International Civil Aviation Organization
Twenty-Fifth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/25)
Video Teleconference, 27 – 30 October 2020

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 the Chinese FIRs and Pyongyang FIR for the reporting period of January to December 2019. The report contains a summary of large height deviation reports received by the China Regional Monitoring Agency (China RMA) for the period and an update of the vertical collision risk.

1. INTRODUCTION

The China Regional Monitoring Agency (China RMA) delivers an annual report distributed to Civil Aviation Administration of China (CAAC) and other relevant stakeholders, for the RVSM (Reduced Vertical Separation Minimum) safety oversight in the Shenyang FIR, Beijing FIR, Shanghai FIR, Guangzhou FIR, Kunming FIR, Wuhan FIR, Lanzhou FIR, Urumqi FIR, Sanya Area Control Centers (ACC), and Pyongyang FIR.

2. DISCUSSION

2.1. Attachment A of the report provides the annual RVSM safety monitoring results of airspace monitored by China RMA in 2019, with analysis based on monthly Traffic Sample Data (TSD) in December 2019 and the Large Height Deviation (LHD) reports for the same year. The Attachment B presents the risk assessment for Pyongyang FIR based on monthly TSD collected in December 2019.

2.2. In 2014, China RMA launched the monthly risk assessment and contribution analysis of operational risk for each non-nil event to the total vertical risk. Figure 1 shows the monthly risk assessment demonstrating the individual event contributed to the Chinese RVSM airspace for the reporting period, and Figure 2 shows the operational risk estimate by categories, demonstrating the individual event contributed to the Chinese RVSM airspace for the reporting period. Detailed analysis of the events will be provided in the Attachment A.

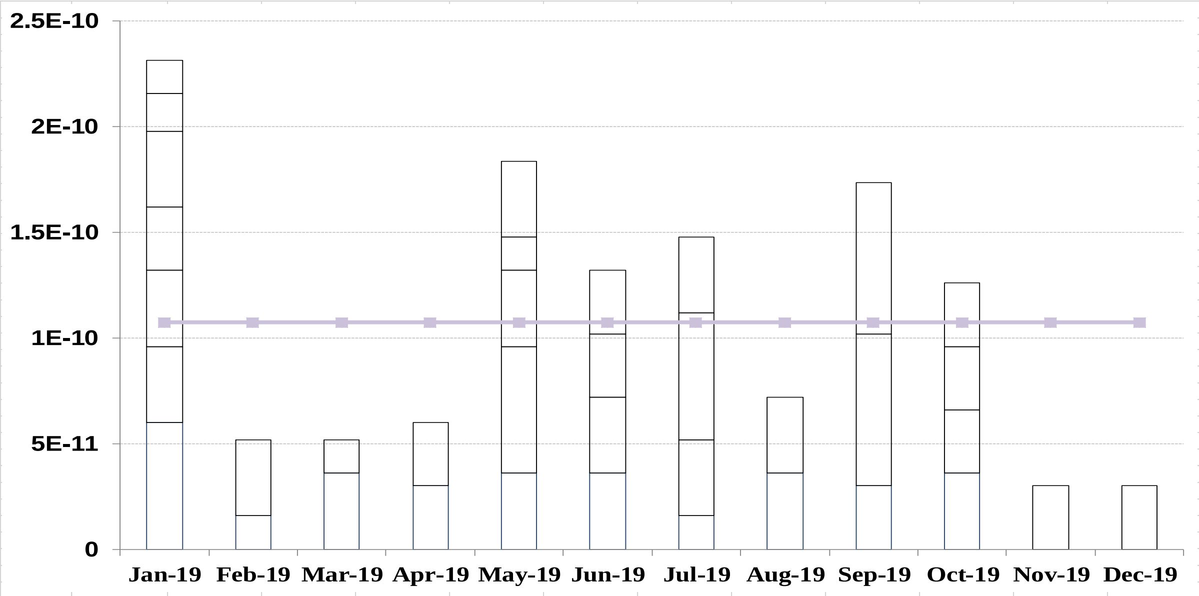

Figure 1: Monthly Risk Assessments Demonstrating the Individual Event Contribution

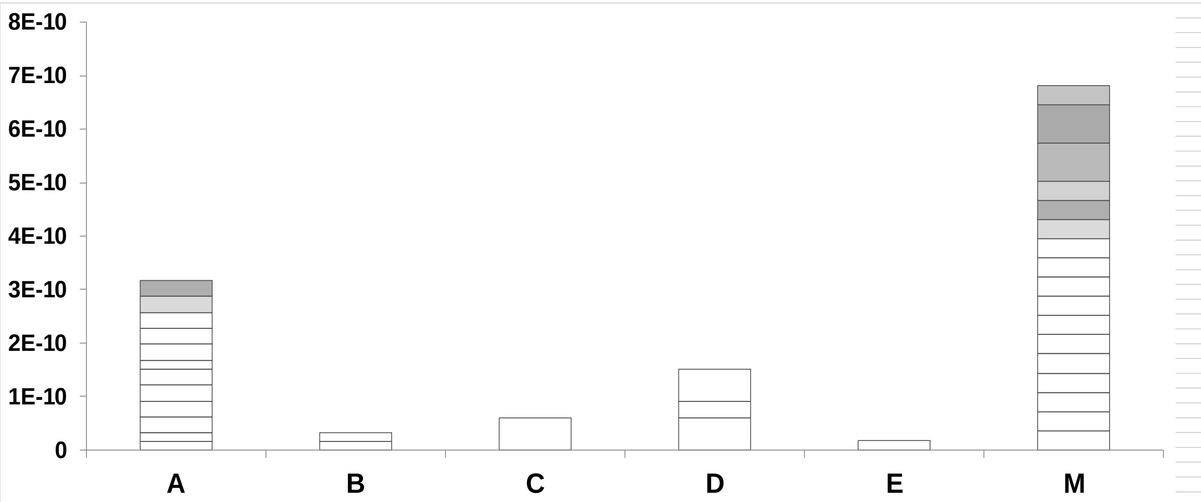

Figure 2: Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

Executive Summary- RVSM airspace of Chinese FIRs

2.3. **Table 1** summarizes Chinese FIRs RVSM technical, operational, and total risks. **Figure 3** presents collision risk estimate trends during the period from January 2019 to December 2019. The vertical collision risk estimate for Chinese RVSM airspace in December 2019 is below the target level of safety (TLS) value of 5.0 x 10-9 fatal accidents per flight hour (fapfh).

The RVSM Airspace of Chinese FIRs – estimated annual flying hours = 2445184.6hours *(note: estimated hours based on Dec 2019 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.148×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.219×10^{-9}	2.5×10^{-9}	Below Technical TLS
Total Risk	$\mathbf{1.367 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Below Overall TLS**

Table 1: Chinese FIRs Risk Estimates

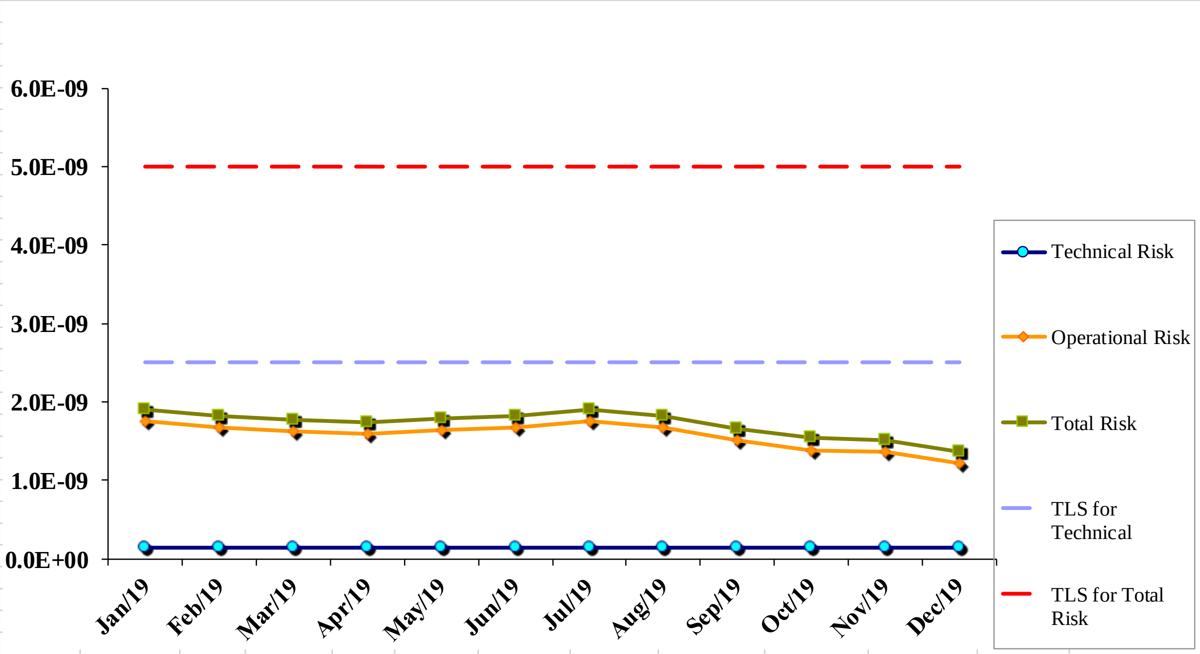

Figure 3: Airspace of Chinese FIRs RVSM Risk Estimate Trends

2.4. **Table 2** presents a summary of the LHD causes within the nine Chinese FIRs from January to December 2019.

LHD Code	LHD Category Description	No. of LHD Occurrences
A	Flight crew failing to climb/descend the aircraft as cleared;	16
B	Flight crew climbing/descending without ATC Clearance	2
C	Incorrect operation or interpretation of airborne equipment	1
D	ATC system loop error	5
E	ATC transfer of control coordination errors due to human factors	4
F	ATC transfer of control coordination errors due to technical issues	0
G	Aircraft contingency leading to sudden inability to maintain level	0
H	Airborne equipment failure and unintentional or undetected level change	3
I	Turbulence or other weather related cause	30
J	TCAS resolution advisory and flight crew correctly responds	0
K	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	0
M	Other	18
Total		79

Table 2: Summary of LHD Causes Within Chinese FIRs

2.5. **Figure 4** provides the geographic location of risk bearing LHD reports within the Chinese FIRs during the assessment period.

2.6. LHD Hot Spot Areas: 1) Guangzhou ACC: Several Category M events were reported from the end of 2016, and some of them had relatively long-time communication failure. As discussed in the RASMAG MAWG/6, there was no measurable vertical or horizontal risk associated with communication failure incidents if communication failure procedures have been executed correctly, and such events should not be counted as LHD. Eventually, China RMA suggested reviewing and removing the Hot Spot considering that the mitigation measures have been effectively taken. (Please refer to another working paper to this meeting for detailed information).

Figure 4: Airspace of the Chinese FIRs – Risk Bearing LHD

2.7. LHD Hot Spot areas: Urumqi FIR interface with Pakistan Lahore FIR: both Urumqi and Lahore FIR have confirmed that the communication and surveillance ability are enhanced and therefore the number of LHDs is reducing year by year. There was only one LHD reported due to a coordination error occurred in 2019, please refer to **Table 3**.

Year	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
No. of LHDs	21	10	8	6	1	1

Table 3: LHD Reporting Statistics for Urumqi interface with Pakistan from 2014 to 2019

2.8. The area of Hong Kong FIR interface with Guangzhou/Sanya FIRs was identified as a Hot Spot since 2015. Then China RMA proposed suggestions to the ATMB and taken remedial actions to reduce the occurrence of the LHDs, such as improving security culture and forming scrutiny groups. After much effort, the situation sees significant improvement, and no LHD event has occurred in the area since 2018.

2.9. It is suggested that all three Hot Spots mentioned in 2.6, 2.7 and 2.8 should be removed since there are few or none LHD occurrence in these areas and remedial actions have effectively taken.

Executive Summary- RVSM airspace of Pyongyang FIR

2.10. Table b summarizes Pyongyang FIR RVSM technical, operational, and total risks. Figure 5 presents collision risk estimate trends in the reporting period. The operational risk reaches 0.0 x 10-9 fapfh because no LHD event was reported, and the technical risk is 3.02 x 10-9 fapfh. The estimate of the overall vertical collision risk is 3.02 x 10-9 fapfh in December 2019. This estimate meets the TLS value of 5.0 x 10-9 fapfh.

RVSM Airspace of DPR Korea – estimated annual flying hours = 3358.0 hours *(note: estimated hours based on the Dec 2019 traffic sample data.)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	3.02×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	0.0	2.5×10^{-9}	Below Technical TLS
Total Risk	$\mathbf{3.02 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Below Overall TLS**

Table 4: Pyongyang FIR RVSM Risk Estimates

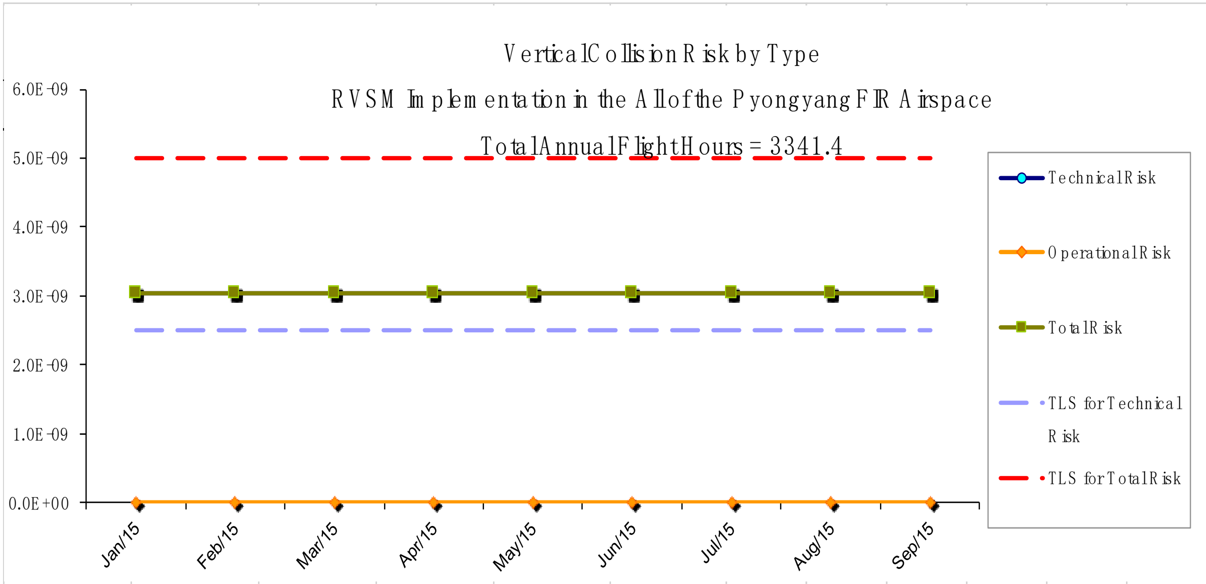

Figure 5: Airspace of Pyongyang FIR RVSM Risk Estimate Trends

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this paper;

b) consider the suggestion in Section 2.9; and

c) discuss any relevant matters as appropriate.

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AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF CHINESE FLIGHT INFORMATION REGIONS JANUARY 2019 – DECEMBER 2019

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

September 2020

SUMMARY

This report presents the airspace safety oversight from China Regional Monitoring Agency (China RMA) for the reporting time from January to December 2019. 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 2019 -December 2019. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Chinese FIRs RVSM airspace in December 2019 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 the Chinese Flight Information Regions (Chinese FIRs), including Shenyang FIR, Beijing FIR, Shanghai FIR, Guangzhou FIR, Kunming FIR, Wuhan FIR, Lanzhou FIR, Urumqi FIR, and Sanya Area Control Center (ACC).

1.2 The report covers the reporting period from January to December 2019 in the China RMA’s responsible FIRs. Each year, China RMA produces two reports requested by the Regional Airspace Safety Monitoring Advisory Group (RASMAG).

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

2. Data Submissions

2.1 China RMA requests traffic movement sample by month and monthly large height deviation reports from the Air Traffic Service (ATS) providers annually. The second and third column of Table 1 lists the Flight Information Regions (FIRs) and relevant Area Control Centers (ACCs) in Chinese airspace.

2.2 Traffic Sample Data (TSD)

2.2.1 Traffic sample data for December 2019 for the airspace of the Chinese FIRs were adopted in the assessment of risk for the RVSM airspace. **Table 1** contains a summary of the TSD received by China RMA for each FIR.

FIR Name	FIR Code	Data Collected in ACCs	Collecting Method	Status	Remarks
Beijing	ZBPE	Beijing	Automatic system	Received	Data completed
		Taiyuan	-	-	Included in Beijing ACC
		Hohhot	Automatic system	Received	Data completed
		Zhengzhou	-	-	Included in Beijing ACC
Shanghai	ZSHA	Shanghai	Automatic system	Received	Data completed
		Qingdao	Automatic system	Received	Data completed
		Jinan	-	-	Included in Qingdao ACC
		Xiamen	-	-	Included in Shanghai ACC
		Nanchang	-	-	Included in Shanghai ACC
		Hefei	-	-	Included in Shanghai ACC
Guangzhou	ZGZU	Guangzhou	Automatic system	Received	Data completed
		Guilin	-	-	Included in Guangzhou ACC
		Zhanjiang	-	-	Included in Sanya ACC
		Nanning	Automatic system	Received	Data completed
		Changsha	-	-	Included in Guangzhou ACC
Wuhan	ZHWH	Wuhan	-	-	Included in Guangzhou ACC
Shenyang	ZYSH	Shenyang	Automatic system	Received	Data completed
		Dalian	Automatic system	Received	Data completed
		Harbin	Automatic system	Received	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
Kunming	ZPKM	Kunming	Automatic system	Received	Data completed
		Chengdu	Automatic system	Received	Data completed
		Lhasa	Automatic system	Received	Data completed
		Guiyang	-	-	Included in Chengdu ACC
Sanya	ZJSA	Sanya	Automatic system	Received	Data completed

Table 1: Summary of TSD of December 2019 in the Airspace of Chinese FIRs

2.3 **Large Height Deviation (LHD)**

2.3.1 Series of cumulative 12-month of LHD reports were adopted in this safety assessment starting from January 2019 to December 2019. **Table 2** provides the summary of LHD reports submitted by each FIR

FIR Name	Beijing	Shanghai	Guangzhou	Wuhan	Shenyang	Lanzhou	Urumqi	Kunming	Sanya
Jan-18	X	X	X	X	X	X	X	X	X
Feb-18	X	X	X	X	X	X	X	X	X
Mar-18	X	X	X	X	X	X	X	X	X
Apr-18	X	X	X	X	X	X	X	X	X
May-18	X	X	X	X	X	X	X	X	X
Jun-18	X	X	X	X	X	X	X	X	X
Jul-18	X	X	X	X	X	X	X	X	X
Aug-18	X	X	X	X	X	X	X	X	X
Sep-18	X	X	X	X	X	X	X	X	X
Oct-18	X	X	X	X	X	X	X	X	X
Nov-18	X	X	X	X	X	X	X	X	X
Dec-18	X	X	X	X	X	X	X	X	X

Table 2: Summary of LHD Reports collected from Chinese FIRs

X = LHD 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 2019 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 the Chinese FIRs in the reporting period:

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)	No. of flight levels transitioned without clearance
Jan-19	7	1.75	4
Feb-19	7	2.5	6
Mar-19	7	1.5	5
Apr-19	4	0	6
May-19	12	1.5	11
Jun-19	6	1	4
Jul-19	8	1	7
Aug-19	7	1	1
Sep-19	6	2	1
Oct-19	8	0.5	3
Nov-19	3	0	2
Dec-19	4	0	3
Total	79	12.75	53

Table 3: Summary of non-nil LHDs in Chinese FIRs in 2019

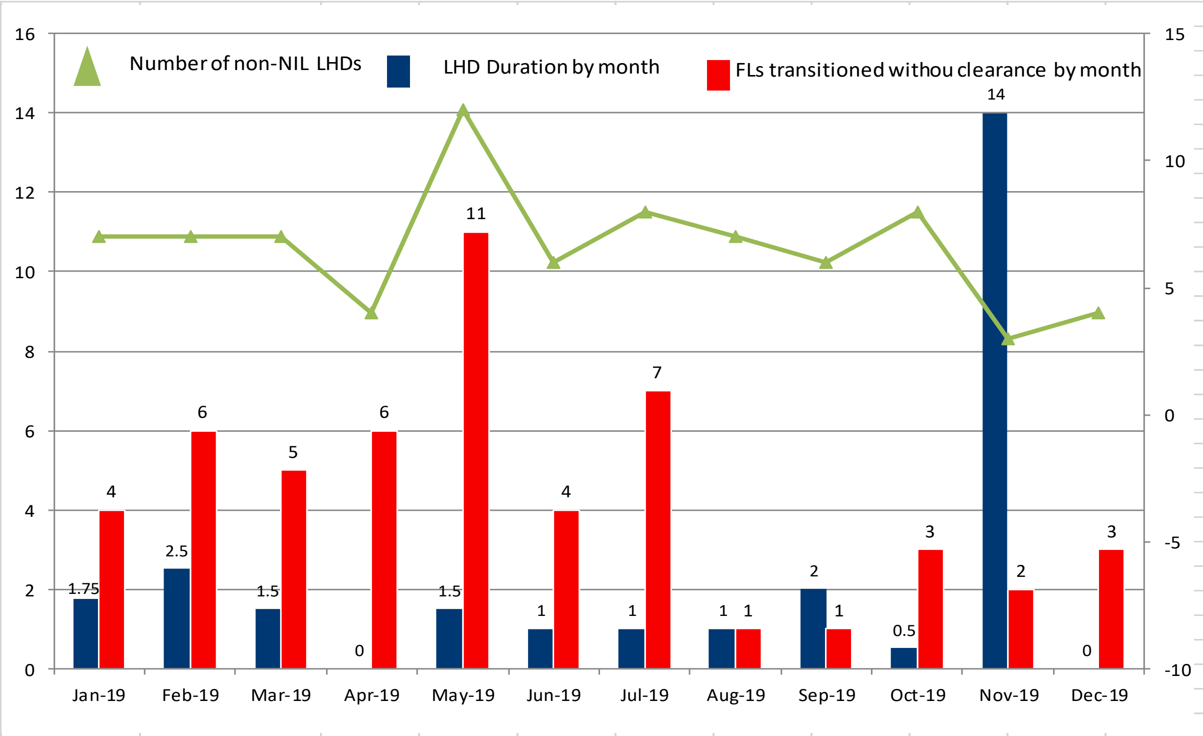


Figure 1: Illustrations of reported LHDs in Chinese FIRs in 2019

3.3 The LHD reports are categorized by the description of the event. Table 4, Figure 2 and Figure 3 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	16	0	13
B	Flight crew climbing/descending without Air Traffic Control (ATC) Clearance	2	0	2
C	Incorrect operation or interpretation of airborne equipment	1	0	2
D	ATC system loop error	5	0	9
E	ATC transfer of control coordination errors due to human factors	4	0.25	0
F	ATC transfer of control coordination errors due to technical issues	0	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	3	0	4
I	Turbulence or other weather related cause	30	3	23
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	18	9.5	0
Total		79	12.75	53

Table 4: Summary of LHD Categories in 2019

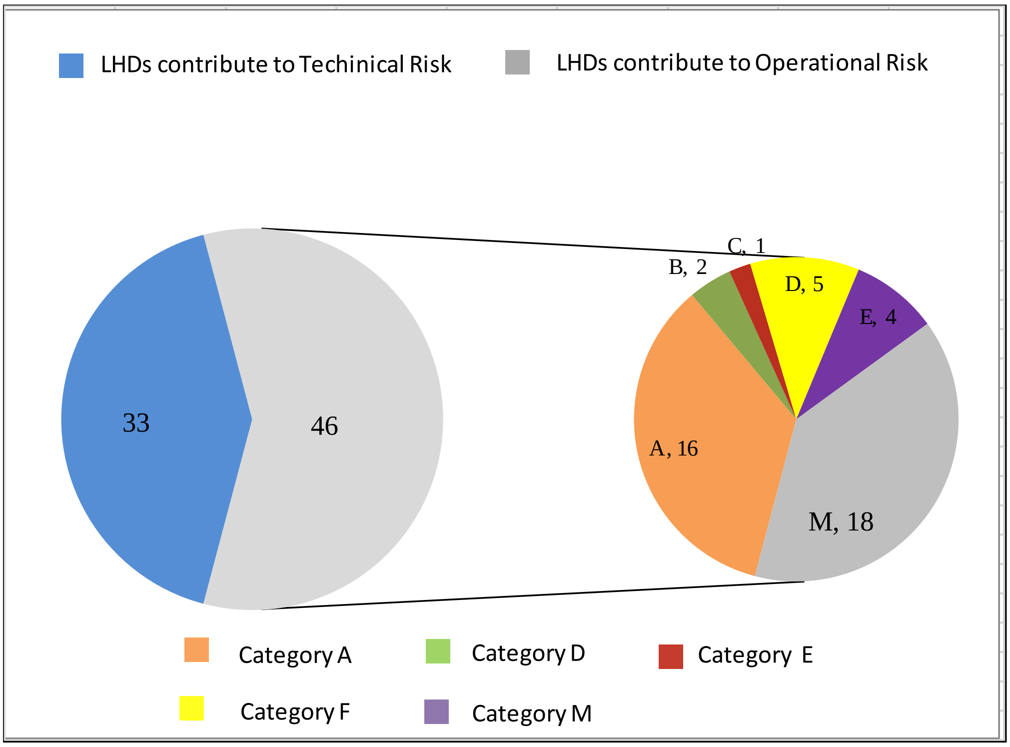


Figure 2: Breakdown of Operation Risk Contributors (Category and Number of Events)

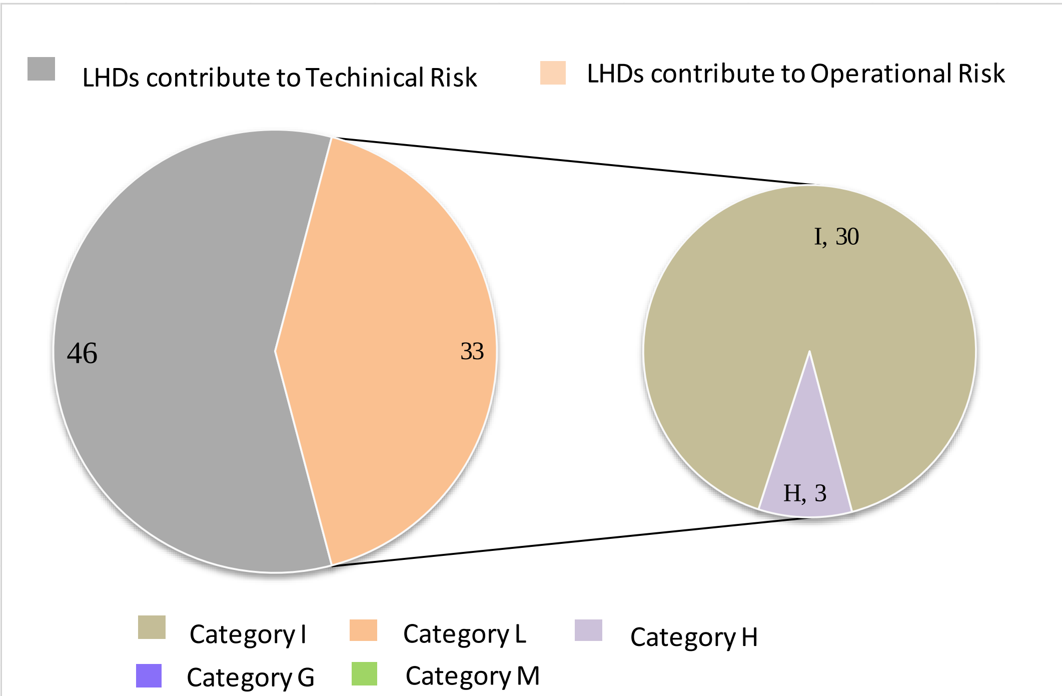


Figure 3: Breakdown of Technical Risk Contributors (Categories and Number of Events)

3.4 LHD Analysis and Safety Treatment of Identified LHDs

Appendix A and B details LHDs inside/outside China RMA's responsible area in the reporting period. **Figure 10** presents geographical locations of all the LHDs received by China RMA.

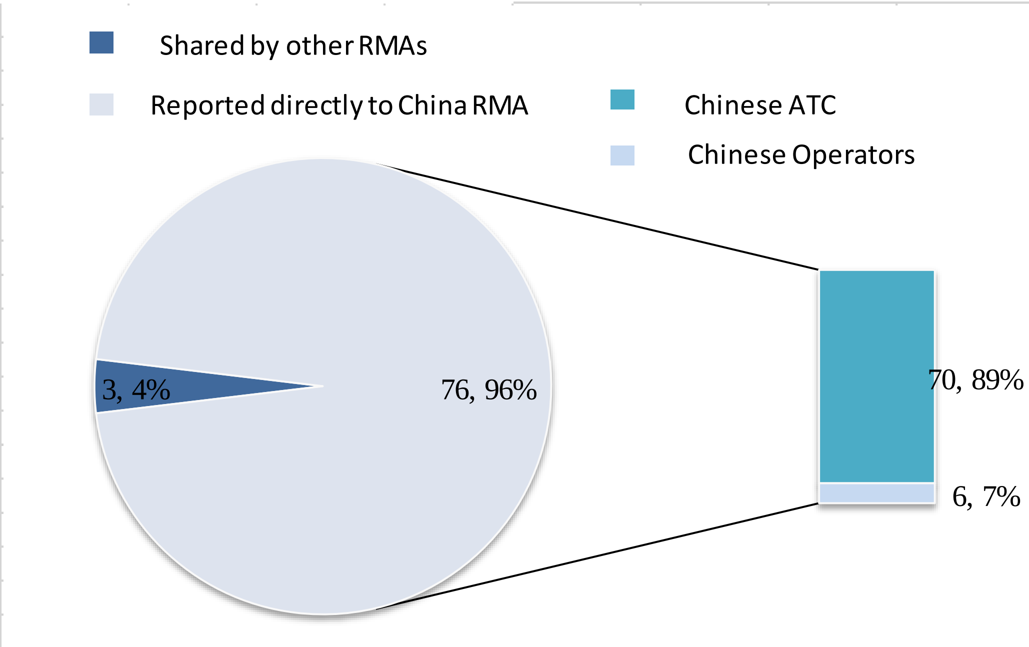


Figure 4: Breakdown of Events Received by China RMA

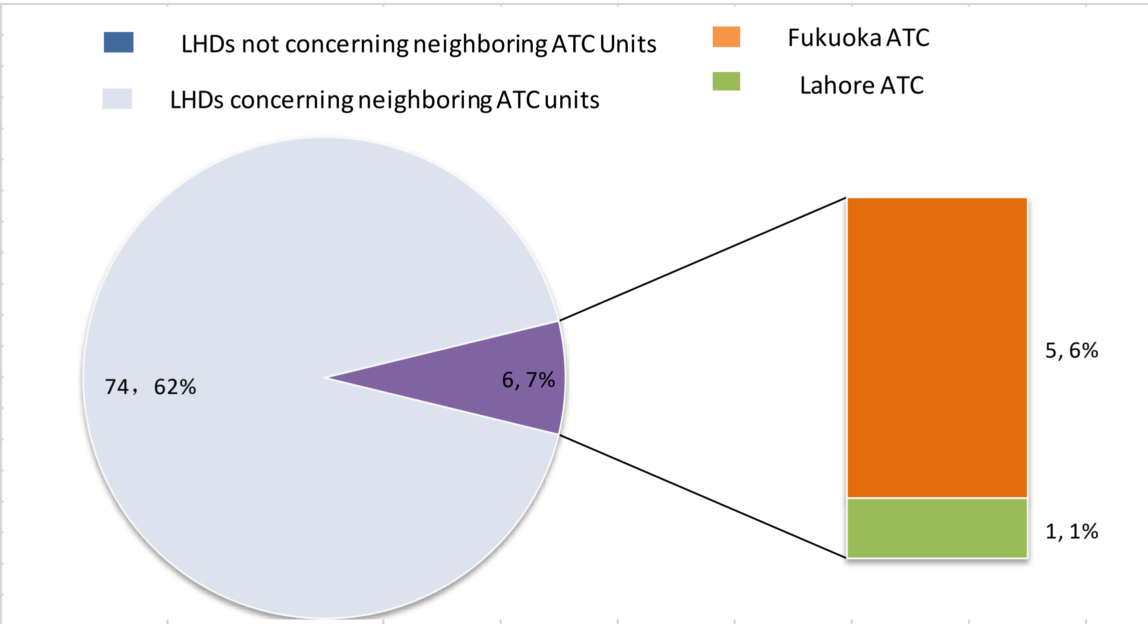


Figure 5: Breakdown of Events Concerning Neighboring ATS Units

- 79 LHD events were received during the reporting period. The number of LHDs this year decreased because few or none LHDs were reported in Hot Spot areas.
- As agreed on the RASMAG MAWG/6, no measurable vertical or horizontal risk associated with communication failure incidents if the loss of communication procedures were

executed correctly, and such events should not be counted as LHD, so such events were not be included in the LHD analysis of 2019.

- 73 events occurred inside China RMA's responsible area and 6 events occurred around the area.
- 6 events were reported by the Chinese operators and 73 were reported by the Chinese ATC. It should be noticed that if an event was not only reported by Chinese operator or ATC, but shared by neighboring RMA or ATS unit, it would be counted as reported by Chinese operator or ATC; **Figure 4** presents the breakdown of events received by the China RMA.
- 6 events concerning neighboring ATS units. **Figure 5** presents the breakdown of events concerning neighboring ATS units.
- Category M becomes a major contributor to the operational risk in this analysis.

3.5 **Figure 6** demonstrates the monthly risk assessment and the individual event contribution, while **Figure 7** presents the operational risk estimate by categories visualizing the individual event contribution. The obvious high risk was in January and caused by category M and category D LHDs.

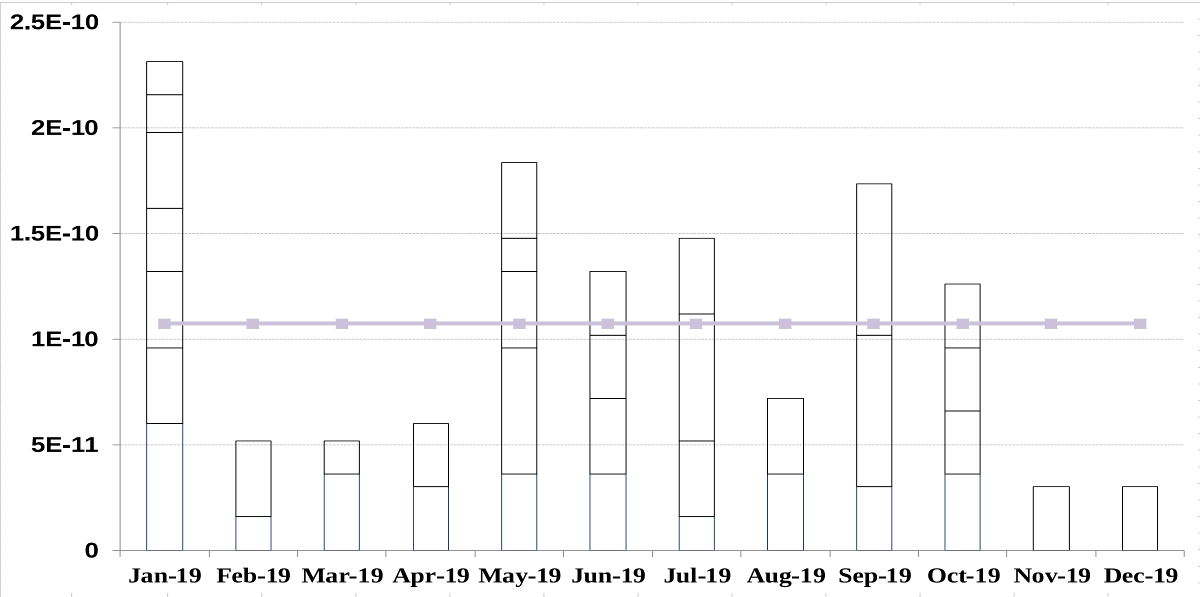


Figure 6: Monthly Assessed Risk Demonstrating the Individual Event Contribution

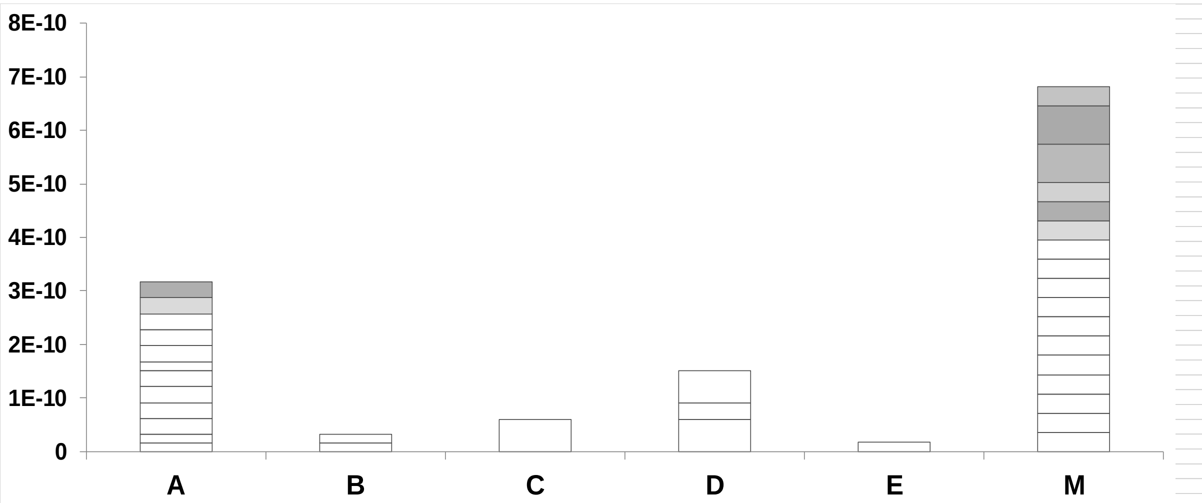


Figure 7: Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

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 Chinese 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 2019, the continuous LHD reports in the airspace of Chinese airspace between January 2019 and December 2019 were adopted to produce the risk estimates presented in this report.

4.4. **Collision Risk Model (CRM) parameters Estimate**

4.4.1. **Table 5** 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 Chinese 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 Overlap	6.88 x 10^{-7}	Value used in the Western Pacific/South China Sea safety assessment
$\left\|\overline{\dot{h}(\theta)}\right\|$	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)
$\left\|\overline{\dot{y}}\right\|$	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
$\left\|\overline{\dot{z}}\right\|$	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

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
λ_y	Average aircraft wingspan	0.02073Nm	TSD
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 5: Estimate of the empirical Parameters in the CRM

4.4.2. **Table 6** summarizes the value and source material for values estimof the empirical parameters of the Traffic Sample Data (TSD). The TSD is adopted for the risk assessment and the safety oversight for the RVSM implementation in the Chinese airspace.

Parameter Symbol	Parameter	Parameter Definition
T	2620549.0	Annual flight hours
E_z(same)	0.0845	Same-direction vertical occupancies
E_z(opposite)	0.1037	Opposite-direction vertical occupancies
Crossing pairs	3501624	Annual estimate of crossing pairs in crossing route
$\overline{\|\Delta V\|}$	38.7889	Average relative along-track speed between aircraft on same direction routes
$\overline{\|V\|}$	446.6520	Average absolute aircraft ground speed

Table 6: 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 8** presents the Technical Risk computed by the TSD collected in December 2019.

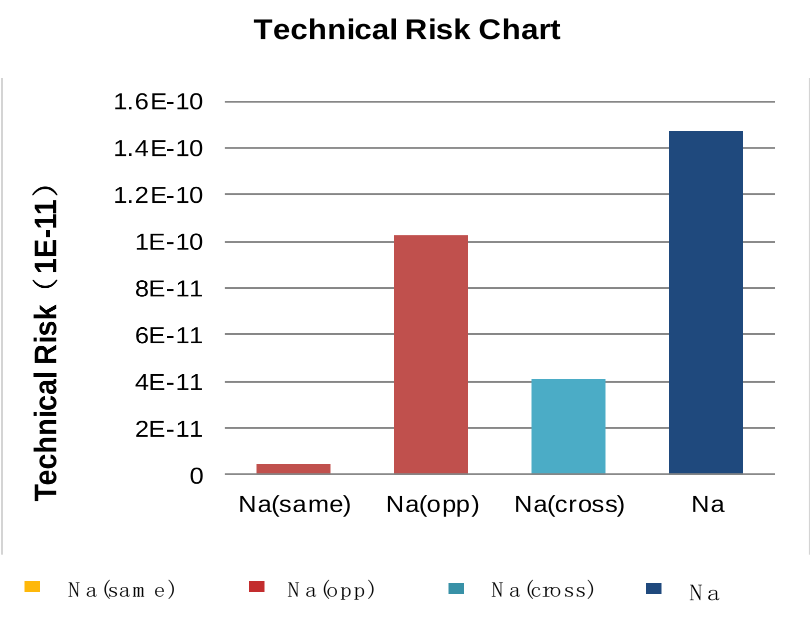


Figure 8: Technical Risk Bar Chart Computed by the TSD Collected in December 2019

4.5.2. **Table 7** 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 0.121 x 10-9 fapfh. The operational risk estimate is 1.063 x 10-9 fapfh. The estimate of the overall vertical collision risk is 1.184x 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 = 2620549 hours *(note: estimated hours based on Dec 2019 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.148×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.219×10^{-9}	2.5×10^{-9}	Below Operational TLS
Total Risk	$\mathbf{1.367 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Below Overall TLS**

Table 7: Risk Estimates for the RVSM Implementation in the airspace of Chinese FIRs

4.5.3. **Figure 9** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports.

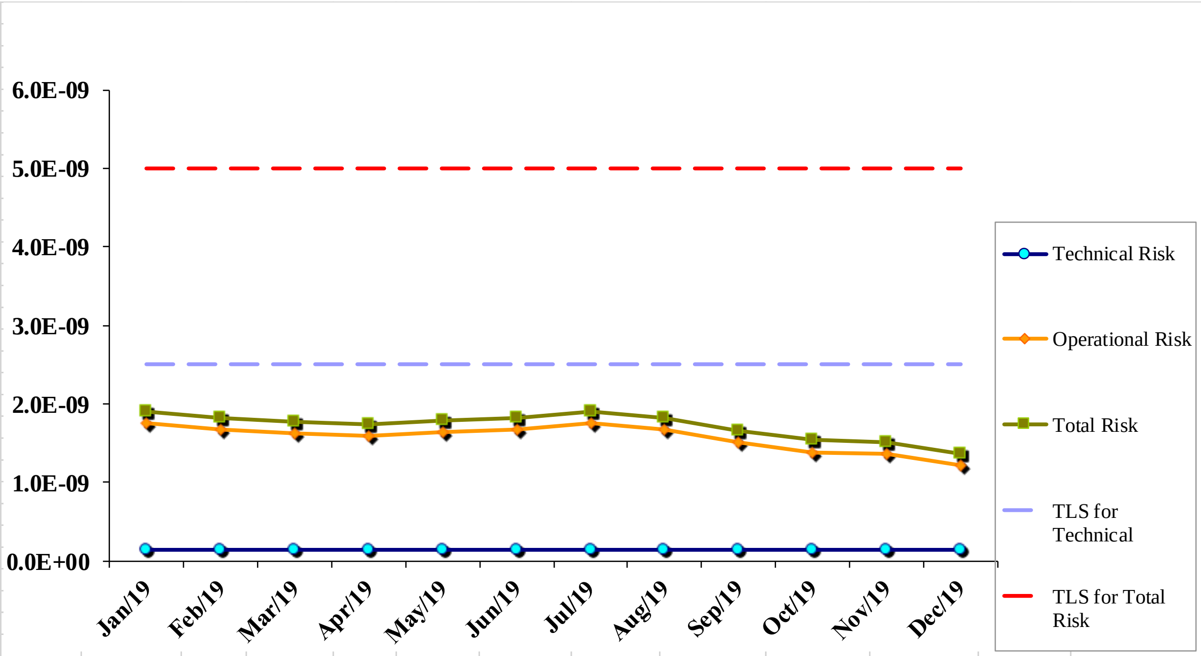


Figure 9: Trends of Risk Estimates for the Airspace of Chinese FIRs

4.5.4. Based on these collision risk estimates, the technical risk estimates from the available TSD and LHD reports satisfy the agreed TLS value of no more than 2.5 x 10-9, and the total risk is also below the TSL value which is 5.0 x 10-9 fapfh.

Appendix A Detail of LHDs inside Chinese FIRs from January 2019 to December 2019

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
1	7-Jan-19	Beijing ACC	DUBAG	0	2	Pilot misunderstands clearance message	D
2	15-Jan-19	Guangzhou ACC	MUBEL	0.5		Lose RVSM capability due to TCAS failure	M
3	16-Jan-19	Guangzhou ACC	Unknown	0.5		Lose RVSM capability due to TCAS failure	M
4	22-Jan-19	Beijing ACC	Unknown	0	1	Pilot misunderstands clearance message	D
5	22-Jan-19	Guangzhou ACC	ML	0.5		Lose RVSM capability due to TCAS failure	M
6	27-Jan-19	Urumqi ACC	PURPA	0.25		No time revision	E
7	29-Jan-19	Beijing ACC	Unknown	0	1	Pilot not descend/climb the aircraft as cleared	A
8	10-Feb-19	Beijing ACC	Unknown	0	1	Turbulence	I
9	12-Feb-19	Beijing ACC	DOTOS	0	1	Pilot not descend/climb the aircraft as cleared	A
10	17-Feb-19	Chengdu ACC	Unknown	0.5	1	Turbulence	I
11	20-Feb-19	Shanghai ACC	Unknown	1	1	Turbulence	I
12	21-Feb-19	Urumqi ACC	PORUP	0	1	Turbulence	I
13	23-Feb-19	Guangzhou ACC	Unknown	0.5		Lose RVSM capability due to TCAS failure	M
14	27-Feb-19	Shanghai ACC	Unknown	0.5	1	Turbulence	I
15	6-Mar-19	Guangzhou ACC	MAMSI	0	1	Turbulence	I
16	11-Mar-19	Guangzhou ACC	Unknown	0	1	Turbulence	I
17	13-Mar-19	Chengdu ACC	Unknown	0	1	Turbulence	I
18	18-Mar-19	Guangzhou ACC	Unknown	0.5		Lose RVSM capability due to TCAS failure	M
19	22-Mar-19	Shanghai ACC	Unknown	0	1	Pilot descend/climb the aircraft without ATC clearance	B
20	30-Mar-19	Chengdu ACC	Unknown	1	0	Turbulence	I
21	31-Mar-19	Chengdu ACC	Unknown	0	1	Turbulence	I
22	7-Apr-19	Beijing ACC	TODAM	0	1	Pilot not descend/climb the aircraft as cleared	A
23	13-Apr-19	Guangzhou ACC	ONEMI	0	1	Turbulence	I
24	20-Apr-19	Xi'an ACC	ATBUG	0	3	Pilot misunderstands clearance message	D
25	24-Apr-19	Beijing ACC	Unknown	0	1	Pilot not descend/climb the aircraft as cleared	A
26	3-May-19	Guangzhou ACC	ESDOS	0	1	Airborne equipment failure	H

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
27	3-May-19	Guangzhou ACC	DOTMI	0.5		Lose RVSM capability due to TCAS failure	M
28	4-May-19	Shanghai ACC	Unknown	0	2	Pilot misunderstands clearance message	D
29	6-May-19	Guangzhou ACC	TAMOT	0	1	Turbulence	I
30	11-May-19	Urumqi ACC	IDOPU		1	Turbulence	I
31	12-May-19	Beijing ACC	Unknown	0	1	Turbulence	I
32	16-May-19	Guangzhou ACC	PAVTU	0.5		Lose RVSM capability	M
33	17-May-19	Beijing ACC	Unknown	0	1	Airborne equipment failure	H
34	19-May-19	Shanghai ACC	Unknown	0	2	Airborne equipment failure	H
35	19-May-19	Shanghai ACC	Unknown	0	1	Turbulence	I
36	20-May-19	Guangzhou ACC	Unknown	0	1	Pilot descend/climb the aircraft without ATC clearance	B
37	21-May-19	Guangzhou ACC	MABAG	0.5		Lose RVSM capability	M
38	7-Jun-19	Guangzhou ACC	ESKAM	0.5		Lose RVSM capability due to TCAS failure	M
39	11-Jun-19	Guangzhou ACC	Unknown	0	1	Turbulence	I
40	14-Jun-19	Guangzhou ACC	OVTAN	0.5		Lose RVSM capability due to TCAS failure	M
41	19-Jun-19	Urumqi ACC	SADAN	0	1	Pilot not descend/climb the aircraft as cleared	A
42	21-Jun-19	Beijing ACC	UKBAD	0	1	Pilot not descend/climb the aircraft as cleared	A
43	22-Jun-19	Guangzhou ACC	OVTAN	0	1	Turbulence	I
44	1-Jul-19	Shanghai ACC	Unknown	0	1	Turbulence	I
45	8-Jul-19	Beijing ACC	Unknown	0	1	Pilot not descend/climb the aircraft as cleared	A
46	10-Jul-19	Guangzhou ACC	BEKOL	0	1	Turbulence	I
47	15-Jul-19	Guangzhou ACC	Unknown	0.5		Lose RVSM capability due to TCAS failure	M
48	18-Jul-19	Guangzhou ACC	Unknown	0	1	Turbulence	I
49	21-Jul-19	Nanning ACC	Unknown	0	2	Pilot incorrect operation	C
50	23-Jul-19	Guangzhou ACC	Unknown	0.5		Lose RVSM capability due to TCAS failure	M
51	26-Jul-19	Beijing ACC	Unknown	0	1	Turbulence	I
52	3-Aug-19	Guangzhou ACC	OBLIK	0.5		Lose RVSM capability due to TCAS failure	M
53	4-Aug-19	Beijing ACC	MAPMU			Bad weather	I
54	7-Aug-19	Guangzhou ACC	Unknown			Turbulence	I
55	8-Aug-19	Guangzhou ACC	BEBEM		1	Turbulence	I

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
56	10-Aug-19	Guangzhou ACC	GOSMA			Turbulence	I
57	14-Aug-19	Guangzhou ACC	OBLIK	0.5		Lose RVSM capability	M
58	21-Aug-19	Beijing ACC	Unknown			Pilot not descend/climb the aircraft as cleared	A
59	1-Sep-19	Guangzhou ACC	Unknown			Turbulence	I
60	2-Sep-19	Shanghai ACC	REMIM		1	Pilot not descend/climb the aircraft as cleared	A
61	3-Sep-19	Guangzhou ACC	XEBUL	1		Lose RVSM capability due to TCAS failure	M
62	4-Sep-19	Guangzhou ACC	DOTMI			Pilot not descend/climb the aircraft as cleared	A
63	6-Sep-19	Guangzhou ACC	NOMAR			Turbulence	I
64	12-Sep-19	Guangzhou ACC	DOTMI	1		Lose RVSM capability due to TCAS failure	M
65	1-Oct-19	Guangzhou ACC	LAGEX	0.5		Lose RVSM capability due to TCAS failure	M
66	7-Oct-19	Beijing ACC	BEGRI		1	Pilot not descend/climb the aircraft as cleared	A
67	18-Oct-19	Guangzhou ACC	BEBEM		1	Pilot not descend/climb the aircraft as cleared	A
68	27-Oct-19	Guangzhou ACC	BEKOL			Lose RVSM capability	M
69	12-Nov-19	Urumqi ACC	IPMUN		0		I
70	3-Dec-19	Nanning ACC	TEBAK		1	Pilot not descend/climb the aircraft as cleared	A
71	14-Dec-19	Kunming ACC	BIDRU		1	Bad weather	I
72	20-Dec-19	Xi'an ACC	Unknown		1	Bad weather	I
73	30-Dec-19	Beijing ACC	ATPIR		0	Pilot not descend/climb the aircraft as cleared	A

Appendix B Detail of LHDs outside China RMA's responsible area from January 2019 to December 2019

No	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
1	4-Oct-19	Fukuoka ACC	SADLI			Late level revision	E
2	4-Oct-19	Fukuoka ACC	SADLI			No FL revision	E
3	6-Oct-19	Fukuoka ACC	SADLI			No FL revision	E
4	17-Oct-19	Fukuoka ACC	Unknown		1	Pilot not descend/climb the aircraft as cleared	A
5	11-Nov-19	Brisbane	Unknown		1	Pilot not descend/climb the aircraft as cleared	A
6	16-Nov-19	Fukuoka ACC	NIRAT		1	ATC system loop error	D

Appendix C Geographic Location of Risk Bearing LHD within airspace of Chinese FIRs from January to December 2019

Figure 10 provides the geographic location of risk bearing LHD reports within Chinese FIRs during the reporting period.

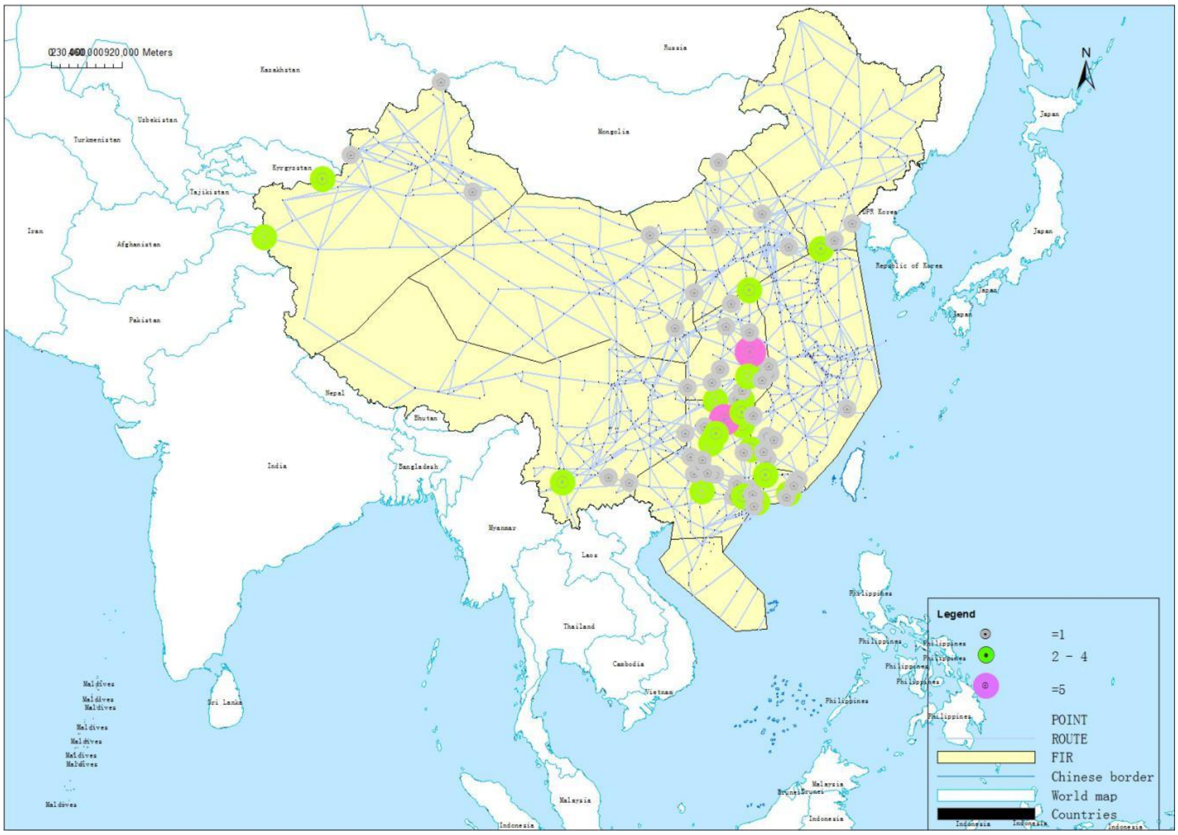


Figure 10: Chinese FIRs- Risk Bearing (Non-NIL) RVSM LHDs in 2019

ATTACHMENT B

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF PYONGYANG FLIGHT INFORMATION REGION JANUARY 2019 -DECEMBER 2019

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

September 2020

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 2019 -December 2019. 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 the airspace of Pyongyang FIR.

1.2 The report covers the reporting period from January to December 2019 in Pyongyang FIR. Each year, China RMA produces two reports 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 January 2019 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 2019 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 2019 to December 2019.

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.	2.46×10^{-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	6.88×10^{-7}	Value used in the Western Pacific/South China Sea safety assessment
$\left\|\overline{\dot{h}(\theta)}\right\|$	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)
$\left\|\overline{\dot{y}}\right\|$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	4 knots	Value specified in ICAO Doc. 9574
$\left\|\overline{\dot{z}}\right\|$	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	0.03162	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	3358.0	Annual flight hours
E_z(same)	0.0	Same-direction vertical occupancies
E_z(opposite)	0.122	Opposite-direction vertical occupancies
Crossing pairs	144.0	Annual estimate of crossing pairs in crossing route
$\overline{\lvert \Delta V \rvert}$	NaN	Average relative along-track speed between aircraft on same direction routes
$\overline{\lvert V \rvert}$	512.357	Average absolute aircraft ground speed

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

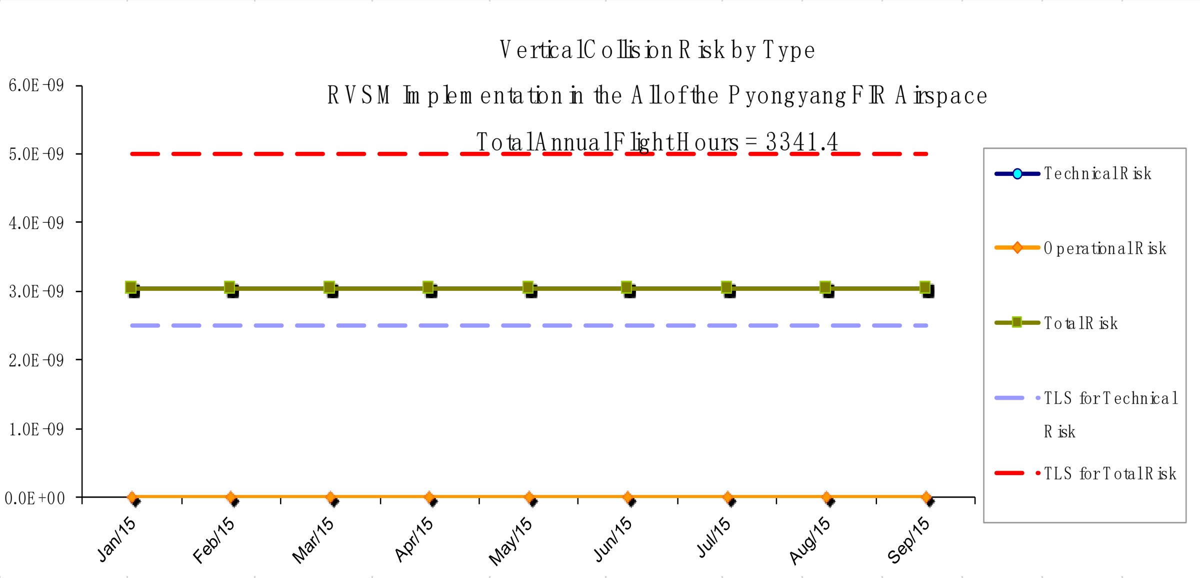
4. Estimate of Vertical Collision Risk for DPR Korea's RVSM Airspace

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, the operational risk remains 0.0 x 10^{-9} fapfh, and the technical risk is 1.621 x 10^{-9} fapfh. The estimate of the overall vertical collision risk is 1.621 x 10^{-9} fapfh in December 2019. This estimate meets the regionally agreed TLS value of 5.0 x 10^{-9} fapfh.

RVSM Airspace of DPR Korea – estimated annual flying hours = 3358.0 hours *(note: estimated hours based on the Dec 2019 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	3.02 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	0.0 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Total Risk	**3.02 x 10^{-9}**	**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.