International Civil Aviation Organization

The Twenty-First Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/21)

Bangkok, Thailand, 14-17 June 2016

Agenda Item 5: Airspace Safety Monitoring Activities/Requirements in the Asia/Pacific Region

CHINA 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 Chinese Flight Information Regions and the airspace of Pyongyang Flight Information Region for the time period of January 2015 to December 2015. This report contains a summary of large height deviation reports received by the China RMA for that time period and an update of the vertical collision risk.

1. INTRODUCTION

1.1 China Regional Monitoring Agency (China RMA) produces a periodic report which is distributed annually to Civil Aviation Administration of China (CAAC) and ICAO.

2. DISCUSSION

2.1. This paper provides the results of the airspace safety oversight for the RVSM operation in the airspace of Chinese FIRs for the time period of January 2015 to December 2015, as given in Attachment A. The analysis conducted for the airspace of China FIRs is based on one-month traffic sample data (TSD) collected in December 2015 and the latest 12-month Large Height Deviation (LHD) reports until December 2015. The estimates of total risk shows the TLS was being met in the airspace. Attachment B presents the risk assessment for Pyongyang FIR of DPR Korea based on one-month traffic sample data (TSD) collected in December 2015.

2.2. Compared with the same period of 2014, the number of LHDs received by China RMA from January 2015 to December 2015 was increasing due to three primary factors illustrated as below. Firstly, from the beginning of 2015, the ATS units began to use the new version of LHD reporting template, which brought much convenience for controller to record; Secondly, China RMA, MAAR and the related SCS(South China Sea) ATS units had a scrutiny group meeting in July 2015,which resulted in establishing good mechanism of data sharing regarding Hong Kong and SCS FIRs; Thirdly, China RMA made coordination with JASMA/PARMO/MAAR for LHDs concerning Incheon FIR AKARA Corridor interface with Shanghai/Fukuoka/Taipei FIRs in 2015,which improve the reporting culture.

2.3. From late 2014, China RMA started to conduct monthly risk assessment and also analyzed the contribution of operational risk for each non-nil event to the total risk. **Figure 1** shows the monthly assessed risk demonstrating the individual event contribution for the Chinese RVSM airspace for the time period of January 2015 to December 2015, and **Figure 2** shows the operational risk estimate by categories demonstrating the individual event contribution for the Chinese RVSM airspace for the reporting period. From **Figure 1**, it is noticed that in February, there were two LHDs with relatively long time and contribute more to the operational risk. From **Figure 2**, it shows that category E and M are the main contributors to the risks. In the attachment A to this paper, China RMA will provide detail analysis for each event.

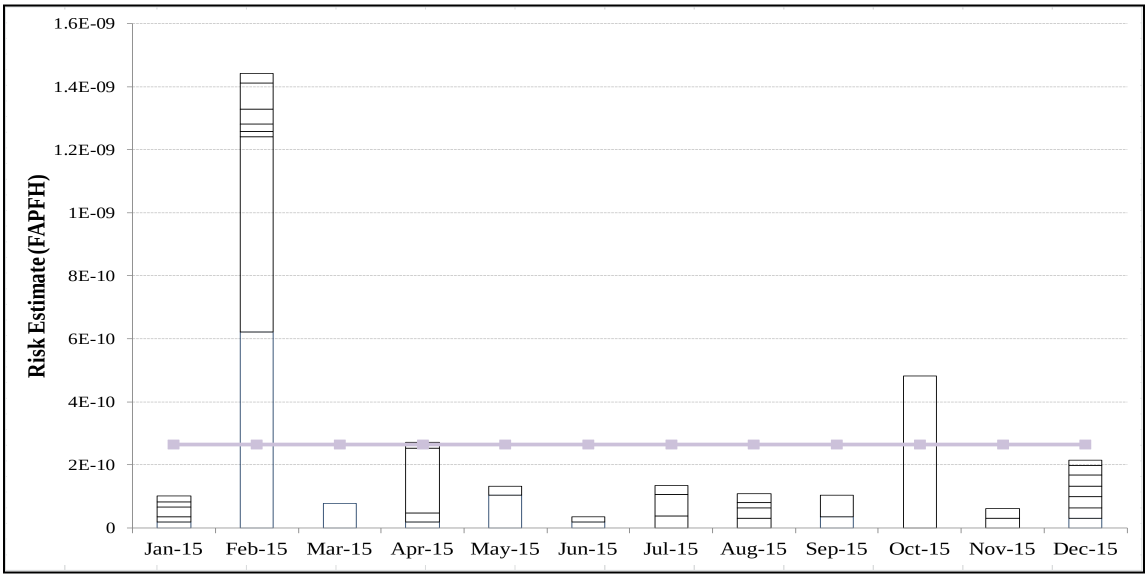

Figure 1: Monthly Assessed Risk Demonstrating the Individual Event Contribution

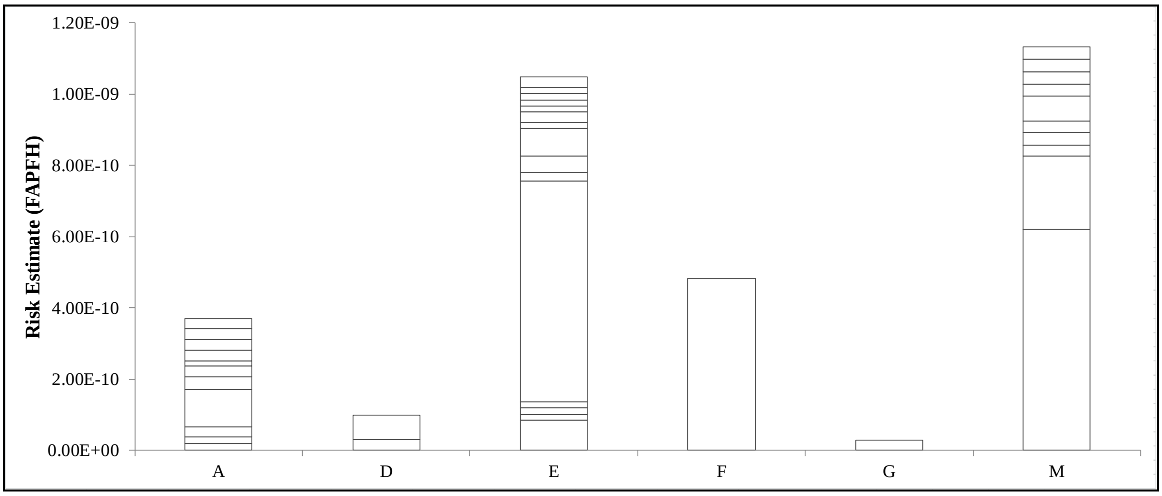

Figure 2: Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

2.4. For the safety assessment of Pyongyang FIR, China RMA had a technical exchange with DPR Korea in August 2015, and presented the regional safety monitoring assessment of RASMAG/20 and highlighted the continuous non-LHD reporting in Pyongyang FIR over years. China RMA suggested the potential reasons leading to the non-reporting and shared some of her experience in refining LHD data collection mechanism and some progress made from SCS Scrutiny Group. The importance of reporting coordination error as an LHD was also addressed. DPR Korea expressed that they would review and refine their LHD reporting procedure after this meeting. China RMA received two LHD reports from Pyongyang FIR in 2015.

Executive Summary- RVSM airspace of Chinese FIRs

2.5. **Table 1** summarizes Chinese FIRs RVSM technical, operational, and total risks. **Figure 3** presents collision risk estimate trends during the period from January 2015 to December 2015. The vertical collision risk estimate for Chinese RVSM airspace in December 2015 is below the target level of safety (TLS) value of 5.0 x 10^{-9} fapfh.

The RVSM Airspace of Chinese FIRs – estimated annual flying hours = 2285269.28 hours *(note: estimated hours based on Dec 2015 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG MAWG/3 Total Risk	7.95 x 10^{-9}	*5.0 x 10^{-9}*	*Above TLS*
Technical Risk	0.113x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	3.161 x 10^{-9}	-	-
Total Risk	**3.274 x 10^{-9}**	5.0 x 10^{-9}	**Below Overall TLS**

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

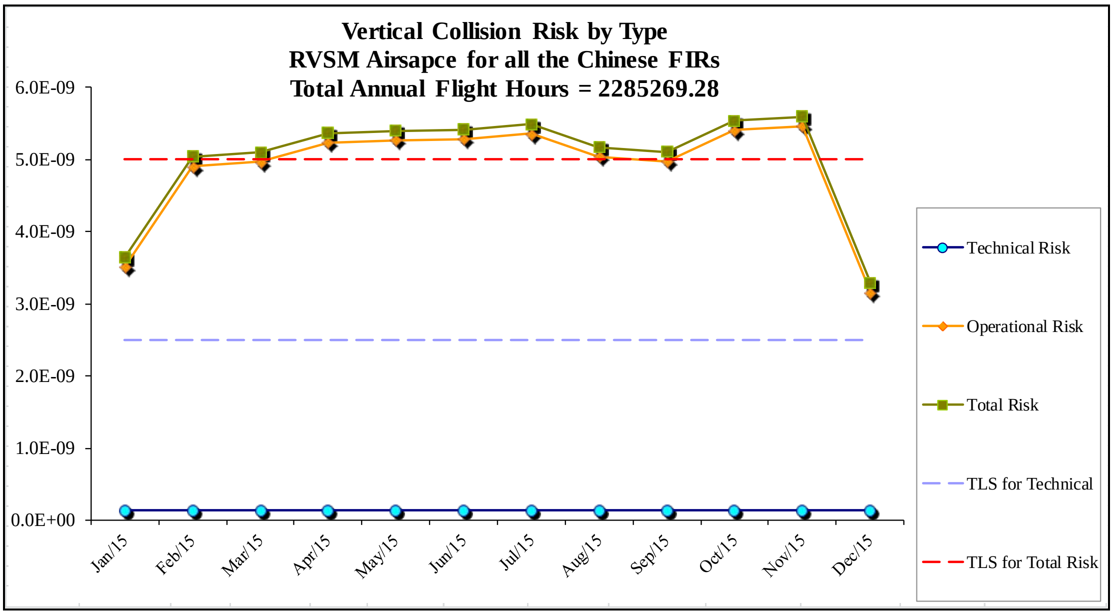

Figure 3: Airspace of Chinese FIRs RVSM Risk Estimate Trends

2.6. **Table 2** presents a summary of the LHD causes within Airspace of Chinese FIRs from January 2015 to December 2015.

LHD Code	**LHD Category Description**	**No. of LHD Occurrences**
A	Flight crew failing to climb/descend the aircraft as cleared;	15
D	ATC system loop error	2
E	ATC transfer of control coordination errors due to human factors	72
F	ATC transfer of control coordination errors due to technical issues	2
G	Aircraft contingency leading to sudden inability to maintain level	3
H	Airborne equipment failure and unintentional or undetected level change	2
I	Turbulence or other weather related causes;	13
L	An aircraft being provided with RVSM separation is not RVSM approved	1
M	Other	10

LHD Code	LHD Category Description	No. of LHD Occurrences
Total		120

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

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

Figure 4: Airspace of Chinese FIRs – Risk Bearing LHD

2.7. LHD Hot Spot Areas: 1) Hong Kong FIR interface with Guangzhou/Sanya FIRs: The South China Sea scrutiny group meeting was held to address the LHDs in this area. The LHD data sharing and reporting mechanism has been improved 2) Urumqi FIR interface with Pakistan Lahore FIR: China is working with Pakistan in improving the surveillance and communication situation in this area.

2.8. It should be noticed that the area between Ulaanbaatar FIR and Beijing FIR is no longer hot spot, China RMA received updates from Beijing ACC some remedial actions were taken to the reduce the Category E LHD events near the border.

2.9. At RASMAG MAWG/3 meeting, China RMA submitted a working paper (WP/13) introducing the LHD coordination progress in these areas.

Executive Summary- RVSM airspace of Pyongyang FIR

Table 3 summarizes Pyongyang FIR RVSM technical, operational, and total risks. **Figure 5** presents collision risk estimate trends during the period from January 2015 to December 2015. The December 2015 operational risk value is 833.601 x 10^{-9} fapfh. The estimate of the overall vertical collision risk is 834.098 x 10^{-9} fapfh. This estimate doesn't meet the regionally agreed TLS value of 5.0 x 10^{-9} fapfh.

RVSM Airspace of DPR Korea – estimated annual flying hours = 3387.8 hours *(note: estimated hours based on the December 2015 traffic sample data. Estimate represents the sum of total flying hours for Pyongyang FIR)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
RASMAG MAWG/3 Total Risk	8.98 x 10^{-9}	2.5 x 10^{-9}	*Above TLS*
Technical Risk	0.497 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	833.601 x 10^{-9}	-	-
Total Risk	**834.098 x 10^{-9}**	**5.0 x 10^{-9}**	**Above Overall TLS**

Table 3: Airspace of Pyongyang FIR RVSM Risk Estimates

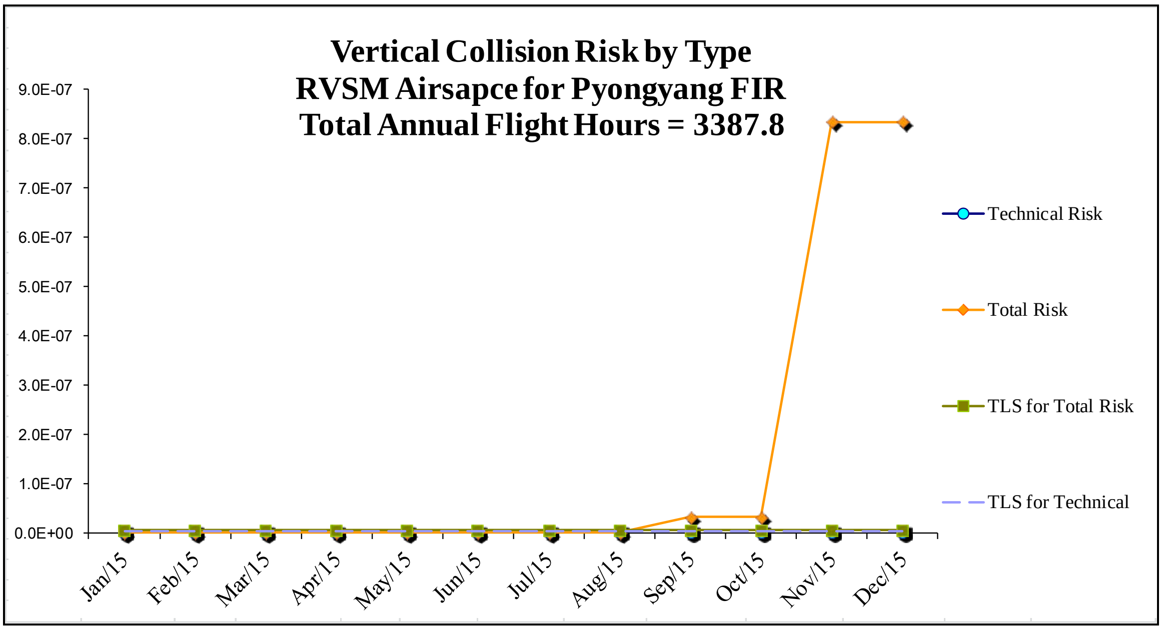

Figure 5: Airspace of Pyongyang FIR RVSM Risk Estimate Trends

Figure 6 provides the geographic location of risk bearing LHD reports within airspace of Pyongyang FIR during the assessment period.

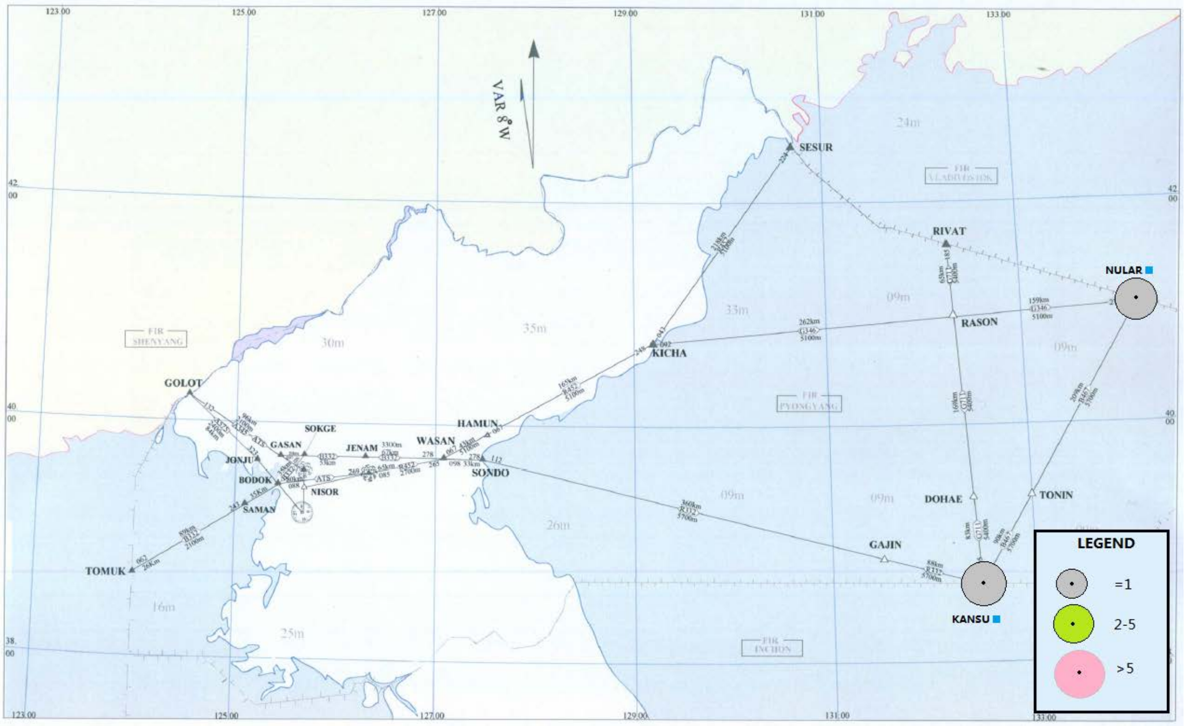

Figure 6: Airspace of Pyongyang FIR – Risk Bearing LHD

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the results of the airspace safety oversight presented in this paper;

b) remove Beijing/ Ulaanbaatar from the LHD hot spot areas;

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 2015 - DECEMBER 2015

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

May 2015

SUMMARY

This report presents the airspace safety oversight from China Regional Monitoring Agency for the time period January 2015 - December 2015. 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 Chinese FIRs. This report contains a summary of large height deviation reports received by China RMA for the most recent reporting period of January 2015 - December 2015. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Chinese RVSM airspace in December 2015 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 Chinese FIRs.

1.2 This report covers the current reporting period January 2015 - December 2015 in the China RMA's ongoing process of providing periodic updates of information relevant to the continued safe use of the RVSM in the airspace of Chinese FIRs. China RMA produces two reports each calendar year following the standardize reporting period and format guidelines set forth by the International Civil Aviation Organization's (ICAO's) Asia and Pacific Region Regional Airspace Safety Monitoring Advisory Group (RASMAG).

1.3 Within this report, the reader will find the summary of airspace safety oversight for the airspace of Chinese FIRs, including the Large Height Deviation (LHD) reports analysis and an update of the vertical collision risk estimate for Chinese RVSM 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 2015 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 FIR's.

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	-	-	Included in Beijing ACC
		Zhengzhou	-	-	Included in Beijing ACC
Shanghai	ZSHA	Shanghai	Automatic system	Received	Data completed
		Qingdao	Automatic system	Received	Data completed
		Jinan	Automatic system	Received	Data completed
		Xiamen	-	-	Included in Shanghai ACC
		Nanchang	-	-	Included in Shanghai ACC
		Hefei	-	-	Included in Shanghai ACC
Guangzhou	ZGZU	Guangzhou	Automatic system	Received	Data completed
		Guilin	Automatic system	Received	Data completed
		Zhanjiang	Automatic system	Received	Data completed
		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
		Hailar	Automatic system	Received	Data completed
Lanzhou	ZLHW	Lanzhou	Automatic system	Received	Data completed
		Xi'an	Automatic system	Received	Data completed
Urumqi	ZWUQ	Urumqi	Manual	Received	Data completed
Kunming	ZPKM	Kunming	Automatic system	Received	Data completed
		Chengdu	Automatic system	Received	Data completed
		Lhasa	Manual	Received	Data completed
		Guiyang	-	-	Included in Chengdu ACC
Sanya	ZJSA	Sanya	Automatic system	Received	Data completed

Table 1: Summary of Traffic Sample Data of December 2015 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 2015 to December 2015. **Table 2** provides the summary of LHD reports submitted by each FIR.

FIR Name	Beijing	Shanghai	Guangzhou	Wuhan	Shenyang	Lanzhou	Urumqi	Kunming	Sanya
Jan-15	X	X	X	X	X	X	X	X	X
Feb-15	X	X	X	X	X	X	X	X	X
Mar-15	X	X	X	X	X	X	X	X	X
Apr-15	X	X	X	X	X	X	X	X	X
May-15	X	X	X	X	X	X	X	X	X
Jun-15	X	X	X	X	X	X	X	X	X
Jul-15	X	X	X	X	X	X	X	X	X
Aug-15	X	X	X	X	X	X	X	X	X
Sep-15	X	X	X	X	X	X	X	X	X
Oct-15	X	X	X	X	X	X	X	X	X
Nov-15	X	X	X	X	X	X	X	X	X
Dec-15	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 received LHD reports shown in **Table 2**, the LHD occurrences between January 2015 and December 2015 in the airspace of Chinese FIRs are summarized as follows:

3.2. **Table 3** and **Figure 1** summarize the number of LHD occurrences, associated LHD durations (in minutes) and the number of flight levels transitioned without clearance by month in the airspace of Chinese FIRs between January 2015 and December 2015:

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)	No. of flight levels transitioned without clearance
Jan-15	16	0.75	4
Feb-15	20	19.58	8
Mar-15	9	1.11	1
Apr-15	13	3.5	3
May-15	12	1.5	3
Jun-15	6	2	1
Jul-15	11	1.08	5
Aug-15	13	0.5	3
Sep-15	3	1.5	0
Oct-15	4	7	1
Nov-15	5	0.1	4
Dec-15	8	2.25	2
Total	120	40.87	35

Table 3: Summary of non-nil LHDs in Chinese FIRs between January 2015 and December 2015

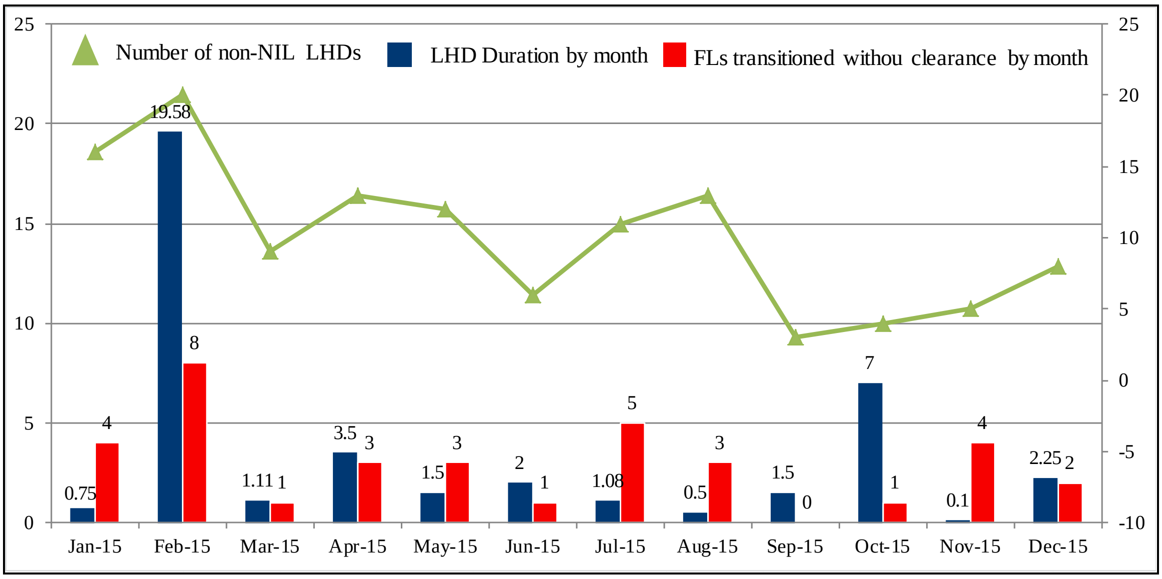

Figure 1: Illustrations of reported LHDs in Chinese FIRs between January 2015 and December 2015

3.3. The large height deviation reports are separated by categories based on the details provided for each event. **Table 4**, **Figure 2** and **Figure 3** summarize the number of LHD occurrences inside Chinese RVSM airspace by 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;	15	1.5	14
D	ATC system loop error	2	1	2
E	ATC transfer of control coordination errors due to human factors	72	13.44	3
F	ATC transfer of control coordination errors due to technical issues	2	7	0
G	Aircraft contingency leading to sudden inability to maintain level	3	0	9
H	Airborne equipment failure and unintentional or undetected level change	2	0	1
I	Turbulence or other weather related causes;	13	1.68	6
L	An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)	1	0.25	0
M	Other: flight crews are unable to establish normal air-ground communications with the responsible ATS unit	10	16	0
Total		120	40.87	35

Table 4: Summary of LHD Categories during the reporting period

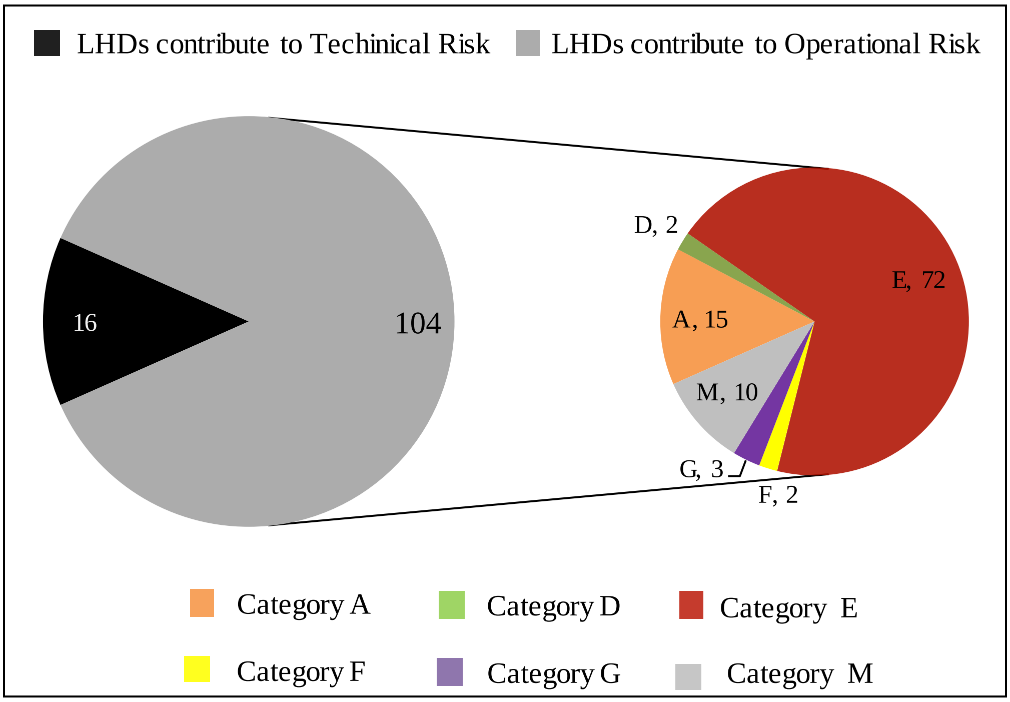

Figure 2: Breakdown of operation risk contributors (Category and Number of events)

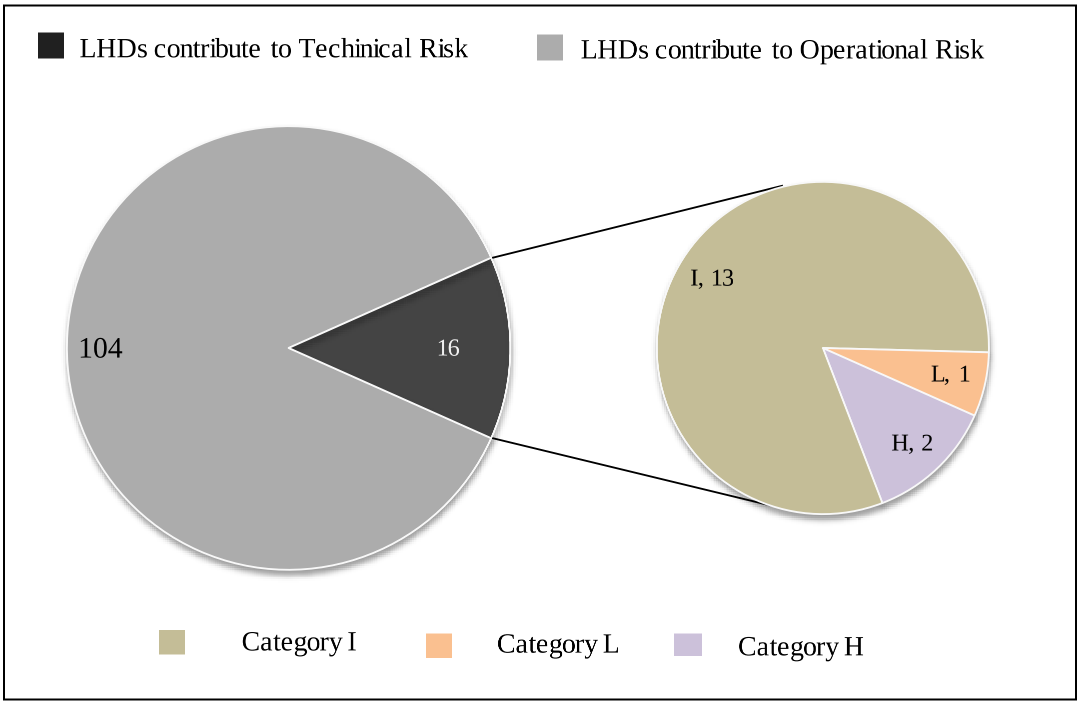

Figure 3: Breakdown of technical risk contributors (Category and Number of events)

LHD Analysis and Safety Treatment of Identified LHDs

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

In light of the above, the LHD occurrences received by China RMA are summarized as follows:

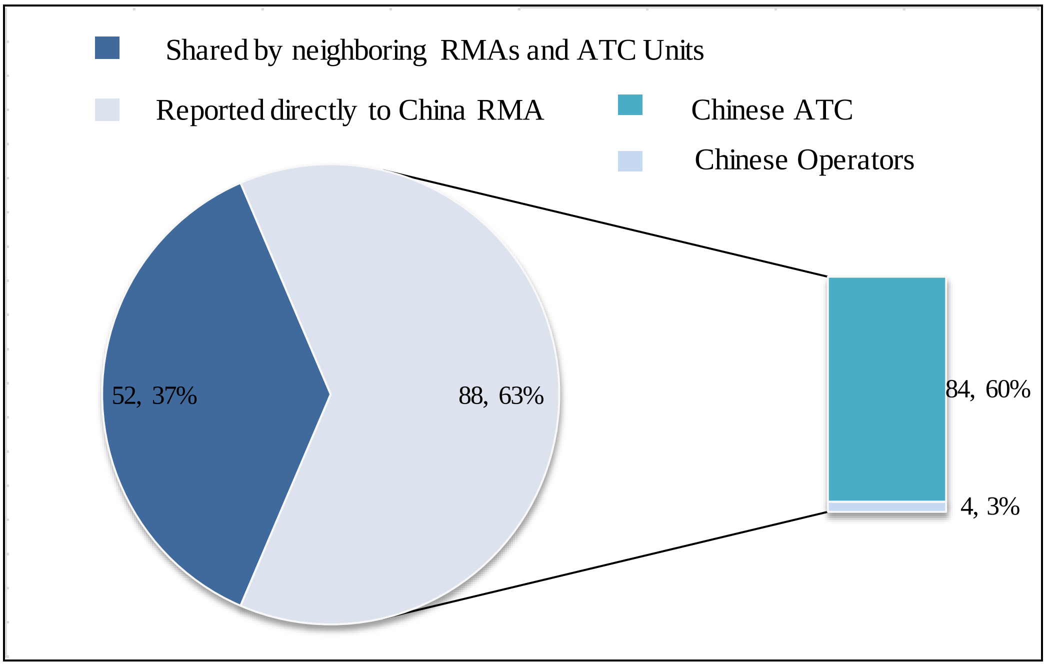

Figure 4: Breakdown of events that China RMA received according to data sources

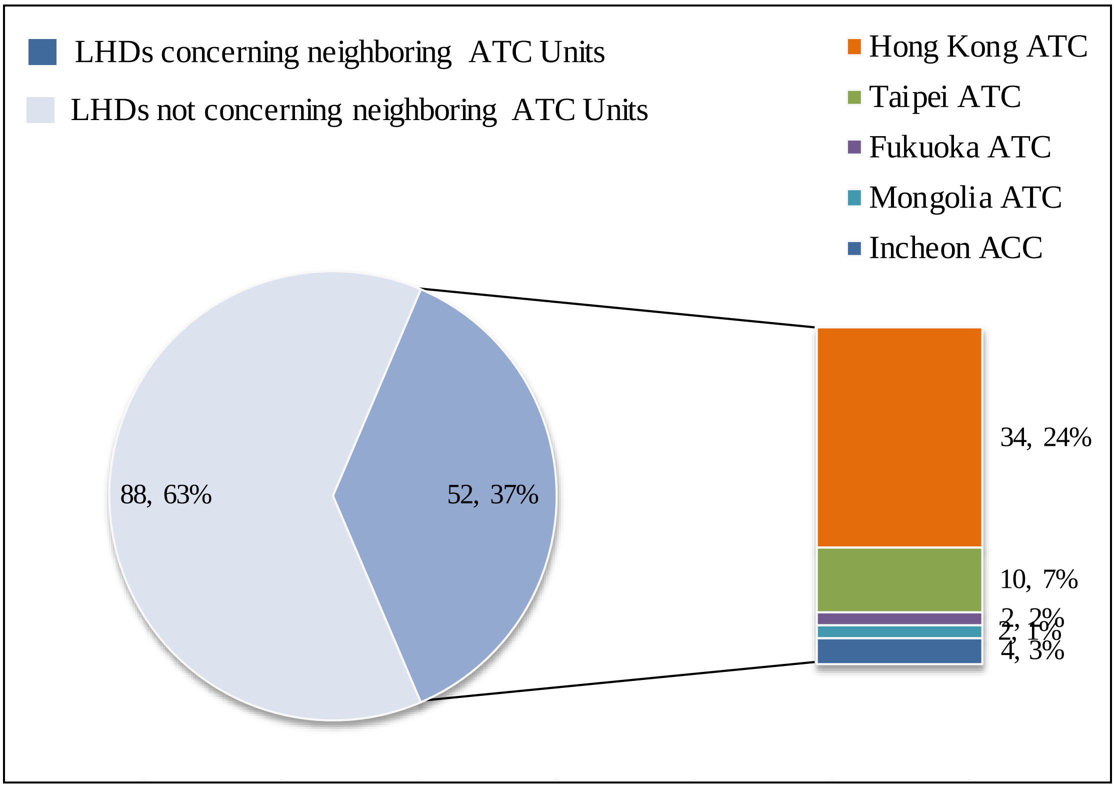

Figure 5: Breakdown of events concerning neighboring ATS units

- There were 140 reported large height deviations during the reporting period;
- 120 events occurred inside China RMA's responsible area and 20 events occurred outside;
- 4 events were reported by Chinese operators and 84 were reported by Chinese ATC, and 52 were shared by neighboring RMAs and ATS units; Figure 4 presents the breakdown of events that China RMA received according to data sources;
- Among the 52 events shared by neighboring RMAs and ATS units, 34 events were reported by Hong Kong ATC(MAAR), 10 by Taipei ATC(MAAR), 2 by Fukuoka ATC(JASMA), and 2 by Mongolia ATC(MAAR),and 4 by Incheon ATC(PARMO); Figure 5 presents the breakdown of events concerning neighboring ATS units;
- Category E errors still had the largest proportion in the number of events reported. The data analysis and following remedial actions were summarized as below:
  - South China Sea (SCS) Scrutiny Group for LHDs concerning Hong Kong FIR interface with Guangzhou/Sanya FIRs: LHDs reported in this area were mainly due to late revision of time or altitude. China RMA, MAAR and the related SCS ATS units had a scrutiny group meeting in 2015. After the scrutiny group meeting, the LHD reporting and data sharing in this area is improving. Though this area was still a 'hot spot' currently, relevant ATCs had already pay attention to coordination errors and take active actions. China RMA will continue to track the trend of LHDs in this area and provide further feedback to RASMAG.
  - Urumqi FIR interface with Lahore FIR: the key problem leading to continuous LHDs is due to the limit of communication and surveillance. CNS division of ATMB, CAAC is working with Pakistan CAA to promote the VSAT station establishment near the border and to improve the communication and surveillance in this area. At present, CNS division of ATMB, CAAC has completed the bidding work of relevant equipment and the test of electromagnetic environment in Pakistan.
  - Coordination with JASMA/PARMO/MAAR for LHDs concerning Incheon FIR AKARA Corridor interface with Shanghai/Fukuoka/Taipei FIRs: LHDs reported in this area were mainly due to late revision of time or altitude. China RMA began to establish quick contact with JASMA for exchanging LHDs through email from July 2015, and Shanghai ATC reported that they started to pay more attention to coordination errors in AKARA Corridor and give timely

feedback for LHD investigations concerning coordination errors. According to the number of LHDs reported and query from JASMA, LHDs between Shanghai and Fukuoka was reducing this year. For LHDs concerning Taipei ATC, China RMA established quick contact with MAAR. Shanghai ATC reported that they would report and investigate LHDs concerning Taipei on a timely manner. China RMA will continue to track the trend of LHDs in this area.

- Beijing interface with Ulaanbaatar ATC: after investigation, it was found that most of the events were due to late revision from Beijing side. It was known that Beijing ACC transferred flight to Ulaanbaatar ATC by automatic system and the EST message was sent automatically by the system, but there was not any notification provided to controller when the EST message was sent, which resulted in the situation that controller may change the flight level after the EST message was sent, thus the LHD occurred. Based on this phenomenon, Beijing ACC adjusted some parameters of the system, set up relevant work procedures, added reference line to relevant routes, and requested controllers on duty that they can change FL before the reference line. If the controller want to change FL after the reference line, they must firstly check whether the automation system has sent the EST message, and if the system has not sent the EST message, they can directly change the FL, but if the system has sent the message, the controller must resend EST message manually after changing FL or make coordination with Ulaanbaatar ACC by telephone. In addition, Beijing ACC upgraded the automatic system, so the reliability of the system greatly improved.

■ Category M becomes the major contributor to the operational risk in this analysis. Seven events were due to inability to maintain RVSM separation, such as TCAS failure or Navigation system failure, and other three events were due to flight crews unable to establish normal air-ground communications with the responsible ATS units. Based on the description of events, the flight crew did not reply the controllers during the flight and after a few minutes the aircraft flew out of the Chinese airspace and the controller was unable to obtain further information. All of these events occurred in radar control area and the controllers could see the aircraft, but unable to establish contact with the pilot. If the LHDs of this category continue increase in the future, China RMA will make some sub-subcategories for this category to statistical analyze, and report this situation to CAAC(Civil Aviation Administration of China).

3.4. **Figure 6** shows the monthly assessed risk demonstrating the individual event contribution, and **Figure 7** shows the operational risk estimate by categories demonstrating the individual event contribution. The obvious high risk was in February, and caused by LHDs with longer duration.

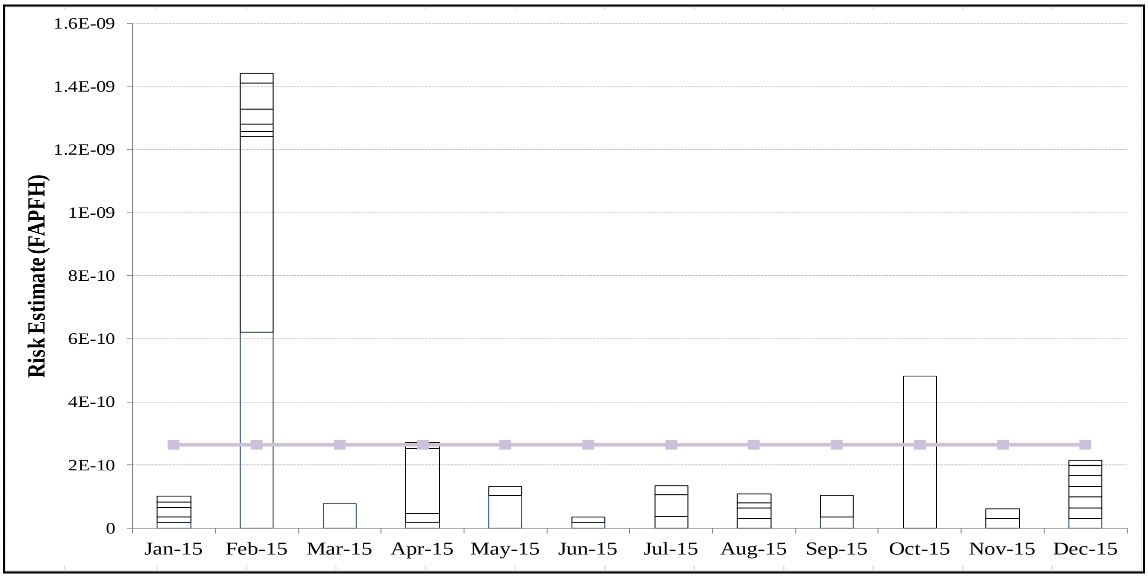

Figure 6: Monthly Assessed Risk Demonstrating the Individual Event Contribution

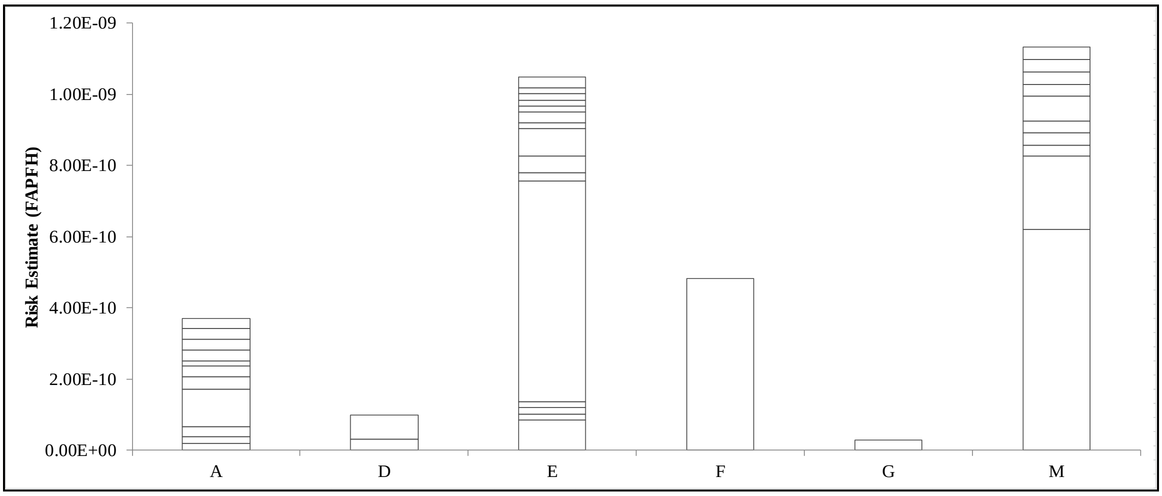

Figure 7: Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

4. Estimate of Vertical Collision Risk for Chinese RVSM Airspace

4.1. The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) continued to be met in Chinese RVSM 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 airspace of Chinese FIRs. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of implementing the RVSM in this airspace.

4.3. The TSD of December 2015, the continuous LHD reports in the airspace of Chinese FIRs between January 2015 and December 2015 are used to produce the risk estimates presented in this report.

4.4. Estimate of the CRM parameters

4.4.1. **Table 5** 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 the airspace of Chinese FIRs.

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	5.604 x 10^{-9}	

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
	in vertical overlap.		
$P_y(0)$	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	6.88×10^{-7}	Value used in the Western 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)
$\overline{\lvert \dot{y} \rvert}$	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
$\overline{\lvert \dot{z} \rvert}$	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 5: Estimate of the empirical Parameters in the CRM

4.4.2. **Table 6** 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 the airspace of Chinese FIRs.

Parameter Symbol	Parameter	Parameter Definition
T	2285269.28	Annual flight hours
E_z(same)	0.0758	Same-direction vertical occupancies
E_z(opposite)	0.1180	Opposite-direction vertical occupancies
Crossing pairs	2894688	Annual estimate of crossing pairs in crossing route
$\overline{\lvert \Delta V \rvert}$	41.7994	Average relative along-track speed between aircraft on same direction routes
$\overline{\lvert V \rvert}$	453.1351	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 2015.

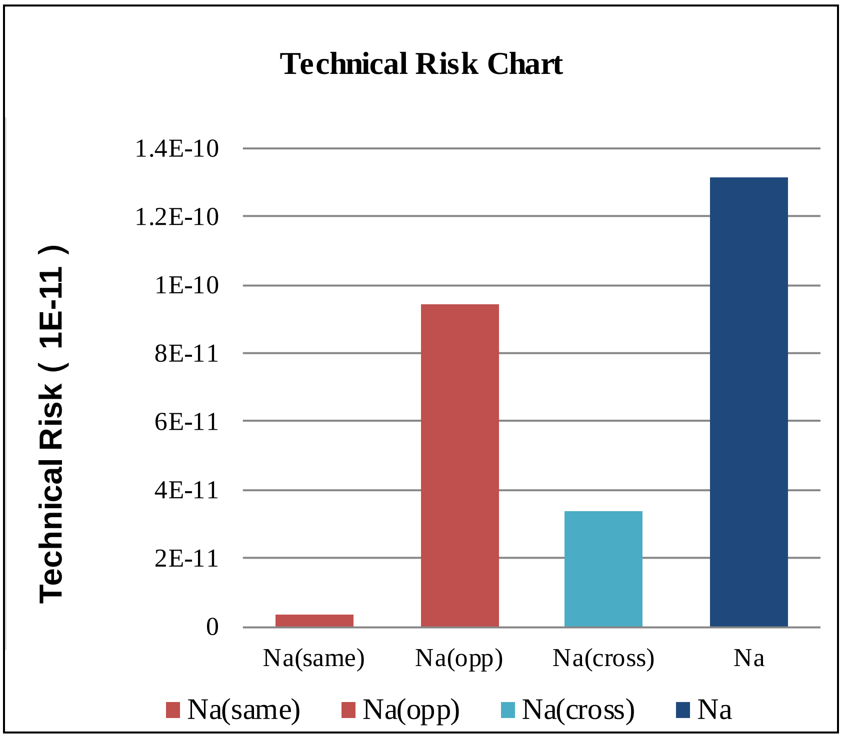

Figure 8: Technical Risk Bar Chart computed by the TSD collected in December 2015

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 0.1131 x 10^{-9} fapfh. The operational risk estimate is 3.161 x 10^{-9} fapfh. The estimate of the overall vertical collision risk is 3.274 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 = 2285269.28 hours *(note: estimated hours based on Dec 2015 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.113 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	3.161 x 10^{-9}	-	-
Total Risk	**3.274 x 10^{-9}**	5.0 x 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.

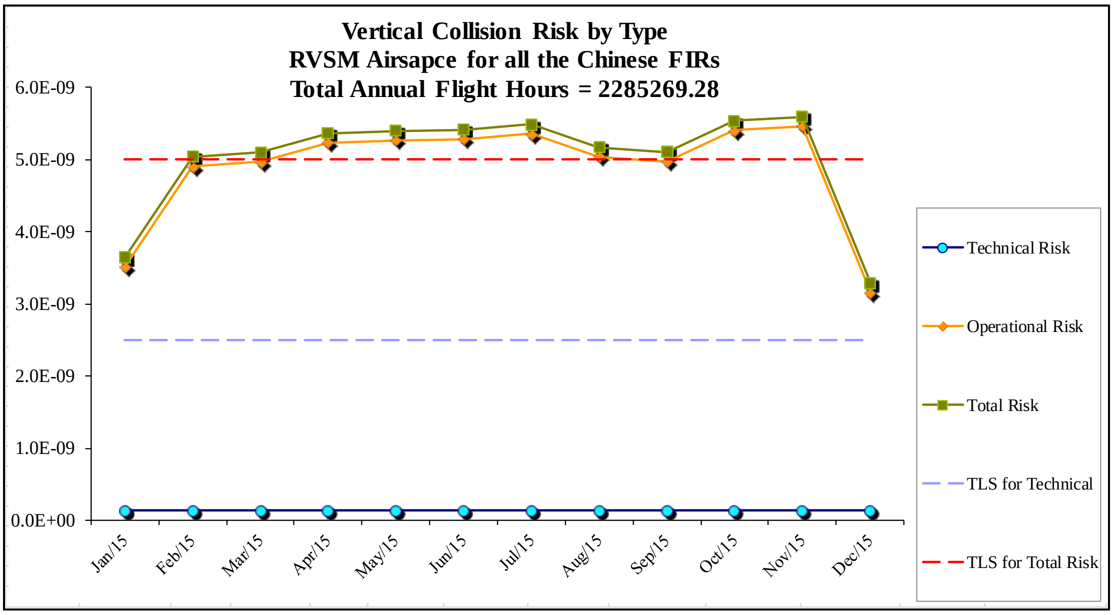

Figure 9: Trends of Risk Estimates for the Airspace of Chinese FIRs

4.5.4. Based on these collision risk estimates, the estimates of technical risk 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 below the TSL value which is 5.0 x 10^{-9} fapfh.

Appendix A Detail of LHDs inside China RMA's responsible area from January 2015 to December 2015

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
1.	01-Jan-15	Urumqi ACC	PURPA	0.25		No transfer	E
2.	14-Jan-15	MAAR/Hong Kong ATC	TAMOT	0		No time revision	E
3.	14-Jan-15	Urumqi ACC	PURPA	0.25		Wrong transfer FL	E
4.	16-Jan-15	Xi'an ATC	VISIN	0		Negative transfer	E
5.	20-Jan-15	MAAR/Hong Kong ATC	SIKOU	0		Wrong transfer FL	E
6.	20-Jan-15	Xi'an ATC	NSH	0	2	Pilot incorrect transcription of ATC clearance	D
7.	21-Jan-15	MAAR/Hong Kong ATC	TAMOT	0		Late transfer	E
8.	21-Jan-15	Xi'an ATC	P178	0		Negative transfer	E
9.	21-Jan-15	Urumqi ACC	PURPA	0.25		Wrong transfer FL	E
10.	24-Jan-15	Sanya ATC	ASSAD	0		Wrong transfer FL	E
11.	29-Jan-15	MAAR/Hong Kong ATC	IKELA	0		Negative transfer	E
12.	29-Jan-15	Beijing ACC	PIDOX- SALIS	0	2	Pilot not descend the aircraft as cleared	A
13.	30-Jan-15	Xi'an ATC	LUVES	0		Negative transfer	E
14.	30-Jan-15	JASMA/Fukuoka ATC	SADLI	0		Late FL revision	E
15.	01-Feb-15	Sanya ATC	SAMAS	9		Failure to communicate	M
16.	03-Feb-15	Urumqi ACC	RULAD	9		Wrong transfer FL and time	E
17.	06-Feb-15	Beijing ACC	CG-YQG	0	1	Pilot not climb the aircraft as cleared	A
18.	07-Feb-15	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E
19.	09-Feb-15	Xi'an ATC	P178	0.33		Negative transfer	E
20.	09-Feb-15	Urumqi ACC	PURPA	0.25		Negative transfer	E
21.	10-Feb-15	Xi'an ATC	P124	1	1	Late transfer	E

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
22.	14-Feb-15	MAAR/Hong Kong ATC	TAMTO	0		Late transfer	E
23.	15-Feb-15	Guangzhou ACC	P159	0		Airborne equipment failure	H
24.	15-Feb-15	MAAR/Hong Kong ATC	SIKOU	0		Wrong transfer FL	E
25.	15-Feb-15	Guangzhou ACC	P159	0	1	Airborne equipment failure	H
26.	16-Feb-15	Asia United Business Aviation Limited	Near ELNEX	0	1	Pilot incorrect operation	A
27.	20-Feb-15	MAAR/Taipei ATC	KASKA	0		Negative transfer	E
28.	22-Feb-15	Chengdu ATC	P366	0	1	Bad weather	I
29.	23-Feb-15	MAAR/Hong Kong ATC	DOSUT	0		Late transfer	E
30.	23-Feb-15	MAAR/Hong Kong ATC	DOSUT	0		Late transfer	E
31.	25-Feb-15	Guangzhou ACC	LKO	0	1	Turbulence	I
32.	25-Feb-15	Guangzhou ACC	LKO	0	1	Turbulence	I
33.	28-Feb-15	Guangzhou ACC	Liuyang	0	1	Pilot not descend/climb the aircraft as cleared	A
34.	02-Mar-15	Xi'an ATC	VISIN	0.86	1	No FL revision	E
35.	06-Mar-15	Sanya ATC	ASSAD	0.25		Not RVSM approval	L
36.	06-Mar-15	Guangzhou ACC	ZF	0		Pilot not descend/climb the aircraft as cleared	A
37.	17-Mar-15	MAAR/Taipei ATC	KASKA	0		Wrong transfer FL	E
38.	17-Mar-15	Xi'an ATC	AGULU	0		No FL revision	E
39.	18-Mar-15	Xi'an ATC	P124	0		No FL revision	E
40.	22-Mar-15	MAAR/Hong Kong ATC	SIKOU	0		Wrong transfer FL	E
41.	25-Mar-15	Sanya ATC	IKELA	0		Late transfer	E
42.	03-Apr-15	Urumqi ACC	PURPA	0.25		Negative transfer	E
43.	12-Apr-15	MAAR/Hong Kong ATC	DOTMA	0		Late transfer	E
44.	12-Apr-15	MAAR/Hong Kong ATC	SIKOU	0		Late FL revision	E

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
45.	14-Apr-15	MAAR/Hong Kong ATC	TAMOT	0		No FL revision	E
46.	17-Apr-15	MAAR/Taipei ATC	KASKA	0		Negative transfer	E
47.	18-Apr-15	MAAR/Hong Kong ATC	DOTMI	0		No FL revision	E
48.	19-Apr-15	MAAR/Hong Kong ATC	IKELA	0		No FL revision	E
49.	20-Apr-15	Lanzhou ACC	JNQ	3		Lose RVSM capability due to TCAS failure	M
50.	21-Apr-15	MAAR/Taipei ATC	R596	0		Negative transfer	E
51.	24-Apr-15	Chengdu ATC	Unknown	0		Bad weather	I
52.	27-Apr-15	Guangzhou ACC	GYA	0		Pilot not descend/climb the aircraft as cleared	A
53.	29-Apr-15	Lanzhou ACC	OMBON	0	3	Airborne equipment failure	G
54.	30-Apr-15	Urumqi ACC	PURPA	0.25		Wrong transfer FL	E
55.	06-May-15	Kunming ACC	BIDRU	1.5		Pilot not descend/climb the aircraft as cleared	A
56.	08-May-15	MAAR/Taipei ATC	KASKA	0		Negative transfer	E
57.	10-May-15	MAAR/Hong Kong ATC	TAMOT	0		Wrong transfer FL	E
58.	10-May-15	MAAR/Taipei ATC	KASKA	0		Negative transfer	E
59.	11-May-15	Zhanjiang ATC	SIKOU	0		No FL revision	E
60.	11-May-15	Guangzhou ACC	MIDOX	0		Fail to communicate	M
61.	13-May-15	Guangzhou ACC	BUBDA	0	3	Special situation	G
62.	14-May-15	MAAR/Hong Kong ATC	TAMOT	0		No FL revision	E
63.	17-May-15	Spring Airlines	Unknown	0		Turbulence	I
64.	20-May-15	Guangzhou ACC	HOK	0		Pilot not descend/climb the aircraft as cleared	A
65.	21-May-15	Zhanjiang ATC	SIKOU	0		Negative transfer	E
66.	31-May-15	MAAR/Taipei ATC	SULEM	0		Negative transfer	E
67.	09-Jun-15	Urumqi ACC	PURPA	0.25		Wrong transfer FL	E
68.	11-Jun-15	Chengdu ATC	JTG	1.5	1	Bad weather	I

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
69.	11-Jun-15	Urumqi ACC	PURPA	0.25		Wrong transfer FL	E
70.	16-Jun-15	UB FIR	INTIK	0		Wrong transfer FL	E
71.	20-Jun-15	UB FIR	NIXAL	0		Wrong transfer FL	E
72.	28-Jun-15	MAAR/Hong Kong ATC	DOTMI	0		No FL revision	E
73.	01-Jul-15	MAAR/Hong Kong ATC	DOTMI	0		Negative transfer	E
74.	16-Jul-15	Spring Airlines	SHR	0.08		Turbulence	I
75.	16-Jul-15	Xi'an ATC	LUVES	0		Bad weather	I
76.	20-Jul-15	Guangzhou ACC	XEBUL	0	2	Pilot not descend/climb the aircraft as cleared	A
77.	20-Jul-15	Beijing ACC	PIDOX	1		ATC issues incorrect clearance	D
78.	22-Jul-15	Guangzhou ACC	NOMUK	0		Turbulence	I
79.	22-Jul-15	Beijing ACC	South of SJW	0	3	Special situation	G
80.	24-Jul-15	JASMA/Fukuoka ATC	SADLI	0		Wrong transfer FL	E
81.	24-Jul-15	Zhanjiang ATC	BHY	0		Turbulence	I
82.	26-Jul-15	MAAR/Hong Kong ATC	DOTMI	0		Negative transfer	E
83.	27-Jul-15	MAAR/Taipei ATC	KASKA	0		Wrong transfer FL	E
84.	05-Aug-15	MAAR/Hong Kong ATC	IKELA	0		Coordination error due to AIDC fail transfer	F
85.	08-Aug-15	Kunming ACC	GMA	0	1	Pilot not descend/climb the aircraft as cleared	A
86.	09-Aug-15	Zhanjiang ATC	SIKOU	0		No time revision	E
87.	10-Aug-15	Guangzhou ACC	TAMOT	0		Wrong transfer FL	E
88.	11-Aug-15	Guangzhou ACC	YIN	0.5		Lose RVSM capability due to TCAS failure	M
89.	15-Aug-15	MAAR/Hong Kong ATC	EPKAL	0		Negative transfer	E
90.	16-Aug-15	Guangzhou ACC	BIPOP	0	1	Pilot not descend/climb the aircraft as cleared	A
91.	17-Aug-15	Beijing ACC	KAMDA	0		Turbulence	I
92.	19-Aug-15	Beijing ACC	FYG	0	1	No FL revision	E

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
93.	22-Aug-15	Sanya ATC	IKELA	0		Separation not in accordance with agreement	E
94.	23-Aug-15	MAAR/Taipei ATC	KASKA	0		Negative transfer	E
95.	26-Aug-15	Guangzhou ACC	DOTMI	0		Negative transfer	E
96.	29-Aug-15	Sanya ATC	IKELA	0		Late transfer	E
97.	04-Sep-15	Guangzhou ACC	GYA	0.5		Lose RVSM capability due to TCAS failure	M
98.	16-Sep-15	Guangzhou ACC	WHA	1		Fail to communicate due to transponder failure	M
99.	27-Sep-15	MAAR/Taipei ATC	KASKA	0		Wrong transfer FL	E
100.	02-Oct-15	JUNEYAO AIR	sosma-binor	0	1	Turbulence	I
101.	14-Oct-15	Guangzhou ACC	DOTMI	0		Wrong transfer FL	E
102.	23-Oct-15	Beijing ACC	OBLIK	7		Negative transfer	F
103.	23-Oct-15	Sanya ATC	IKELA	0		No FL revision	E
104.	03-Nov-15	MAAR/Hong Kong ATC	TAMOT	0		Late transfer	E
105.	05-Nov-15	Guangzhou ACC	XEBUL	0	1	Pilot not descend/climb the aircraft as cleared	A
106.	10-Nov-15	Guangzhou ACC	Liuyang	0.1	1	Turbulence	I
107.	18-Nov-15	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E
108.	19-Nov-15	Guangzhou ACC	Nantang	0	2	Pilot not descend/climb the aircraft as cleared	A
109.	03-Dec-15	Guangzhou ACC	ONEMI	0	1	Pilot not descend/climb the aircraft as cleared	A
110.	05-Dec-15	Guangzhou ACC	LKO	0.5		Lose RVSM capability due to Navigation System failure	M
111.	06-Dec-15	MAAR/Hong Kong ATC	TAMOT	0		Late transfer	E
112.	15-Dec-15	Guangzhou ACC	LIG	0.5		Lose RVSM capability due to TCAS failure	M
113.	21-Dec-15	Guangzhou ACC	P166	0.5		Lose RVSM capability due to TCAS failure	M
114.	22-Dec-15	Guangzhou ACC	LUMKO	0.5		Lose RVSM capability due to Inertial Navigation System failure	M

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
115.	26-Dec-15	Beijing ACC	West of TYN	0	1	Pilot not descend/climb the aircraft as cleared	A
116.	30-Dec-15	Urumqi ACC	RULAD	0.25		Actual time not in accordance with agreement	E
117.	08-Feb-15	PARMO/Incheon ACC	AGAVO	0		Wrong transfer FL	E
118.	24-Mar-15	PARMO/Incheon ACC	AGAVO	0		Wrong transfer FL	E
119.	16-Jan-15	PARMO/Incheon ACC	AGAVO	0		Wrong transfer FL	E
120.	16-Jan-15	PARMO/Incheon ACC	AGAVO	0		Wrong transfer FL	E

Appendix B Detail of LHDs outside China RMA's responsible area from January 2015 to December 2015

No.	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
1.	22-Jan-15	MAAR/Hong Kong ATC	SIKOU	0		Wrong transfer FL	E
2.	15-Feb-15	MAAR/Hong Kong ATC	SIKOU	0		Wrong transfer FL	E
3.	14-Apr-15	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E
4.	19-May-15	MAAR/Hong Kong ATC	TAMOT	0		Negative transfer	E
5.	31-May-15	MAAR/Hong Kong ATC	IKELA	0		Negative transfer	E
6.	06-Sep-15	Shanghai ACC	SULEM	0		Separation not in accordance with agreement	E
7.	06-Sep-15	Shanghai ACC	SULEM	0		Separation not in accordance with agreement	E
8.	06-Sep-15	Shanghai ACC	KASKA	0		Negative transfer	E
9.	14-Sep-15	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E
10.	15-Sep-15	MAAR/Hong Kong ATC	SIKOU	0		Wrong transfer FL	E
11.	25-Sep-15	Shanghai ACC	SULEM	0		Negative transfer	E
12.	25-Sep-15	Shanghai ACC	SULEM	0		Negative transfer	E
13.	25-Sep-15	Shanghai ACC	SULEM	0		Negative transfer	E
14.	12-Oct-15	Urumqi ACC	PURPA	0		Wrong transfer FL	E
15.	17-Oct-15	Urumqi ACC	PURPA	0		Wrong transfer FL	E
16.	01-Nov-15	Shanghai ACC	SULEM	0		Wrong transfer FL	E
17.	16-Nov-15	Shanghai ACC	SULEM	0		Wrong transfer FL	E
18.	19-Nov-15	MAAR/Hong Kong ATC	IKELA	0		Wrong transfer FL	E
19.	08-Dec-15	Guangzhou ACC	DOTMI	0		Wrong transfer FL	E
20.	25-Dec-15	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E

Appendix C Geographic Location of Risk Bearing LHD within airspace of Chinese FIRs from January 2015 to December 2015

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

Figure 10: Chinese FIRs – Risk Bearing (Non-NIL) RVSM Large Height Deviations January 2015- December 2015

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF PYONGYANG FLIGHT INFORMATION REGION JANUARY 2015 - DECEMBER 2015

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

May 2015

SUMMARY

This report presents the airspace safety oversight from China Regional Monitoring Agency for the airspace of Democratic People's Republic of Korea (DPR Korea) for the time January 2015 - December 2015. 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 above the target level of safety (TLS) value of 5.0×10^{-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 This report covers the current reporting period from January 2015 - December 2015 in the China RMA's ongoing process of providing periodic updates of information relevant to the continued safe use of the RVSM in the airspace of Pyongyang FIR. China RMA produces one report each calendar year following the standardized reporting period and format guidelines set forth by the International Civil Aviation Organization's (ICAO's) Asia and Pacific Region Regional Airspace Safety Monitoring Advisory Group (RASMAG).

2. Data Submission

2.1. China RMA requests an annual one-month traffic movement sample and monthly large height deviation reports from the General Administration of Civil Aviation, DPR Korea.

2.2. Traffic Sample Data (TSD)

2.2.1. Traffic sample data for December 2015 for the RVSM airspace of DPR Korea were 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 December 2015 in the DPR Korea's RVSM Airspace

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

2.3.1. Pyongyang ATC reported two LHDs in 2015, one is occurred in September, and the other is occurred in November. In the first event, the air traffic controller instructed the aircraft to climb to a certain flight level but received no response from pilot for about 35 seconds. The air traffic controller did not realize radio communication failure. After then, by use of back-up radio transceiver, the air traffic controller was able to contact the pilot and issue instructions. In the second event, one flight flied with any communication with ACC within Pyongyang FIR for about 15 minutes. During that time, Pyongyang ACC tried to contact with the flight on his 120.9MHz in use and emergency frequency 121.5MHz respectively so many times, communication was received finally just before crossing NULAR. The two events were categorized as Category M. Appendix A provides detail of the two events. Appendix B shows the geographical location of the two events.

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

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
$\overline{\lvert \dot{h}(\theta) \rvert}$	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)
$\lvert \overline{\dot{y}} \rvert$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	4 knots	Value specified in ICAO Doc. 9574
$\lvert \overline{\dot{z}} \rvert$	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	0.03162	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	3387.8	Annual flight hours
E_z(same)	0.0	Same-direction vertical occupancies
E_z(opposite)	0.0373	Opposite-direction vertical occupancies
Crossing pairs	204	Annual estimate of crossing pairs in crossing route
$\lvert \overline{\Delta V} \rvert$	NaN	Average relative along-track speed between aircraft on same direction routes
$\lvert \overline{V} \rvert$	502.6551	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. The technical risk is estimated to be 0.497 x 10^{-9} fapfh. The operational risk estimate is 833.601 x10^{-7} fapfh. The estimate of the overall vertical collision risk is 834.098 x 10^{-7} fapfh, which is above the TLS value of 5 x 10^{-9} fapfh.

RVSM Airspace of DPR Korea – estimated annual flying hours = 3387.8 hours *(note: estimated hours based on the December 2015 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	0.497 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	833.601 x 10^{-9}	-	-
Total Risk	**834.098 x 10^{-9}**	**5.0 x 10^{-9}**	**Above 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.

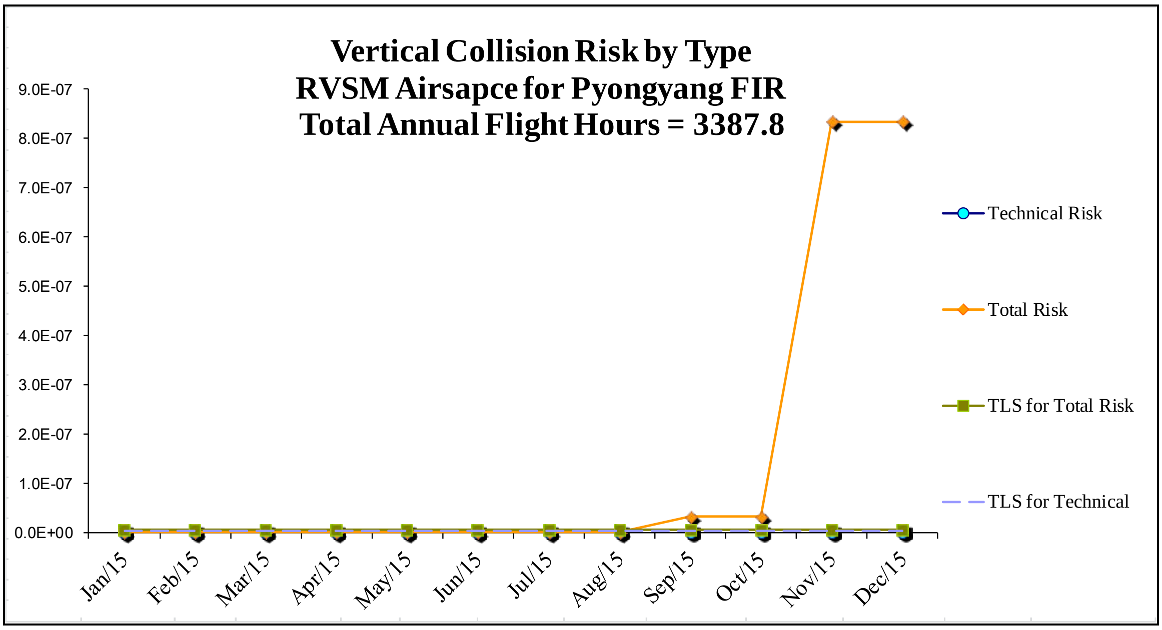

Figure 1: Trends of Risk Estimates for the Airspace of Pyongyang FIR

4.3. As shown in Figure 1, the total annual flight hours in 2015 (3387.8) was significantly decreasing compared to its counterpart in 2014(5012.6). China RMA communicated with our point of contact in Pyongyang FIR to enquire about the reason for the TSD remarkably decrease. Our point of contact replied that the reason was associated with meteorological conditions, operators' own operation issues, and consequently, they may use other airways outside of Pyongyang FIR.

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

Appendix A Detail of LHDs reported in Pyongyang FIR from January 2015 to December 2015

	EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
1.	01-Sep-15	Pyongyang ATC	NULAR	0.58		radio communication failure	M
2.	06-Nov-15	Pyongyang ATC	KANSU-NULAR	15		radio communication failure	M

Appendix B Geographic Location of Risk Bearing LHD within airspace of Pyongyang FIR from January 2015 to December 2015

Figure 2 provides the geographic location of risk bearing LHD reports within airspace of Pyongyang FIR during the reporting period.

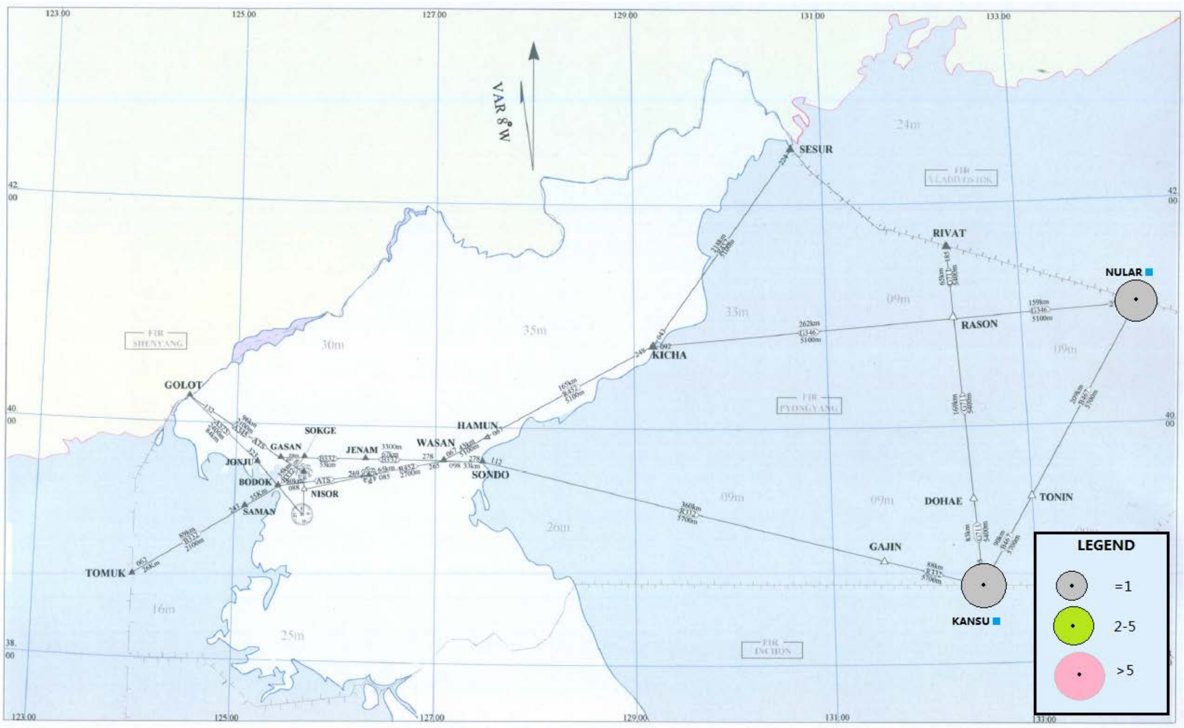

Figure 2. Pyongyang FIR – Risk Bearing (Non-NIL) RVSM Large Height Deviations January 2015 - December 2015