International Civil Aviation Organization

The Twentieth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/20)

Bangkok, Thailand, 26-29 May 2015

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

CHINA RMA SAFTY REPORT

(Presented by the 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 2014 to December 2014. 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 2014 to December 2014, 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 2014 and the latest 12-month Large Height Deviation (LHD) reports until December 2014. The estimates of total risk shows the TLS was not 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 2014. There was no Large Height Deviation occurred for the time period of January 2014 to December 2014 in Pyongyang FIR.

2.2. It is noticeable that in 2014 China RMA received a number of LHDs due to ATC coordination errors from other RMAs but these events were not reported by domestic ATC. China RMA submitted a report to ATMB, CAAC to raise attention and call to action. China RMA conducted an intensive investigation into the causes leading to lack of LHD reporting, especially for the lack of LHDs that do not have ‘actual deviation’ (for instance, coordination errors due to operational/technical reasons, unable to establish communication between controller and pilot, etc.). China RMA submitted a separate paper to RASMAG/20 to present the relevant progress. In the second half of 2014, China RMA took actions to improve LHD reporting in China by holding LHD workshops in all regional ATMBs, updating training materials and simplifying the LHD reporting template. It is found that the situation is improving and the number of coordination errors may continue to increase. China RMA will continue to track these changes and report updates to relevant parties.

2.3. In 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, and **Figure 2** shows the operational risk estimate by categories demonstrating the individual event contribution. The obvious high risk in December was the result of a Category M LHD which was the result of a failure to establish communication between controller and pilot. The duration of the occurrence was assessed as 26 minutes. **Figure 2** shows that the numbers of Category E and F events are increasing. The increase is likely due to 1) the LHDs share from other RMAs 2) the actions taken by China RMA to increase the awareness of controllers on coordination errors.

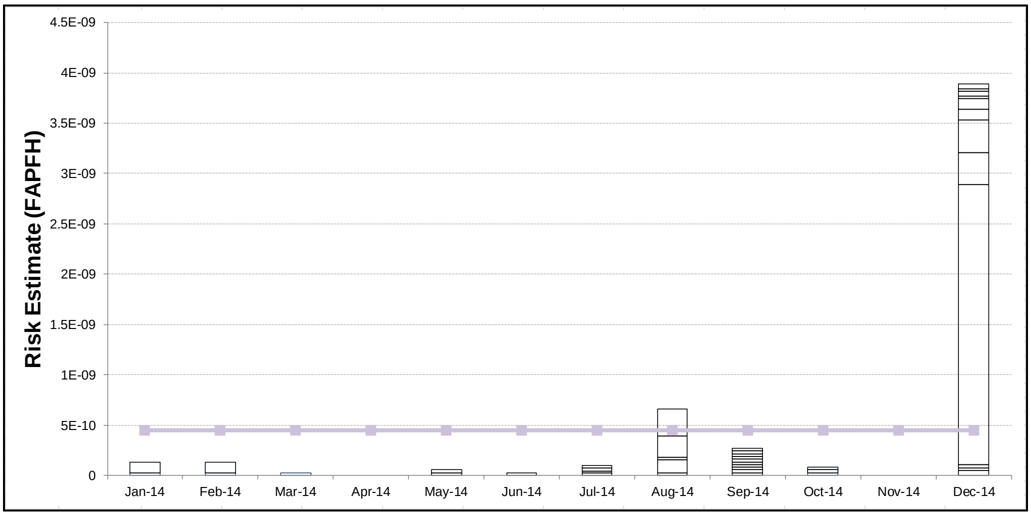

Figure 1: Monthly Assessed Risk Demonstrating the Individual Event Contribution

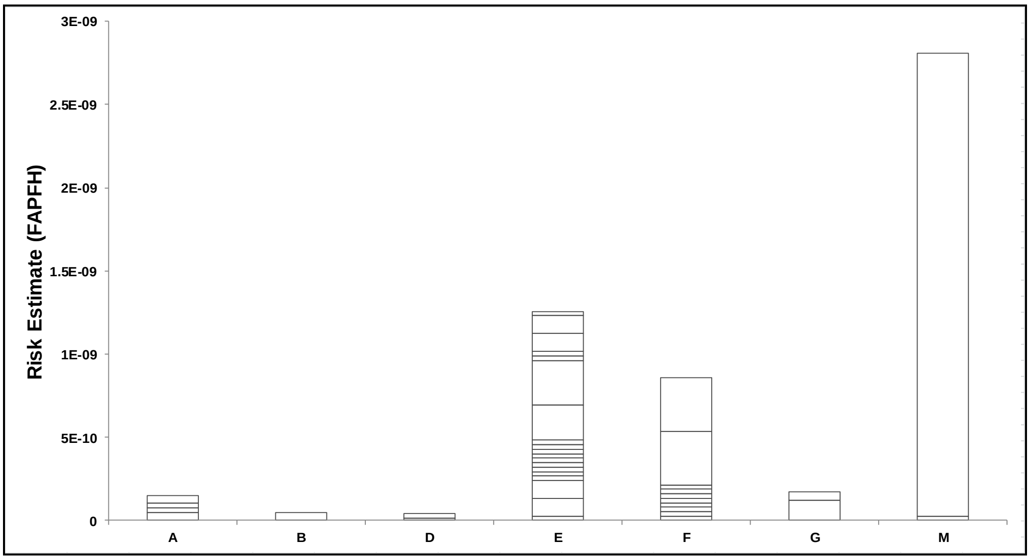

Figure 2: Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

<u>Executive Summary- RVSM airspace of Chinese FIRs</u>

2.4. **Table 1** summarizes Chinese FIRs RVSM technical, operational, and total risks. **Figure 3** presents collision risk estimate trends during the period from Jan 2014 to Dec 2014. The vertical collision risk estimate for Chinese RVSM airspace in Dec 2014 is above the target level of safety (TLS) value of 5.0 x 10^{-9} fapfh.

The RVSM Airspace of Chinese FIRs – estimated annual flying hours = 2124690.6 hours *(note: estimated hours based on Dec 2014 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 19 Total Risk	2.99×10^{-9}	*5.0×10^{-9}*	*Below TLS*
Technical Risk	0.1899×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	5.31×10^{-9}	-	-
Total Risk	**5.50×10^{-9}**	5.0×10^{-9}	**Above Overall TLS**

Table 1: Airspace of Chinese FIRs RVSM Risk Estimates

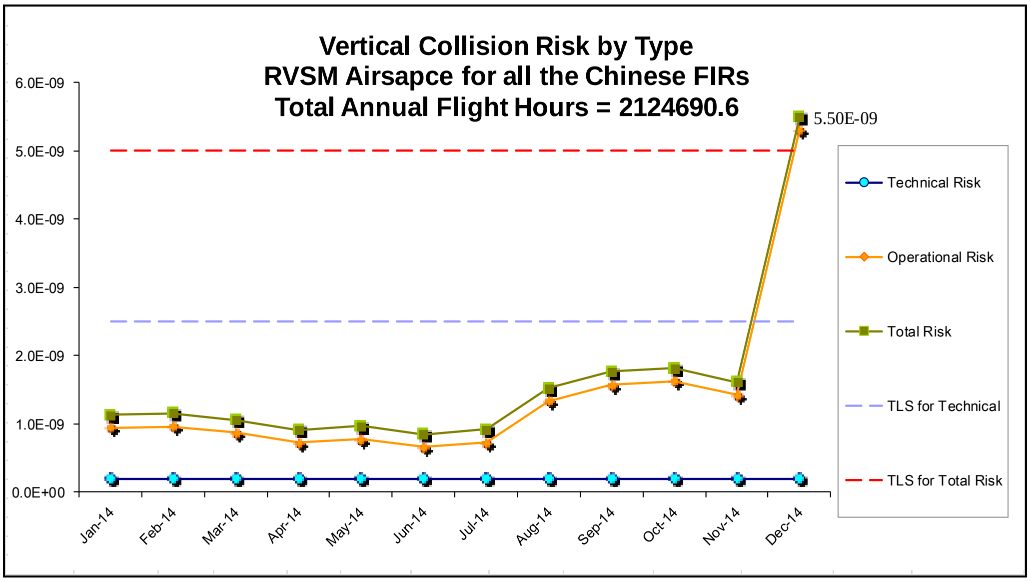

Figure 3: Airspace of Chinese FIRs RVSM Risk Estimate Trends

2.5. **Table 2** presents a summary of the LHD causes within Airspace of Chinese FIRs from Jan 2014 until Dec 2014.

LHD Code	LHD Category Description	No. of LHD Occurrences
A	Flight crew failing to climb/descend the aircraft as cleared;	4
B	Flight crew climbing/descending without ATC Clearance	1
D	ATC system loop error	2
E	ATC transfer of control coordination errors due to human factors	70
F	ATC transfer of control coordination errors due to technical issues	12
G	Aircraft contingency leading to sudden inability to maintain level	2
H	Airborne equipment failure and unintentional or undetected level change	1
I	Turbulence or other weather related causes;	6
J	TCAS resolution advisory and flight crew correctly responds	3
M	Other	2
Total		103

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

2.7 **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

2.8 'PURPA'(near China – Pakistan borders) continues to be a main hot spot. China RMA submitted a paper to RASMAG/20 to present the coordination made and the progress of China and Pakistan made in improving the communication and surveillance status in this area. Some new hot spots appeared near South China Sea are transfer-of-control points. Most of these LHDs are due to coordination errors. The concerns were raised by ATMB, CAAC and actions were taken to inform the relevant Chinese ATCs to investigate and take actions.

Executive Summary- RVSM airspace of Pyongyang FIR

2.9 **Table 3** summarizes Pyongyang FIR RVSM technical, operational, and total risks. **Figure 5** presents collision risk estimate trends during the period from Jan. 2014 to Dec. 2014. Since there were no reports of operational error in the reporting period, the December 2014 operational risk value is 0.0 x 10^{-9} fapfh. The estimate of the overall vertical collision risk is 0.207 x 10^{-9} fapfh. This estimate meets the regionally agreed TLS value of 5.0 x 10^{-9} fapfh.

Pyongyang FIR – estimated annual flying hours = 5012.6 hours ***(note: estimated hours based on Dec 2014 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
RASMAG 19 Total Risk	1.58 x 10^{-9}	*5.0 x 10^{-9}*	*Below TLS*
Technical Risk	0.207 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	0.00 x 10^{-9}	-	-
Total Risk	**0.207 x 10^{-9}**	5.0 x 10^{-9}	**Below TLS**

Table 3: Airspace of Pyongyang FIR RVSM Risk Estimates

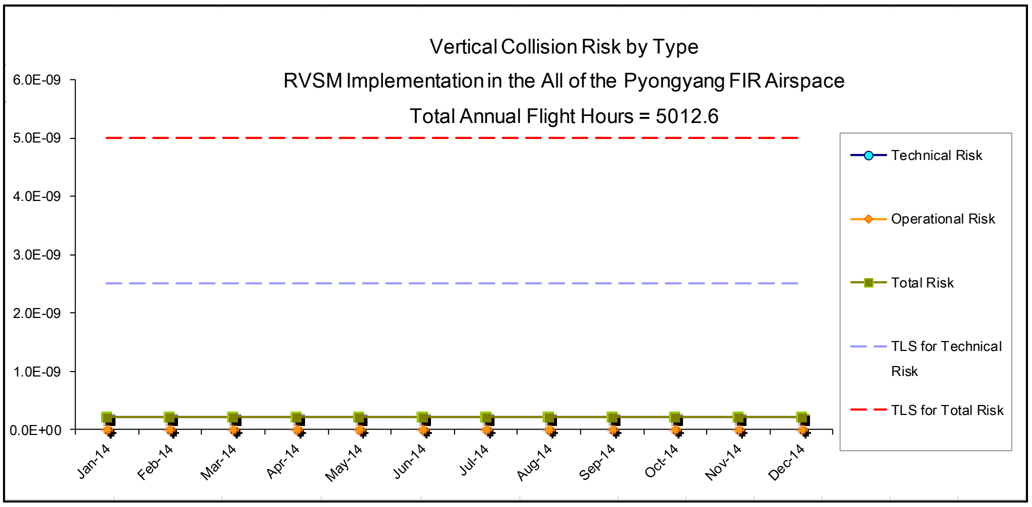

Figure 5: Airspace of Pyongyang FIR RVSM Risk Estimate Trends

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

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

b) discuss any relevant matters as appropriate;

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ATTACHMENT A

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF CHINESE FLIGHT INFORMATION REGIONS JANUARY 2014 - DECEMBER 2014

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 2014 - December 2014. 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 2014 - December 2014. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Chinese RVSM airspace in Dec 2014 is above 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 2014 - December 2014 in the China RMA's ongoing process of providing periodic updates of information relevant to the continued safe use of the RVSM in in the airspace of Chinese FIRs. China RMA produces one report 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 2014 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	Automatic system	Received	Data completed
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	Manual	Received	Data completed
Lanzhou	ZLHW	Lanzhou	Automatic system	Received	Data completed
		Xian	Automatic system	Received	Data completed
Urumqi	ZWUQ	Urumqi	Automatic system	Received	Data completed
Kunming	ZPKM	Kunming	-	-	Included in Chengdu ACC
		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 2014 in the Airspace of Chinese FIRs

It should be noted that Zhengzhou ACC was transferred to North China regional ATMB, and the data collection for Zhengzhou ACC is now from Beijing.

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 2014 - December 2014. **Table 2** provides the summary of LHD reports submitted by each FIR.

FIR Name	Beijing	Shanghai	Guangzhou	Wuhan	Shenyang	Lanzhou	Urumqi	Kunming	Sanya
Jan-14	X	X	X	X	X	X	X	X	X
Feb-14	X	X	X	X	X	X	X	X	X
Mar-14	X	X	X	X	X	X	X	X	X
Apr-14	X	X	X	X	X	X	X	X	X
May-14	X	X	X	X	X	X	X	X	X
Jun-14	X	X	X	X	X	X	X	X	X
Jul-14	X	X	X	X	X	X	X	X	X
Aug-14	X	X	X	X	X	X	X	X	X
Sep-14	X	X	X	X	X	X	X	X	X
Oct-14	X	X	X	X	X	X	X	X	X
Nov-14	X	X	X	X	X	X	X	X	X
Dec-14	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 2014 and December 2014 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 2014 and December 2014:

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)	No. of flight levels transitioned without clearance
Jan-14	5	1.25	0
Feb-14	13	4.25	4
Mar-14	3	0.25	1
Apr-14	7	1.6	0
May-14	7	3.1	2
Jun-14	4	0.25	1
Jul-14	7	0.5	2
Aug-14	12	6	7
Sep-14	14	2.5	0
Oct-14	9	0.75	1
Nov-14	2	0.03	0
Dec-14	20	36.25	8
Total	103	56.73	26

Table 3: Summary of non-nil LHDs in Chinese FIRs between January 2014 and December 2014

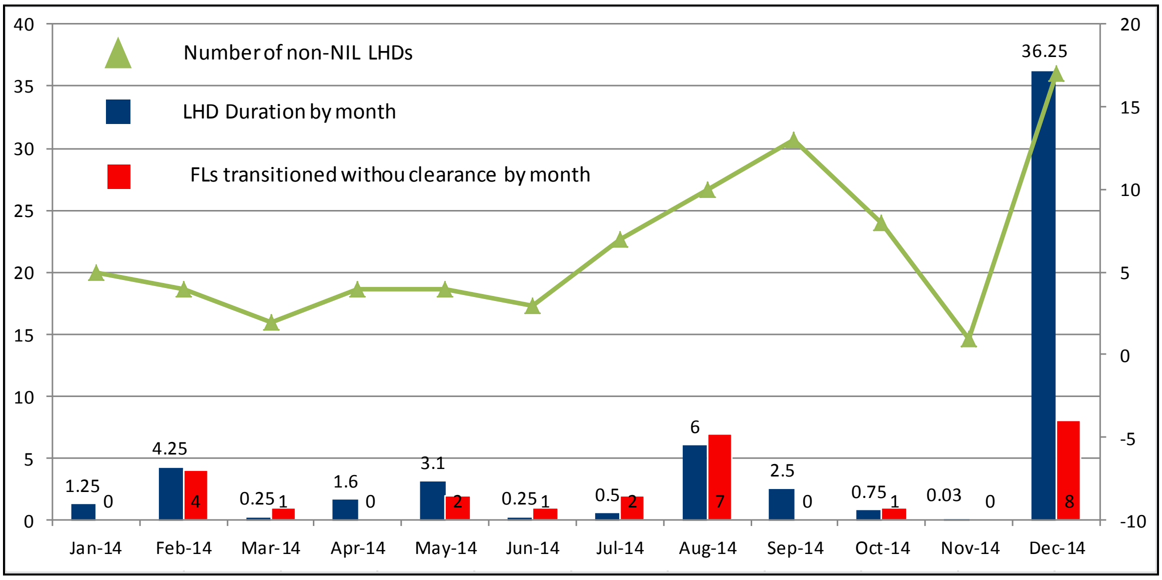

Figure 1: Illustrations of non-nil LHDs in Chinese FIRs during the reporting period

3.3. **Figure 2** and **Figure 3** summarize the number and ratio of non-nil LHDs that China RMA received during the reporting period according to the data sources.

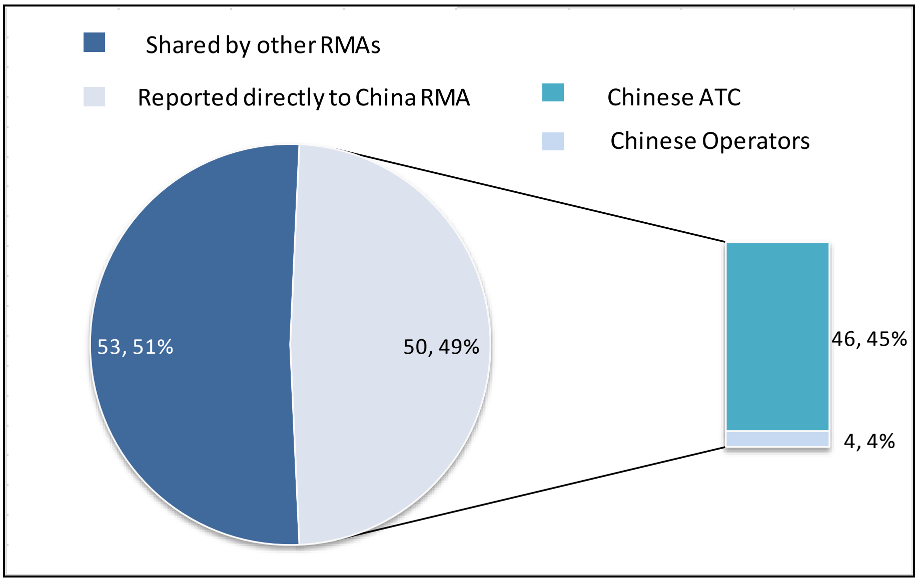

Figure 2: Breakdown of events reported directly to China RMA according to data sources

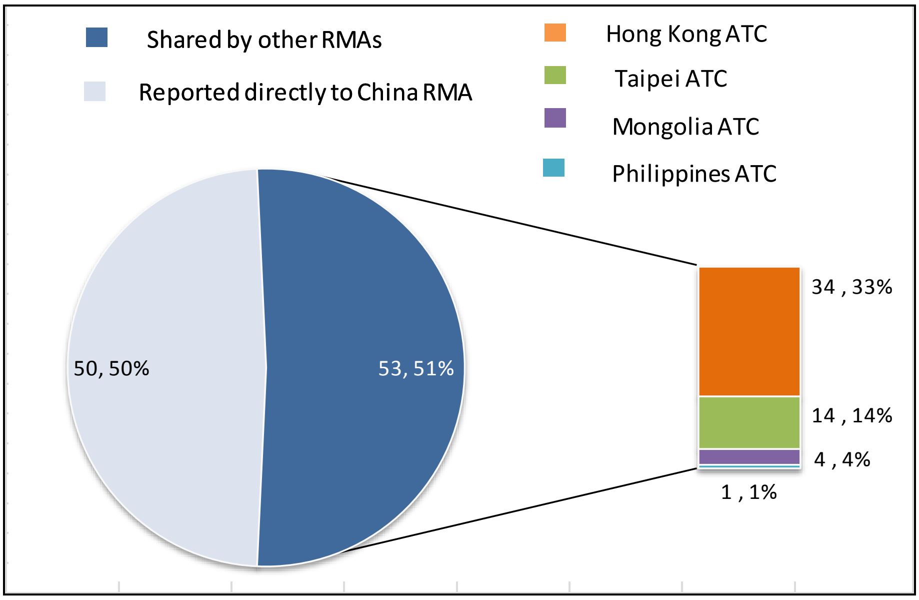

Figure 3: Breakdown of events shared by other RMAs according to data sources

3.4. The large height deviation reports are separated by categories based on the details provided for each event. **Table 4**, **Figure 4** and **Figure 5** summarize the number of LHD occurrences 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;	4	0	4
B	Flight crew climbing/descending without ATC Clearance	1	0	2
D	ATC system loop error	2	0	2
E	ATC transfer of control coordination errors due to human factors	70	20.7	0

LHD Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. of flight levels transitioned without clearance
F	ATC transfer of control coordination errors due to technical issues	12	10	0
G	Aircraft contingency leading to sudden inability to maintain level	2	0	6
H	Airborne equipment failure and unintentional or undetected level change	1	0	1
I	Turbulence or other weather related causes;	6	0.03	7
J	TCAS resolution advisory and flight crew correctly responds	3	0	3
M	Other	2	26	1
Total		103	56.73	26

Table 4: Summary of LHD Categories in the Airspace of Chinese FIRs

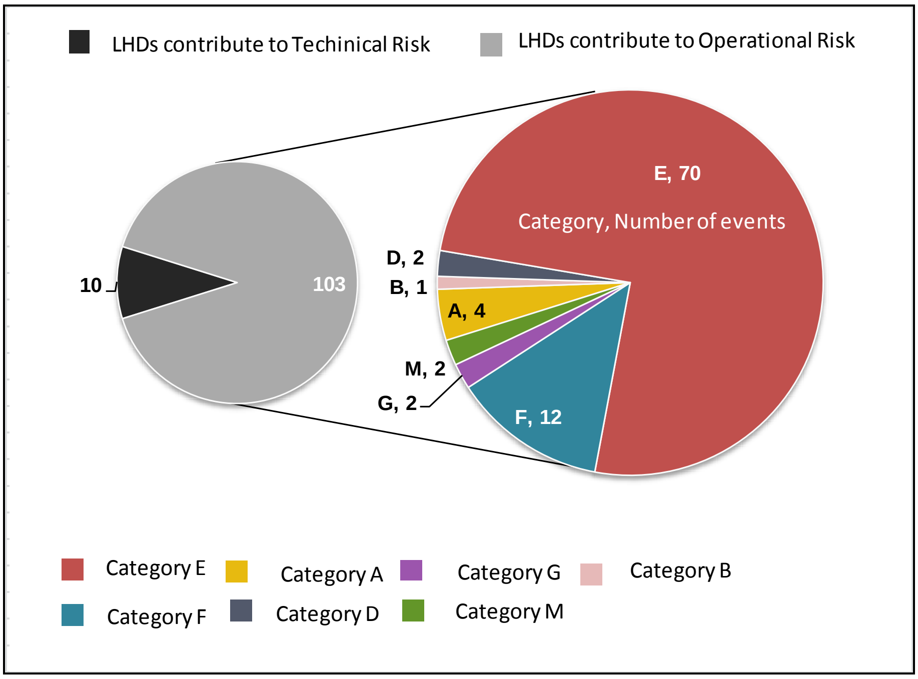

Figure 4: Breakdown of operation risk contributors (Category and Number of events)

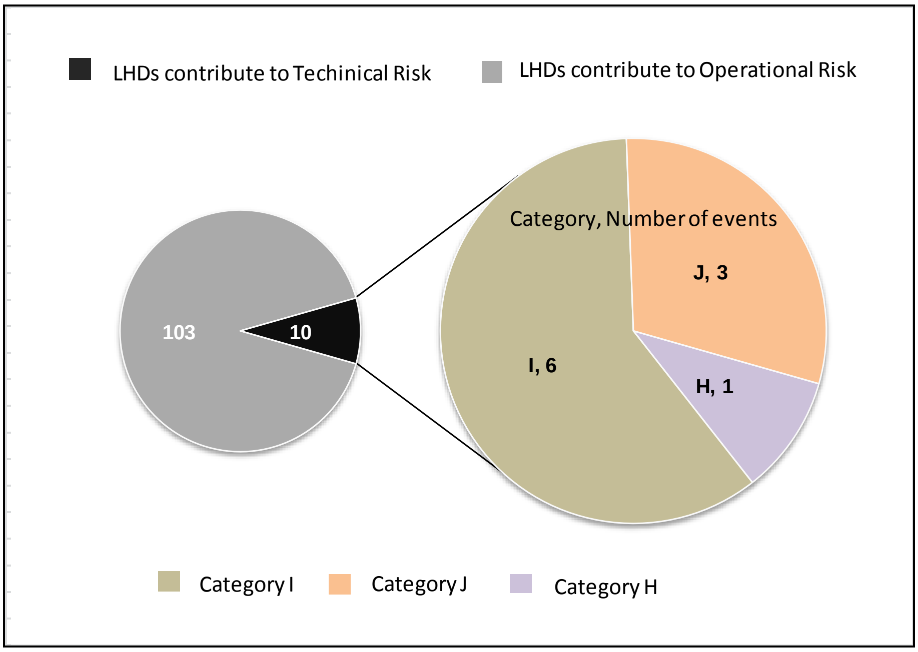

Figure 5: Breakdown of technical risk contributors (Category and Number of events)

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 hot spot of LHDs in the reporting period.
In light of the above, the LHD occurrences in the China RVSM airspace are summarized as follows:

- There were 103 reported large height deviations (56.73 min duration/26 levels crossed without clearance) during the reporting period. The number and duration are increasing compared to last year.
- Among the 103 LHDs reported, 53 events were shared by other RMAs (MAAR), 4 events were reported by Chinese operators and 46 were reported by Chinese ATC. Among the 53 events from MAAR, 34 events were reported by Hong Kong ATC, 14 by Taipei ATC, 4 by Mongolia ATC and 1 by Philippines ATC. It is noticeable that the LHDs from other MAAR were caused by ATC coordination errors but these events were not reported by domestic ATC, especially a number of Category E error events. China RMA submitted a report to ATMB, CAAC to raise the relevant ATCs' attention and call to action.
- It is presented that the number of Category E errors accounted a large portion of the operational risk events. The number of category F events reported is increasing. The increase is likely due to 1) the LHDs share from other RMAs 2) the actions taken by China RMA to increase the awareness of controllers on coordination errors.
- 'PURPA' (near China – Pakistan borders) continues to be a main hot spot. China RMA submitted a paper to RASMAG/20 to present the coordination made and the progress of China and Pakistan improving the communication and surveillance status in this area.
- Some new hot spots appeared near South China Sea are transfer-of-control points. Most of these LHDs are due to coordination errors. The concerns were raised by ATMB, CAAC and actions were taken to inform relevant Chinese ATCs to investigate and take actions. China RMA will continue to track the changes of LHD reporting in this area and report updates to relevant parties.
- The obvious high risk in December was the result of a Category M LHD which was the result of a failure to establish communication between controller and pilot. The duration of the occurrence was assessed as 26 minutes.

  In 2014, China RMA conducted an intensive investigation into the causes leading to lack of LHD reporting, especially for the lack of LHDs that do not have 'actual deviation' (for instance, coordination errors due to operational/technical reasons, unable to establish communication between controller and pilot, etc.). China RMA submitted a separate paper to RASMAG/20 to present the relevant progress. In the second half of 2014, China RMA took actions to improve LHD reporting in China by holding LHD workshops in all regional ATMBs, updating training materials and simplifying the LHD reporting template. It is found that the situation is improving. It is noticeable that the number of reported ATC coordination errors events (operational/technical) is increasing, and also the events due to failure of air-ground communication started to be reported. China RMA will continue to track the LHD reporting situation and provide active feedback to ICAO, ATMB CAAC and relevant ATCs.

3.5. In 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 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 in December was the result of a Category M LHD which was the result of a failure to establish communication between controller and pilot. The duration of the occurrence was assessed as 26 minutes. Figure 7 shows that the numbers of Category E and F events are increasing. The increase is likely due to 1) the LHDs share from other RMAs 2) the actions taken by China RMA to increase the awareness of controllers on coordination errors.

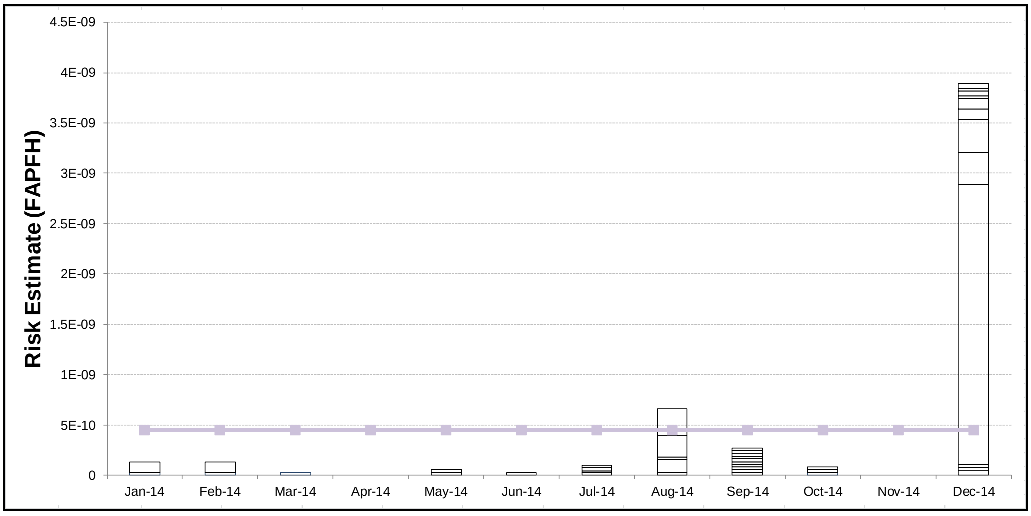

Figure 6: Monthly Assessed Risk Demonstrating the Individual Event Contribution

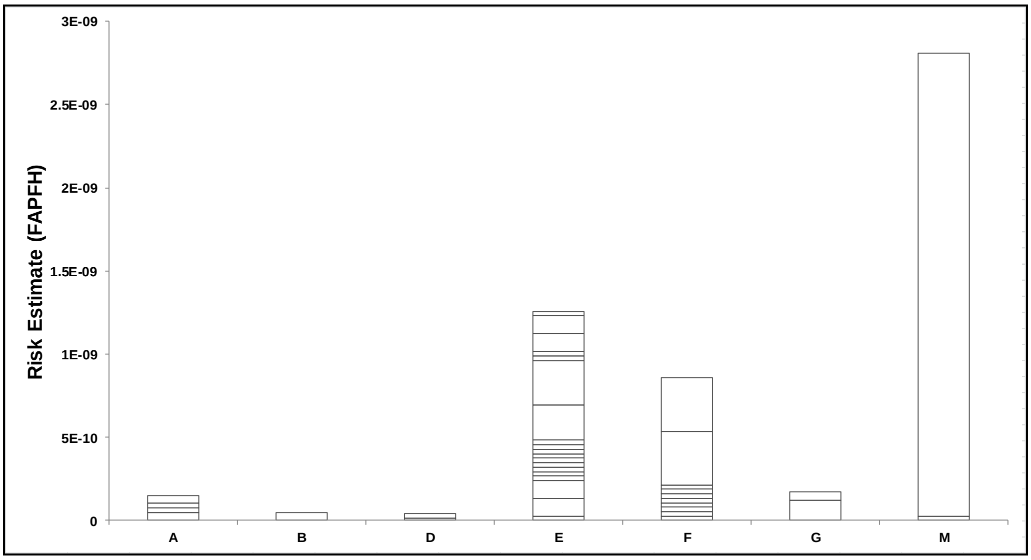

Figure 7: Operational Risk Estimate by Categories Demonstrating the Individual Event Contribution

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 2014, the continuous LHD reports in the airspace of Chinese FIRs between January 2014 and December 2014 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 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

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
$\lvert\dot{z}\rvert$	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	2124690.6	Annual flight hours
E_z(same)	0.0649	Same-direction vertical occupancies
E_z(opposite)	0.1813	Opposite-direction vertical occupancies
Crossing pairs	3331512	Annual estimate of crossing pairs in crossing route
$\overline{\lvert\Delta V\rvert}$	48.42	Average relative along-track speed between aircraft on same direction routes
$\overline{\lvert V\rvert}$	452.65	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 2014.

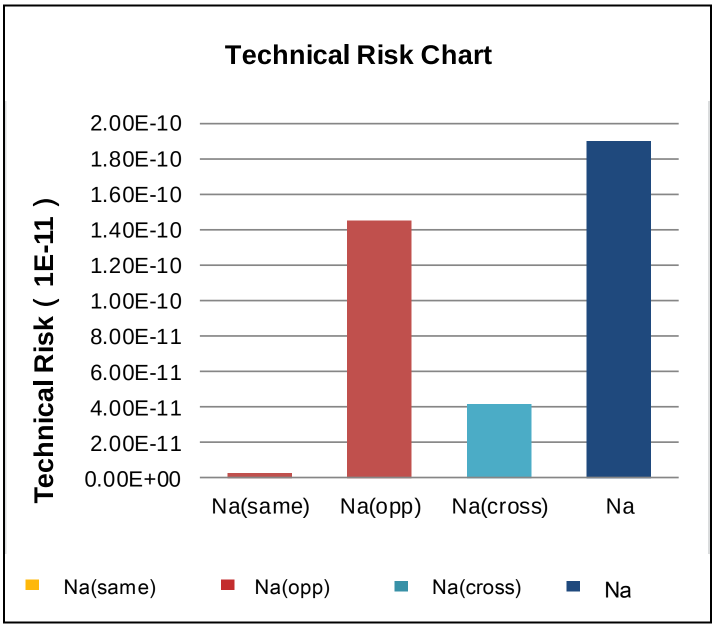

Figure 8: Technical Risk Bar Chart computed by the TSD collected in December, 2014

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 0.19 x 10^{-9} fapfh. The operational risk estimate is 5.31 x 10^{-9} fapfh. The estimate of the overall vertical collision risk is 5.50 x 10^{-9} fapfh, which is above the overall TLS value of 5 x 10^{-9} fapfh.

The RVSM Airspace of Chinese FIRs – estimated annual flying hours = 2124690.6 hours *(note: estimated hours based on Dec 2014 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.1899 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	5.31 x 10^{-9}	-	-
Total Risk	**5.50 x 10^{-9}**	5.0 x 10^{-9}	**Above 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 since January 2014

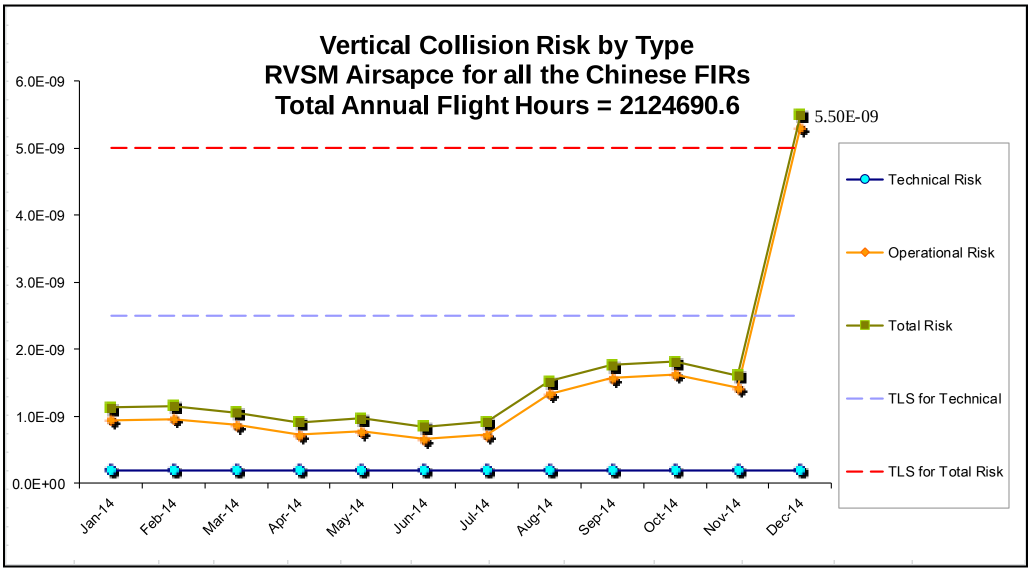

Figure 9: Trends of Risk Estimates for the Airspace of Chinese FIRs

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 2.5×10^{-9}, but the total risk in Dec 2014 is above the TSL value which is 5.0×10^{-9} fapfh.

Appendix A Detail of LHDs inside China RMA's responsible area in 2014

EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
15/Jan/14	MAAR/Hong Kong ATC	IKELA	1		Flight FL revision was not passed	E
25/Jan/14	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E
27/Jan/14	MAAR/Hong Kong ATC	DOTMI	0		No FL revision	E
30/Jan/14	MAAR/Hong Kong ATC	DOTMI	0		No FL revision	E
1/Feb/14	MAAR/Taipei ATC	OLDID	0		Wrong transfer FL received	E
3/Feb/14	MAAR/Hong Kong ATC	IKELA	0		No FL revision	E
5/Feb/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
6/Feb/14	Guangzhou ACC	South of WHA	0	1	TCAS RA alert, Pilot correctly following the resolution advisory	J
6/Feb/14	Guangzhou ACC	South of WHA	0	1	TCAS RA alert, Pilot correctly following the resolution advisory	J
8/Feb/14	Guangzhou ACC	DOTMI	0	1	Pilot failing to climb the aircraft as cleared	A
20/Feb/14	Guangzhou ACC	ZK	0	1	TCAS RA alert, Pilot correctly following the resolution advisory	J
5/Mar/14	Urumqi ACC	RULAD	0.25		Transferred wrong FL or forgot to revise altitude.	E
14/Mar/14	MAAR/Taipei ATC	KASKA	0		No transfer	E
28/Mar/14	Xiamen Airlines	Near P48	0	1	Turbulence	I
3/Apr/14	MAAR/Hong Kong ATC	TAMOT	0		No FL revision	E
9/Apr/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude.	E
11/Apr/14	MAAR/Hong Kong ATC	DOTMI	0		No FL revision	E
11/Apr/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude.	E
1/May/14	MAAR/Philippines ATC	MIGUG	1		No FL revision	E

EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
4/May/14	MAAR/Hong Kong ATC	A470	0		Late transfer	E
6/May/14	Urumqi ACC	PURPA	0.25		No transfer	E
9/May/14	Lanzhou ACC	JTA	0	2	Turbulence	I
28/May/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
5/Jun/14	Lanzhou ACC	ATBUG	0	1	Turbulence	I
12/Jun/14	MAAR/Hong Kong ATC	IKELA	0		Late transfer	E
23/Jun/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
24/Jun/14	MAAR/Taipei ATC	SULEM	0		No transfer	E
3/Jul/14	MAAR/Hong Kong ATC	TAMOT	0		Wrong transfer FL received	E
9/Jul/14	Urumqi ACC	PURPA	0.25		No transfer	E
9/Jul/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude.	E
12/Jul/14	MAAR/Taipei ATC	SULEM	0		No transfer	E
16/Jul/14	Beijing ACC	P295	0	1	ATC issues incorrect clearance and result in a loss of separation.	D
16/Jul/14	Beijing ACC	Near P295	0	1	ATC issues incorrect clearance and result in a loss of separation.	D
24/Jul/14	Urumqi ACC	SARIN	0.25		Wrong transfer FL received	E
6/Aug/14	MAAR/Hong Kong ATC	TAMOT	0		Late time revision	E
10/Aug/14	Urumqi ACC	NUKTI	0	2	Turbulence	I
12/Aug/14	MAAR/Hong Kong ATC	DOTMI	0		No transfer	E
14/Aug/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude	E
14/Aug/14	MAAR/Hong Kong ATC	DOTMI	0		No transfer	E
16/Aug/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
22/Aug/14	Guizhou ACC	ASH	0	5	TCAS equipment outage	G
22/Aug/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E

EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
25/Aug/14	Lanzhou ACC	BUNTA	2		Wrong transfer FL received	E
30/Aug/14	Lanzhou ACC	IKELA	2.5		Wrong transfer FL received	E
31/Aug/14	MAAR/Hong Kong ATC	IKELA	0		No FL revision	E
4/Sep/14	MAAR/Hong Kong ATC	TAMOT	0		No transfer	E
12/Sep/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
16/Sep/14	MAAR/Hong Kong ATC	DOTMI	0		No transfer	E
21/Sep/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
23/Sep/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude	E
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
28/Sep/14	Urumqi ACC	PURPA	0.25		Communication system outage	F
3/Oct/14	Urumqi ACC	SARIN	0		Wrong transfer FL received	E
7/Oct/14	Urumqi ACC	PURPA	0		Wrong transfer FL received	E
7/Oct/14	MAAR/Hong Kong ATC	DOSUT	0		No FL revision	E
10/Oct/14	MAAR/Hong Kong ATC	SIKOU	0		Late transfer	E
11/Oct/14	MAAR/Hong Kong ATC	DOTMI	0		Late transfer	E
13/Oct/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude	E
17/Oct/14	MAAR/Taipei ATC	SULEM	0		Transferred wrong FL or forgot to revise altitude	E
20/Oct/14	Urumqi ACC	PURPA	0		Wrong transfer FL received	E
28/Oct/14	Spring Airlines	ASADA	0	1	Turbulence	I

EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
		AGPOR				
24/Nov/14	MAAR/Taipei ATC	KASKA	0		Transferred wrong FL or forgot to revise altitude	E
27/Nov/14	Zhan Jiang ATC	BIGRO-LH	0.03		Turbulence	I
2/Dec/14	MAAR/Taipei ATC	SULEM	0		Transferred wrong FL or forgot to revise altitude	E
4/Dec/14	MAAR/Hong Kong ATC	IKELA	0		Late transfer	F
7/Dec/14	MAAR/Taipei ATC	DOSUT	0	2	Pilot descent without clearance	B
9/Dec/14	Lanzhou ACC	VISIN	0	1	Airborne equipment failure lead to RVSM inability	M
9/Dec/14	MAAR/Hong Kong ATC	SIKOU	0		Late transfer	E
10/Dec/14	Urumqi ACC	POSOT	0	1	Pilot failing to climb the aircraft as cleared	A
10/Dec/14	Dalian ATC	NODAL	26		Pilot was unable to establish normal air-ground communications with the responsible ATS unit.	M
11/Dec/14	MAAR/Hong Kong ATC	IKELA	0		No FL revision	E
13/Dec/14	MAAR/Hong Kong ATC	DOTMI	0		Late transfer	E
14/Dec/14	Lanzhou ACC	OMBON	3		Coordination errors as a result of equipment outage	F
14/Dec/14	Lanzhou ACC	OMBON	3		Coordination errors as a result of equipment outage	F
15/Dec/14	Xi'an ACC	P178	1		No Transfer	E
15/Dec/14	Xi'an ACC	APOGO	1		Transferred wrong FL or forgot to revise altitude	E
21/Dec/14	Urumqi ACC	PURPA	0.25		Wrong transfer FL received	E
21/Dec/14	Yangze River Express Airlines	b221	0	1	Auto-pilot equipment outage	H
21/Dec/14	Yangze River Express Airlines		0	1	Auto-pilot equipment outage	G
23/Dec/14	Guangzhou ACC	GYA	0	1	Pilot failing to descend the aircraft as cleared	A

EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
27/Dec/14	Beijing ACC	HET	0	1	Pilot failing to climb the aircraft as cleared	A

Appendix B Detail of LHDs outside China RMA's responsible area in 2014

EVENT DATE	SOURCE	LOCATION	DURATION (Min)	FLs TRANSITIONED WITHOUT CLEARANCE	CAUSE	CODE
2/Feb/14	MAAR/Hong Kong ATC	DOTMI	1		No FL revision	E
14/Feb/14	MAAR/Hong Kong ATC	IKELA	0		Late FL revision	E
14/Feb/14	MAAR/Hong Kong ATC	DOTMI	1		Late FL revision	E
15/Feb/14	MAAR/Hong Kong ATC	DOTMI	0		Late transfer	E
20/Feb/14	MAAR/Hong Kong ATC	TAMOT	1		No transfer	E
24/Feb/14	MAAR/Hong Kong ATC	TAMOT	1		Wrong transfer FL received	E
12/Apr/14	MAAR/Hong Kong ATC	DOTMI	0		Late transfer	E
23/Apr/14	MAAR/Mongolia ATC	NIXAL	0.8		No FL revision	E
25/Apr/14	MAAR/Mongolia ATC	NIXAL	0.8		No FL revision	E
23/May/14	MAAR/Mongolia ATC	NIXAL	0.8		No FL revision	E
23/May/14	MAAR/Mongolia ATC	NIXAL	0.8		No FL revision	E
3/Aug/14	MAAR/Hong Kong ATC	DOTMI	1		No FL revision	E
12/Sep/14	MAAR/Hong Kong ATC	EPKAL	0		No FL revision	E
4/Dec/14	MAAR/Hong Kong ATC	DOSUT	2		Late transfer	F
14/Dec/14	MAAR/Hong Kong ATC	IKELA	0		Late FL revision	E

Appendix C LHD Hot Spots reported by China RMA in 2014

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

Figure 10. Chinese FIRs – Risk Bearing (Non-NIL) RVSM Large Height Deviations
January 2014 – December 2014

ATTACHMENT B

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF PYONGYANG FLIGHT INFORMATION REGION JANUARY 2014 - DECEMBER 2014

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 2014 - December 2014. 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 5.0×10^{-9} fapfh, a value well within that range agreed internationally as "safe".

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 2014 - December 2014 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 2014 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 2014 in the DPR Korea's RVSM Airspace

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

2.3.1. Monitoring of large height deviations has been continuous in Pyongyang FIR since 2009, with the criterion to identify a large height deviation set at 300 ft in magnitude. DPR Korea has had knowledge about the concept of large height deviation and continued to collect records of traffic movements and large height deviations from Pyongyang FIR. To date, all LHD reports for the airspace of Pyongyang FIR are NIL reports.

2.3.2. China RMA used to make a conservative estimate for the operational risk for Pyongyang FIR by applying the operational risk of Chinese FIRs as a substitute. But in 2014, the risk of Chinese FIRs is above TLS. It is not rational to still apply this value to Pyongyang FIR considering the relatively small number of flying hours. So in this report, China RMA estimated the operational risk for Pyongyang FIR by considering actual LHD reporting situation in this area.

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

3.1. The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) continued to be met in the RVSM airspace of DPR Korea, thus supporting the ongoing safe application of RVSM.

3.2. This section updates the results of safety oversight for the RVSM implementation in DPRK's airspace, which was fully implemented in November 2009. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of implementing the RVSM in the airspace of Pyongyang FIR. Since there were no reports of operational error in the reporting period, the December 2014 operational risk value is 0.0 x 10^{-9} fapfh.

3.3. The TSD of December 2014 and the LHD data are used to produce the risk estimates presented in this report.

3.4. Estimate of the CRM parameters

3.4.1. **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	0.5380	Conservative value used in NAT,

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
	(with planned vertical separation equal to zero)		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
$\overline{\lvert \dot{h}(\theta) \rvert}$	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	4 knots	Value specified in ICAO Doc. 9574
$\lvert \bar{\dot{z}} \rvert$	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	0.03162	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

3.4.2. **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	5012.6	Annual flight hours
E_z(same)	0.000261	Same-direction vertical occupancies
E_z(opposite)	0.0172	Opposite-direction vertical occupancies
Crossing pairs	408	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
$\overline{\lvert V \rvert}$	445.86	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 0.207 x 10^{-9} fapfh. The operational risk estimate is 0.00 x10^{-9} fapfh. The estimate of the overall vertical collision risk is 0.207 x 10^{-9} fapfh, which satisfies the globally agreed TLS value of 5 x 10^{-9} fapfh.

RVSM Airspace of DPR Korea – estimated annual flying hours = 5012.6hours *(note: estimated hours based on the December 2014 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	0.207 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	0. 00 x 10^{-9}	-	-
Total Risk	0.207 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 since December 2014.

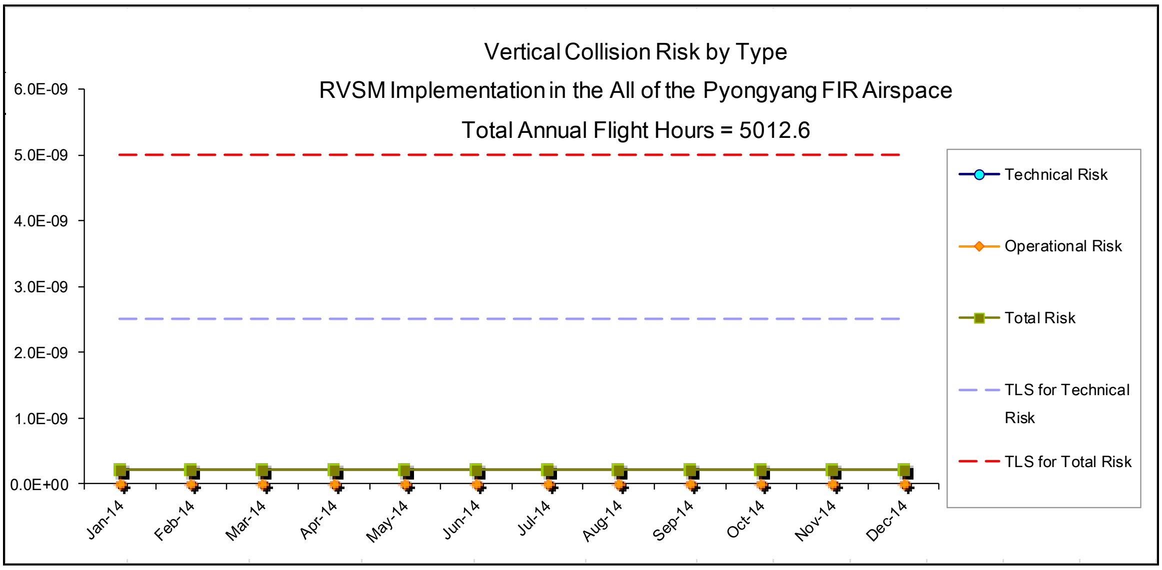

Figure 1: Trends of Risk Estimates for the RVSM Implementation in the Airspace of DPR Korea

4.3. Therefore, the estimates of both technical and total risks 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.