estimates of vertical collision risk for the airspace of Chinese FIRs, in terms of the technical, operational, and total risks. The technical risk is estimated to be 0.10 x 10^{-9} fapfh. The operational risk estimate is 0.09 x 10^{-9} fapfh. The estimate of the overall vertical collision risk is 0.19 x 10^{-9} fapfh, which is below the overall TLS value of 5.0x 10^{-9} fapfh.

The RVSM Airspace of Chinese FIRs – estimated annual flying hours = 1296204.4hours *(note: estimated hours based on Dec 2022 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.10 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	0.09 x 10^{-9}	--	--
Total Risk	**0.19 x 10^{-9}**	**5.0 x 10^{-9}**	**Below Overall TLS**

Table 9. Risk Estimates for the RVSM Implementation in the airspace of Chinese FIRs

4.5.3. **Figure 10** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports.

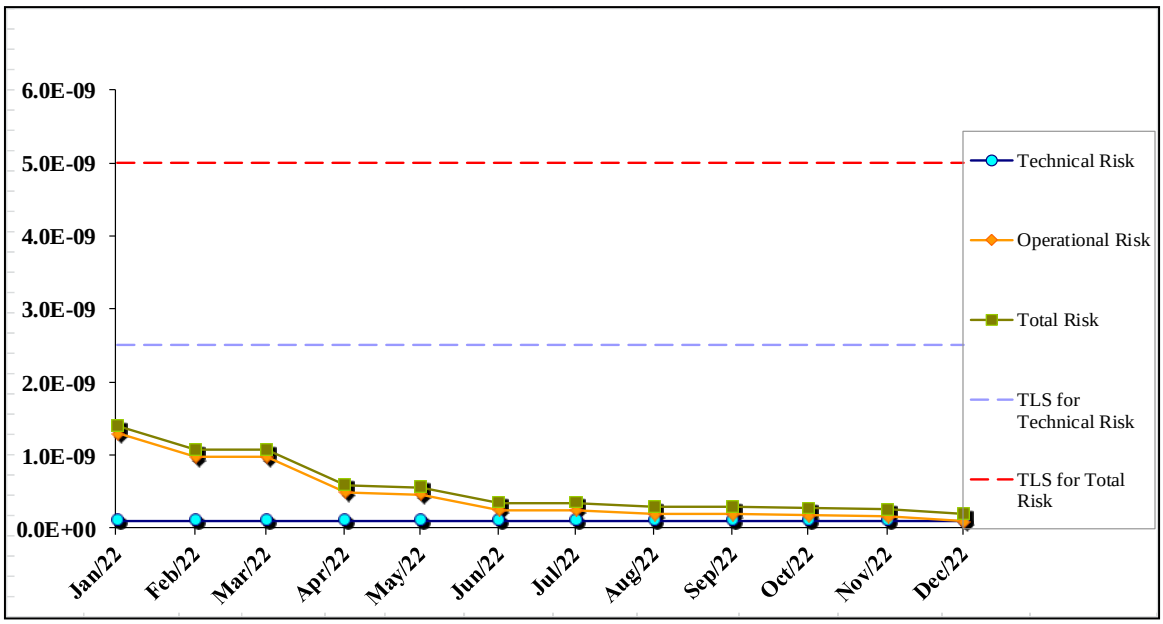

Figure 10. Trends of Risk Estimates for the Airspace of Chinese FIRs

4.5.4. Based on these collision risk estimates, the estimates of both technical risk and total risk from the available TSD and LHD reports satisfy the agreed TLS value of no more than 2.5×10^{-9} and 5.0×10^{-9} fapfh.

Appendix A Detail of LHDs inside Chinese FIRs from January 2022 to December 2022

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
1	07/01/2022	Guangzhou FIR	HOK	0	0	Lose RVSM capability due to TCAS failure	M
2	10/01/2022	Urumqi FIR	OMKEN	0	1	Turbulence	I
3	12/01/2022	Guangzhou FIR	MEGOB	0	0	Lose RVSM capability due to TCAS failure	M
4	12/01/2022	Kunming FIR	SUBUL	0	1	Turbulence	I
5	14/01/2022	Kunming FIR	VABKU	0	0	Turbulence	I
6	16/01/2022	Urumqi FIR	BATUS	0	1	Pilot descend/climb the aircraft without ATC	B
7	17/01/2022	Guangzhou FIR	MAMSI	0	1	Turbulence	I
8	26/01/2022	Beijing FIR	Unknown	0	1	Turbulence	I
9	17/02/2022	Guangzhou FIR	Unknown	0		Lose RVSM capability due to TCAS failure	M
10	17/02/2022	Guangzhou FIR	OMUSA	0	0	Bad weather	I
11	18/02/2022	Guangzhou FIR	AKUBA	0	0	Bad weather	I
12	24/02/2022	Kunming FIR	GMA	0	1	Pilot not descend/climb the aircraft as cleared	A
13	27/02/2022	Urumqi FIR	GOBOK	0	0	Pilot not descend/climb the aircraft as cleared	A
14	13/03/2022	Guangzhou FIR	MEGOB	0		Lose RVSM capability due to TCAS failure	M
15	14/03/2022	Kunming FIR	IPNAG	0	1	Bad weather	I
16	16/03/2022	Lanzhou FIR	GUY	0	1	Bad weather	I
17	17/03/2022	Lanzhou FIR	Unknown	0	0	Bad weather	I
18	18/03/2022	Urumqi FIR	HTN	0	1	Bad weather	I
19	27/03/2022	Urumqi FIR	RIMDU	0	1	Bad weather	I
20	13/04/2022	Guangzhou FIR	IKUBA	0	1	Turbulence	I
22	15/04/2022	Urumqi FIR	UPKOT	0	1	Turbulence	I
22	21/04/2022	Guangzhou FIR	GYA	0	1	Bad weather	I
23	22/04/2022	Guangzhou FIR	REVKU	0		Lose RVSM capability	M
24	24/04/2022	Guangzhou FIR	ATSUD	0	1	Turbulence	I
25	28/04/2022	Guangzhou FIR	Unknown	0	0	Turbulence	I

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
26	13/05/2022	Guangzhou FIR	OMUSA	0		Lose RVSM capability due to TCAS failure	M
27	14/05/2022	Beijing FIR	Unknown	0	1	Turbulence	I
28	21/05/2022	Lanzhou FIR	ELPAN	0	1	Bad weather	I
29	25/05/2022	Shenyang FIR	NUBKI	0		Lose RVSM capability due to TCAS failure	M
30	31/05/2022	Guangzhou FIR	EGEDA	0	1	Turbulence	I
31	03/06/2022	Shanghai FIR	SADLI	0		No transfer	E
32	04/06/2022	Guangzhou FIR	MAMSI	0	0	Turbulence	I
33	11/06/2022	Guangzhou FIR	GLN	0	0	Bad weather	I
34	13/06/2022	Shanghai FIR	SADLI	0		No transfer	E
35	15/06/2022	Urumqi FIR	Unknown	0	1	Turbulence	I
36	17/06/2022	Shenyang FIR	TOSID	0	1	Airborne equipment failure	H
37	18/06/2022	Beijing FIR	HET	0	1	Turbulence	I
38	22/06/2022	Kunming FIR	IPLOL	0	2	Turbulence	I
39	23/06/2022	Beijing FIR	ML	0	1	Turbulence	I
40	26/06/2022	Beijing FIR	OKTOX	0	1	Turbulence	I
41	30/06/2022	Shanghai FIR	SADLI	0		No transfer	E
42	03/07/2022	Guangzhou FIR	WHA	0	0	Turbulence	I
43	05/07/2022	Guangzhou FIR	Unknown	0	1	Turbulence	I
44	06/07/2022	Guangzhou FIR	MAKLA	0		Lose RVSM capability due to TCAS failure	M
45	10/07/2022	Guangzhou FIR	ENKUS	0		Lose RVSM capability due to TCAS failure	M
46	10/07/2022	Kunming FIR	MAKUL	0	1	Turbulence	I
47	19/07/2022	Guangzhou FIR	LUMLU	0	1	Turbulence	I
48	27/07/2022	Kunming FIR	NIXID	0	0	Turbulence	I
49	04/08/2022	Sanya FIR	Unknown	0	0	Turbulence	I
50	12/08/2022	Sanya FIR	SYX	0	1	Turbulence	I
51	12/08/2022	Guangzhou FIR	PAVTU	0		Lose RVSM capability due to TCAS failure	M

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
52	12/08/2022	Sanya FIR	LH	0	1	Turbulence	I
53	26/08/2022	Sanya FIR	SIKOU	0	1	Bad weather	I
54	30/09/2022	Sanya FIR	NYB	0	1	Bad weather	I
55	01/10/2022	Sanya FIR	DABUB	0	1	Bad weather	I
56	02/10/2022	Kunming FIR	Unknown	0	1	Bad weather	I
57	14/10/2022	Sanya FIR	EGEMU	0	1	Bad weather	I
58	14/10/2022	Shanghai FIR	SADLI	0		No transfer	E
59	16/10/2022	Shanghai FIR	SADLI	0		Coordination error due to AIDC fail transfer	F
60	18/10/2022	Urumqi FIR	AVLIM	0	1	Turbulence	I
61	21/10/2022	Shanghai FIR	SADLI	0		Automatic system error	F
62	21/10/2022	Shanghai FIR	SADLI	0		Automatic system error	F
63	21/10/2022	Shanghai FIR	SADLI	0		Automatic system error	F
64	23/10/2022	Shanghai FIR	SADLI	0		Automatic system error	F
65	24/10/2022	Beijing FIR	OMKAK	0	1	Pilot incorrect operation	C
66	25/10/2022	Shanghai FIR	SADLI	0		Automatic system error	F
67	25/10/2022	Shanghai FIR	SADLI	0		Late transfer	E
68	28/10/2022	Shenyang FIR	DOBGA	0		Lose RVSM capability due to Navigation	M
69	26/11/2022	Guangzhou FIR	PAVTU	0		Lose RVSM capability	M
70	09/12/2022	Guangzhou FIR	VIKEB	0		Lose RVSM capability due to TCAS failure	M
71	19/12/2022	Guangzhou FIR	HUY	0		Lose RVSM capability due to TCAS failure	M
72	28/12/2022	Guangzhou FIR	SANES	0		Lose RVSM capability due to TCAS failure	M

Appendix C Geographic Location of Risk Bearing LHD within airspace of Chinese FIRs from January to December 2022

Figure 11 provides the geographic location of risk bearing LHD reports within Chinese FIRs during the reporting period.

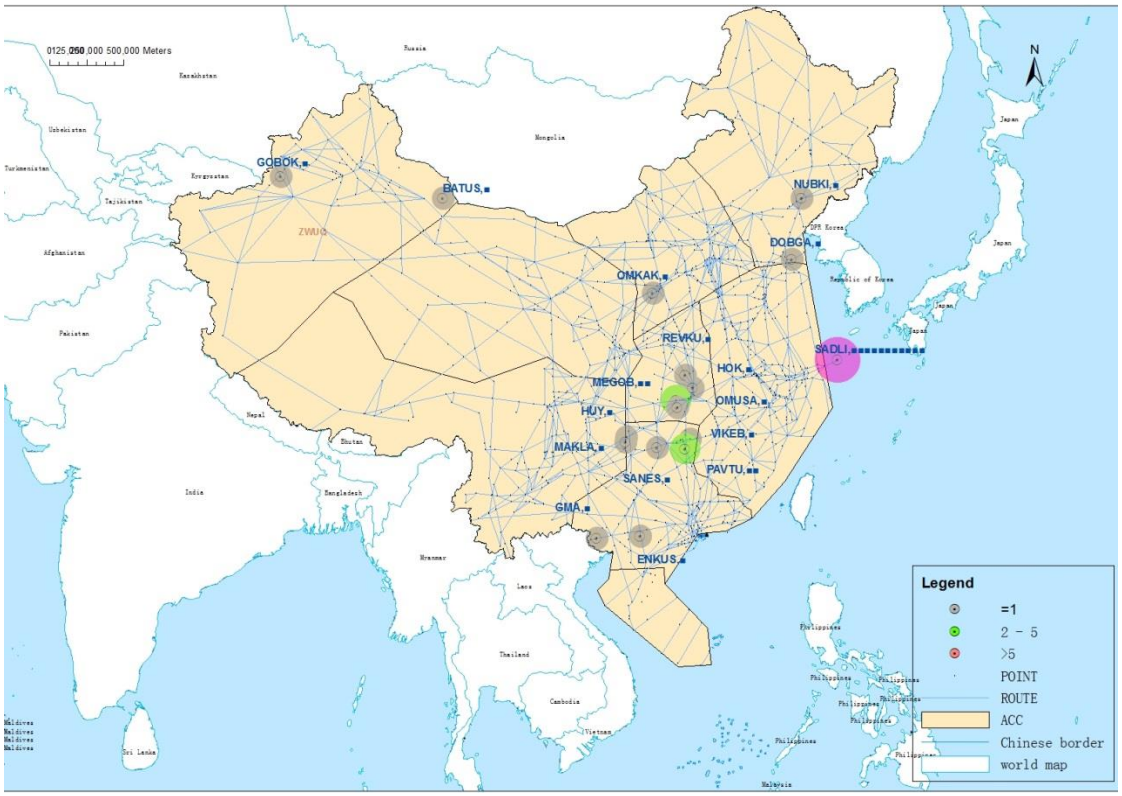

Figure 11. Geographic Location of Risk Bearing LHD Reports in the Region

ATTACHMENT B

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF PYONGYANG FLIGHT INFORMATION REGION JANUARY 2022 -DECEMBER 2022

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

August 2023

SUMMARY

This report presents the airspace safety oversight from China Regional Monitoring Agency (China RMA) for the airspace of Democratic People's Republic of Korea (DPR Korea) for the time January 2022 -December 2022. The purpose of this report is to compare actual performance to safety goals related to continued use of Reduced Vertical Separation Minimum (RVSM) in the airspace of Pyongyang Flight Information Region (FIR). This report also contains an update of the vertical collision risk. The vertical collision risk estimate for the airspace of Pyongyang FIR is below the target level of safety (TLS) value of 5.0 x 10^{-9} fapfh.

1. Introduction

1.1 China Regional Monitoring Agency (China RMA) serves as the regional monitoring agency (RMA) for Pyongyang FIR.

1.2 The report covers the reporting period from January to December 2022 in Pyongyang FIR. Each year, China RMA produces one report requested by the Regional Airspace Safety Monitoring Advisory Group (RASMAG) on the FIR.

2. Data Submission

2.1. China RMA requests an annual one-month traffic movement sample and monthly Large Height Deviation (LHD) reports from the General Administration of Civil Aviation, DPR Korea.

2.2. Traffic Sample Data (TSD)

2.2.1. TSD for December 2022 for the RVSM airspace of DPR Korea was used in the assessment of risk. **Table 1** contains a summary of the traffic sample data received by China RMA for RVSM safety oversight of Pyongyang FIR.

FIR Name	FIR Code	Data Collected in ACC	Collecting Method	Status	Remarks
Pyongyang	ZKKP	Pyongyang	Automatic system	Received	Data completed

Table 1. Summary of Traffic Data of January 2022 in the DPR Korea's RVSM Airspace

2.3. **Large Height Deviation**

2.3.1. There was no LHD event occurred during the period from January 2022 to December 2022.

3. Estimate of Vertical Collision Risk for DPRK's RVSM Airspace

3.1. Estimate of the CRM parameters

3.1.1. **Table 2** summarizes the value and source material for estimating values for each of the empirical parameters of the internationally accepted Collision Risk Model (CRM), which is used to conduct the risk assessment and the safety oversight for the RVSM implementation in DPR of Korea's airspace.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
S_x	Longitudinal separation standard for a region, or Length of longitudinal window used to calculate occupancy	80Nm	Standard value used in overall airspace
S_h	Planned Horizontal Separation	80Nm	Standard value used in overall airspace
$P_z(0)$	Probability of vertical overlap (with planned vertical separation equal to zero)	0.5380	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$P_z(S_z)$	Prob. that 2 aircraft nominally separated by the vertical separation minimum S_z are in vertical overlap.	2.46 x 10^{-8}	
$P_y(0)$	Probability of Lateral Overlap	0.0835	Value used in NAT and average aircraft wingspan
$P_h(\theta)$	Probability of Horizontal Overlap	6.88 x10^{-7}	Value used in the Western Pacific/South China Sea safety assessment
$\overline{\lvert h(\dot{\theta}) \rvert}$	Average relative horizontal speed during overlap for aircraft pairs on routes with crossing angle θ (let θ=45°)	367.4 knots	Value used in Western Pacific/South China Sea safety assessment (corresponds to an average aircraft speed of 480 knots)
$\lvert\bar{\dot{y}}\rvert$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	4 knots	Value specified in ICAO Doc. 9574
$\lvert\bar{\dot{z}}\rvert$	Average absolute relative	1.5 knots	Value used in NAT RVSM safety

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
	vertical speed of an aircraft pair that has lost all vertical separation		assessment
λ_x	Average aircraft length	0.03162	Values used in the preliminary safety assessment report of DPR of Korea
λ_y	Average aircraft wingspan	0.02794	
λ_z	Average aircraft height	0.007	
λ_h	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.03162	

Table 2. Estimate of the empirical Parameters in the CRM

3.1.2. **Table 3** summarizes the values for estimating parameters in the CRM, which we estimated on the basis of TSD collected. They are demonstrated separately by air traffic control status.

Parameter Symbol	Parameter Value	Parameter Definition
T	10.2	Annual flight hours
E_z(same)	0	Same-direction vertical occupancies
E_z(opposite)	0	Opposite-direction vertical occupancies
Crossing pairs	0	Annual estimate of crossing pairs in crossing route
$\overline{\lvert\Delta V\rvert}$	0	Average relative along-track speed between aircraft on same direction routes
$\overline{\lvert V\rvert}$	0	Average absolute aircraft ground speed

Table 3. Estimate of the Parameters based on the collected TSD

4. Estimate of Vertical Collision Risk for DPR Korea's RVSM Airspace

4.1. **Table 4** presents the estimates of vertical collision risk for the airspace of Pyongyang in terms of the technical, operational, and total risks. Since there was no LHD event occurred and few flying hours, the operational risk, the technical risk and the total risk are all 0 in 2022. This estimate meets the regionally agreed TLS value of 5.0 x 10^{-9} fapfh.

RVSM Airspace of DPR Korea – estimated annual flying hours = 10.2 hours *(note: estimated hours based on the Dec 2022 traffic sample data. Estimate represents the sum of total flying hours for Pyongyang FIR)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	0	-	-
Total Risk	**0**	**5.0 x 10^{-9}**	**Below Overall TLS**

Table 4. Risk Estimates for the RVSM Implementation in the Airspace of DPR Korea

4.2. **Figure 1** presents the trends of collision risk estimates for each month using the estimated LHD data during the reporting period.

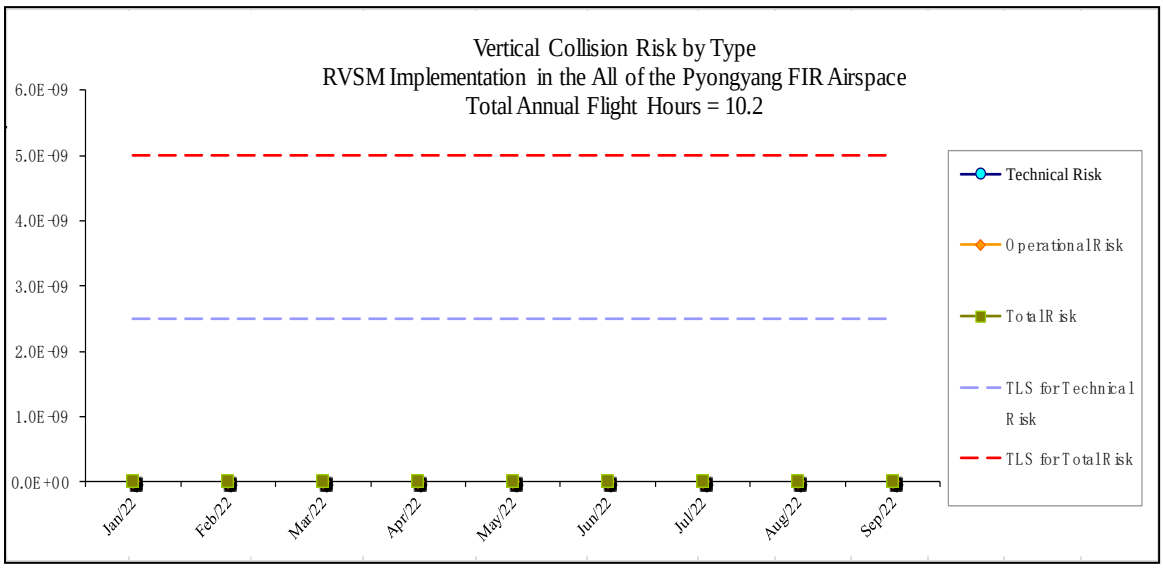

Figure 1. Trends of Risk Estimates for the Airspace of Pyongyang FIR

4.3. Based on these collision risk estimates, the estimates of both technical risk and total risk from the available TSD and LHD reports satisfy the agreed TLS value of no more than 2.5 x 10^{-9} and 5.0 x 10^{-9} fapfh.