International Civil Aviation Organization

The Sixteenth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/16)

Bangkok, Thailand, 20 – 24 February 2011

Agenda Item 3: Reports from Asia/Pacific RMAs

SAFETY MONITORING REPORT FROM CHINA REGIONAL MONITORING AGENCY DECEMBER 2010 - NOVEMBER 2011

(Presented by the China RMA)

SUMMARY

This paper provides 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 1 December 2010 to 30 November 2011. 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 twice 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 and Pyongyang FIR of DPR Korea for the time period of 1 December 2010 - 30 November 2011, as given separately in Attachment A and B. The analysis conducted is based on one-month traffic sample data (TSD) collected in December 2010 and the latest 12-month Large Height Deviation (LHD) reports. The estimates of technical and total risks for the airspace of both Chinese FIRs and Pyongyang FIR of DPR Korea satisfy the agreed TLS value of no more than 2.5×10^{-9} and 5.0×10^{-9} fatal accidents per flight hour.

3. ACTION BY THE MEETING

3.1. The meeting is invited to note the results of the airspace safety oversight presented in the attachment to this working paper.

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ATTACHMENT A

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF CHINESE FLIGHT INFORMATION REGIONS DECEMBER 2010 - NOVEMBER 2011

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

February, 2012

SUMMARY

This report presents the airspace safety oversight from China Regional Monitoring Agency for the time period 1 December 2011 - 30 November 2011. 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 1 December 2010 - 30 November 2011. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Chinese RVSM airspace is below the target level of safety (TLS) value of 5.0 x 10^{-9} fatal accidents per flight hour, 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 Chinese FIRs.

1.2 This report covers the current reporting period 1 December 2010 - 30 November 2011 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 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 Submission

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 2010 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
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
		Zhengzhou	Automatic system	Received	Data completed
Shenyang	ZYSH	Shenyang	Automatic system	Received	Data completed
		Dalian	Manual	Received	Data completed
		Harbin	Manual	Received	Data completed
		Hailar	Manual	Received	Data completed
Lanzhou	ZLHW	Lanzhou	Manual	Received	Data completed
		Xian	Automatic system	Received	Data completed
Urumqi	ZWUQ	Urumqi	Manual	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 2010 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 December 2010 - November 2011. Table 2 provides the summary of LHD reports submitted by each FIR.

FIR Name	**Beijing**	**Shanghai**	**Guangzhou**	**Wuhan**	**Shenyang**	**Lanzhou**	**Urumqi**	**Kunming**	**Sanya**
2010-05	X	X	X	X	X	X	X	X	X
2010-06	X	X	X	X	X	X	X	X	X
2010-07	X	X	X	X	X	X	X	X	X
2010-08	X	X	X	X	X	X	X	X	X
2010-09	X	X	X	X	X	X	X	X	X
2010-10	X	X	X	X	X	X	X	X	X
2010-11	X	X	X	X	X	X	X	X	X
2010-12	X	X	X	X	X	X	X	X	X
2011-01	X	X	X	X	X	X	X	X	X
2011-02	X	X	X	X	X	X	X	X	X
2011-03	X	X	X	X	X	X	X	X	X
2011-04	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 December 2010 and November 2011 in the airspace of Chinese FIRs are summarized as follows:

3.2. Table 3, Figure 1 and Figure 2 summarize the number of LHD occurrences, associated non-NIL LHD durations (in minutes) and the number of flight levels transitioned without clearance by month in the airspace of Chinese FIRs:

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)	No. of flight levels transitioned without clearance
Dec-10	0	0	0
Jan-11	2	10.1	2
Feb-11	0	0	0
Mar-11	3	4	0
Apr-11	7	0.7	8
May-11	1	0	1
Jun-11	3	0.25	10
Jul-11	2	0	2
Aug-11	1	2	0
Sep-11	0	0	0
Oct-11	7	3.15	0
Nov-11	6	0.5	4
Total	32	20.7	27

Table 3**:** Summary of LHD Occurrences in the Airspace of Chinese FIRs

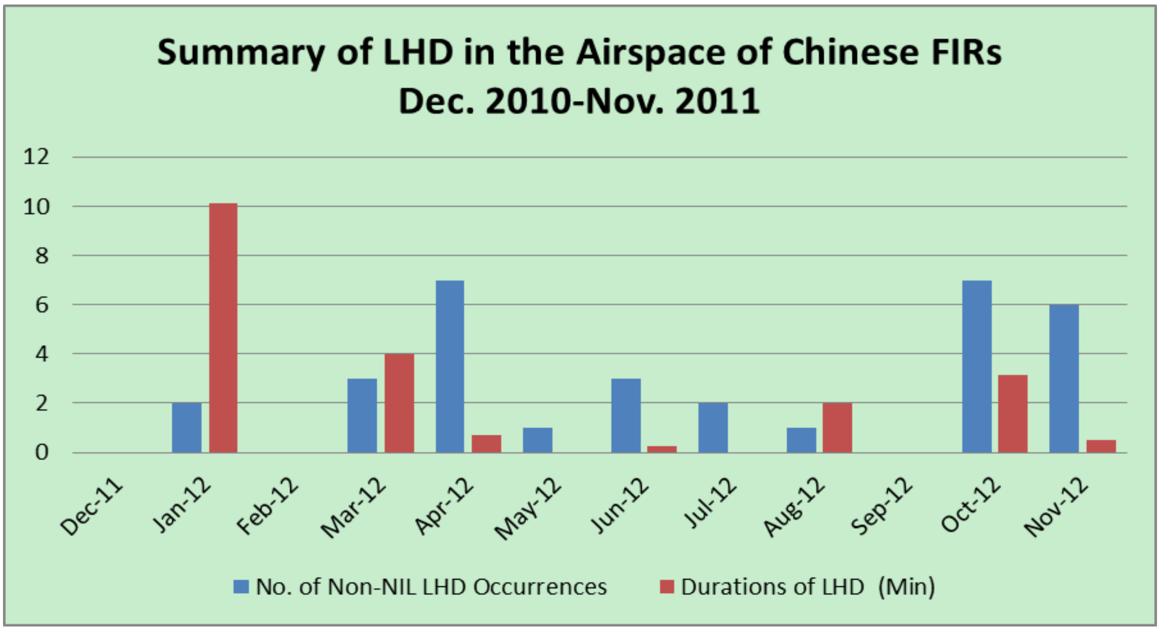

Figure 1: Summary of LHD in the Airspace of Chinese FIRs

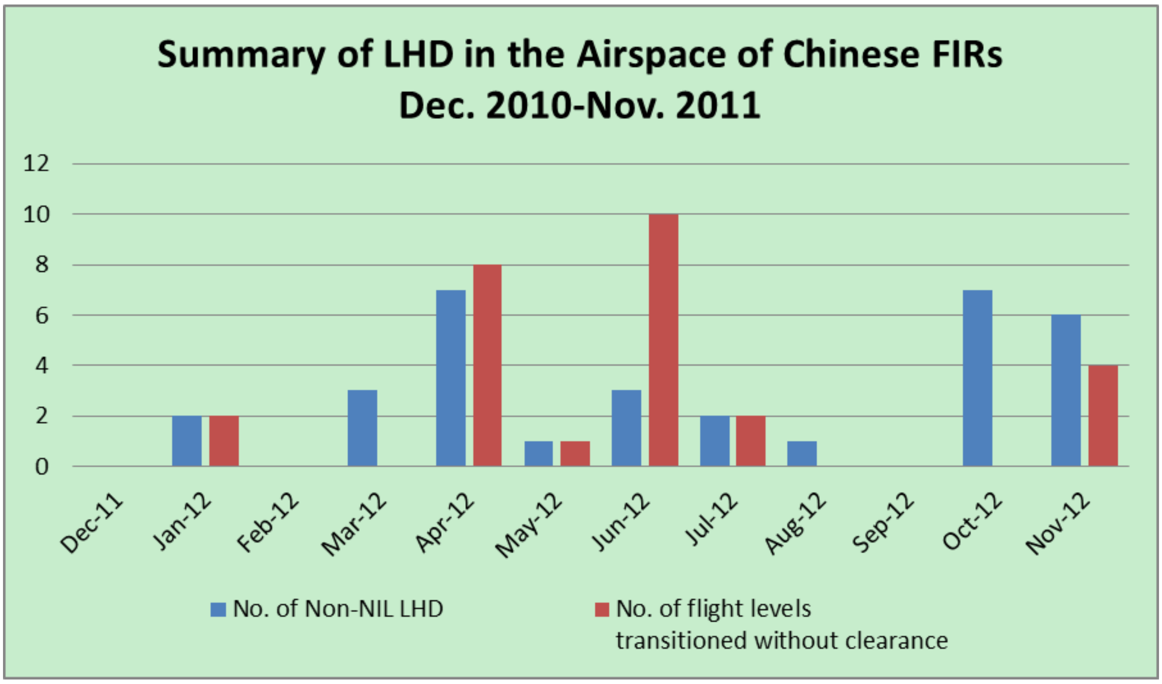

Figure 2: Summary of LHD (No. of flight levels transitioned without clearance) in the Airspace of Chinese FIRs

3.3. The large height deviation reports are separated by categories based on the details provided for each deviation. Table 4, Figure 3 and Figure 4 summarize the number of Non-NIL LHD occurrences by cause of the deviation.

LHD Category 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	10	4
C	Incorrect operation or interpretation of airborne equipment (e.g. incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed instead of re-clearances etc);	3	0.27	3
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);	3	0	3
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters);	10	4.65	0
G	Aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure);	1	0	9
I	Turbulence or other weather related causes;	5	2.65	4
J	TCAS resolution advisory; flight crew correctly following the resolution advisory;	6	3.13	4

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. of flight levels transitioned without clearance
Total (December 2010 - November 2011)		32	20.7	27

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

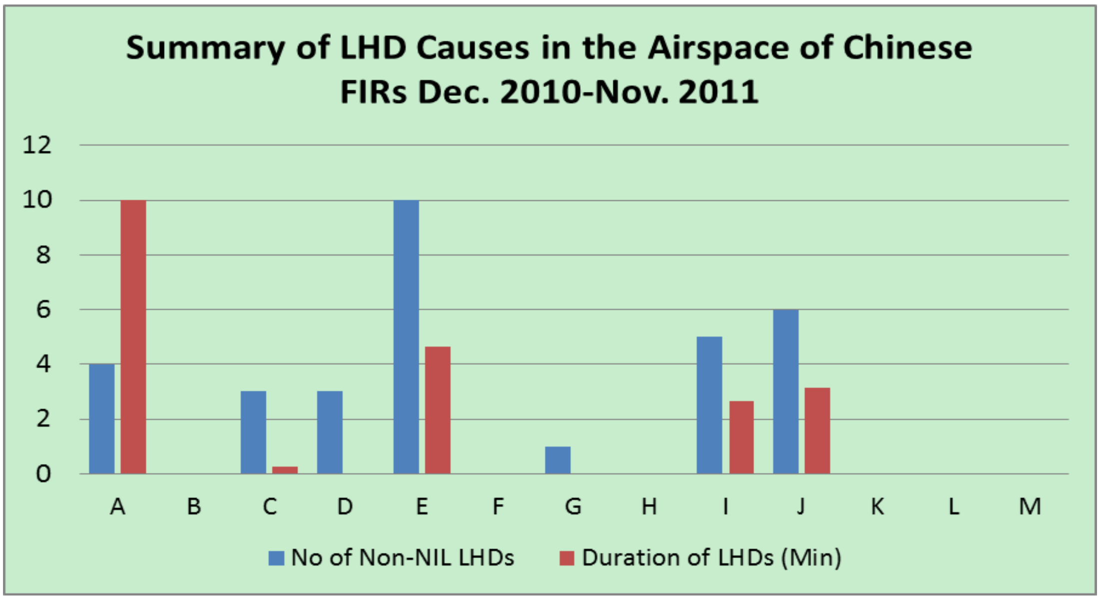

Figure 3: Summary of LHD Causes in the Airspace of Chinese FIRs

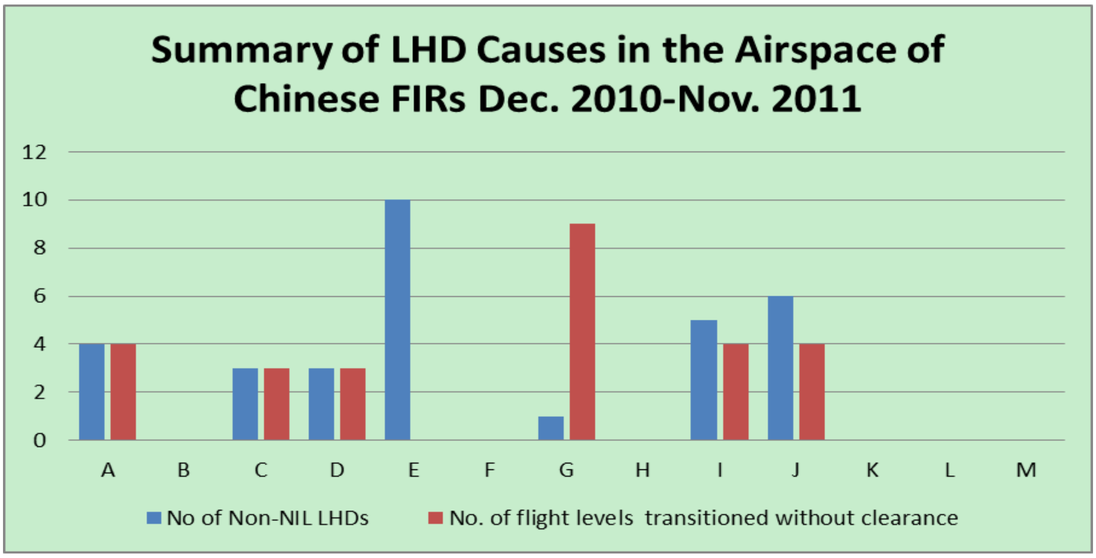

Figure 4: Summary of LHD Causes (No. of flight levels transitioned without clearance) in the Airspace of Chinese FIRs

LHD Analysis and Safety treatment of identified LHDs

The safety assessment process include a detailed review of specific operational errors by RMA members and participants from ANSPs, ATC departments and operators with a view to identifying contributory factors and ensuring procedures and processes are implemented to reduce the likelihood of the same errors recurring.

In light of the above, the LHD occurrences in the China RVSM airspace are summarized as follow:

- There were thirty (32) reported non-NIL large height deviations during the reporting period. Twenty one (21/14.92 min) of the deviations contributes to operational risk and eleven events (11/5.78 min) contributed to the technical risk.

- The main contributor to the operational risk of Chinese RVSM airspace in this reporting period is flight crew failing to climb/descend the aircraft as cleared (Category A). One event with the duration of ten minutes is the main contributor to the operational risk. In this event, the pilot failed to climb the aircraft as cleared, and the air traffic controller failed to find out until ten minutes later. This event was due to operational errors of both pilot and the air traffic controller.

- This analysis also saw the occurrences of Category E reports increased, and the reporting areas are from the ACCs that have boundaries with neighboring countries (including Russian Federation and Pakistan). The occurrences of incorrect coordination of flight levels from ATC to ATC between China (Harbin ACC) and Russian Federation since October 2011 were attributed to the transition to RVSM system. This phenomenon was seen when China implemented in 2007. The China RMA will continue to pay attention to this situation and suggest proper action if this trend is increasing.

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, which was fully implemented on 22 November 2007. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of implementing the RVSM in this airspace. Each monthly risk estimate was 'weighted' by the factors proportionate to the total number of flight hours in Chinese RVSM airspace flow according to the air traffic control status.

4.3. The TSD of December 2010, the continuous LHD reports in the airspace of Chinese FIRs between December 2010 and November 2011 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

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
$P_z(0)$	Probability of vertical overlap (with planned vertical separation equal to zero)	0.4026	Estimated based on the radar data form from Upper Control Area of Beijing, Guangzhou, Shanghai, August 2008
$P_z(S_z)$	Prob. that 2 aircraft nominally separated by the vertical separation minimum S_z are in vertical overlap.	5.604 x 10^{-9}	
$P_y(0)$	Probability of Lateral Overlap	0.025	Estimated by FAA Technical Center based on the proportion of GPS operations observed in the TSD data collected in China
$P_h(\theta)$	Probability of Horizontal Overlap	6.88 x 10^{-7}	Value used in the Western Pacific/South China Sea safety assessment
$\left\|\overline{\dot{h}(\theta)}\right\|$	Average relative horizontal speed during overlap for aircraft pairs on routes with crossing angle θ (let θ=45°)	367.4 knots	Value used in Western Pacific/South China Sea safety assessment (corresponds to an average aircraft speed of 480 knots)
$\left\|\overline{\dot{y}}\right\|$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	2.8 knots	Estimated by FAA Technical Center based on the proportion of GPS operations observed in the TSD data collected in China
$\left\|\overline{\dot{z}}\right\|$	Average absolute relative vertical speed of an aircraft pair that has lost all vertical separation	1.5 knots	Value used in NAT RVSM safety assessment
λ_x	Average aircraft length	0.02345Nm	Estimated based on the collected 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	**ATC status**	**Parameter**	**Parameter Definition**
T	Radar	2235934	Annual flight hours
	Procedural	406844	
E_z(same)	Radar	0.0255	Same-direction vertical occupancies
	Procedural	0.0206	
E_z(opposite)	Radar	0.1803	Opposite-direction vertical occupancies
	Procedural	0.1827	
Crossing pairs	Radar	2197272	Annual estimate of crossing pairs in crossing route
	Procedural	227952	
$\overline{\lvert\Delta V\rvert}$	Radar	51.4120	Average relative along-track speed between aircraft on same direction routes
	Procedural	57.3425	
$\overline{\lvert V\rvert}$	Radar	443.4629	Average absolute aircraft ground speed
	Procedural	450.5758	

Table 6**:** Estimate of the Parameters based on the collected TSD in separate ATC status

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 5 presents the Technical Risk computed by the TSD collected in December 2010.

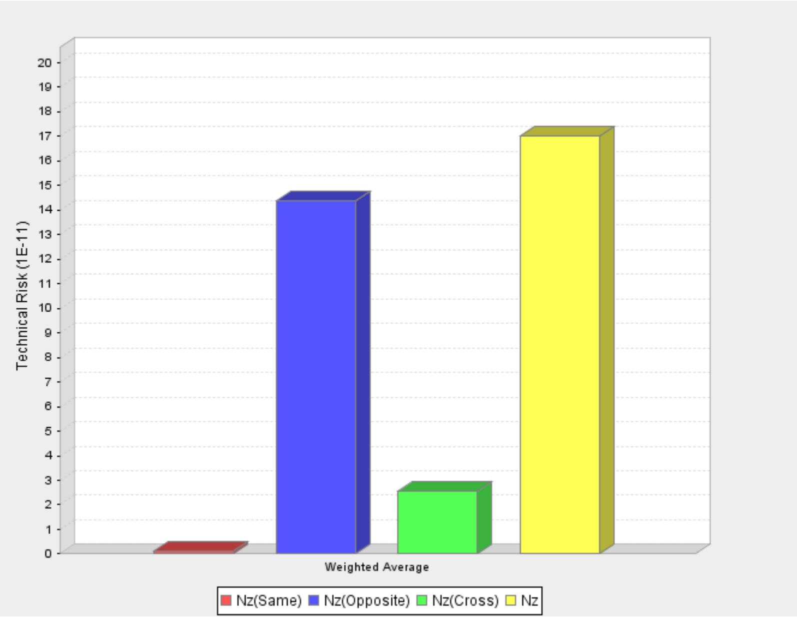

Figure 5: Technical Risk Bar Chart computed by the TSD collected in December, 2010

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 0.170 x 10^{-9}

fatal accidents per flight hour. The operational risk estimate is 1.502 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 1.67 x 10^{-9} fatal accidents per flight hour, which satisfies the globally agreed TLS value of 5 x 10^{-9} fatal accidents per flight hour.

The RVSM Airspace of Chinese FIRs– estimated annual flying hours = 2 642 778 hours *(note: estimated hours based on the December 2010 traffic sample data. Estimate represents the sum of total flying hours for Radar and Procedural control area)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.170 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	1.502 x 10^{-9}	-	-
Total Risk	**1.67 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 6 presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports since December 2010.

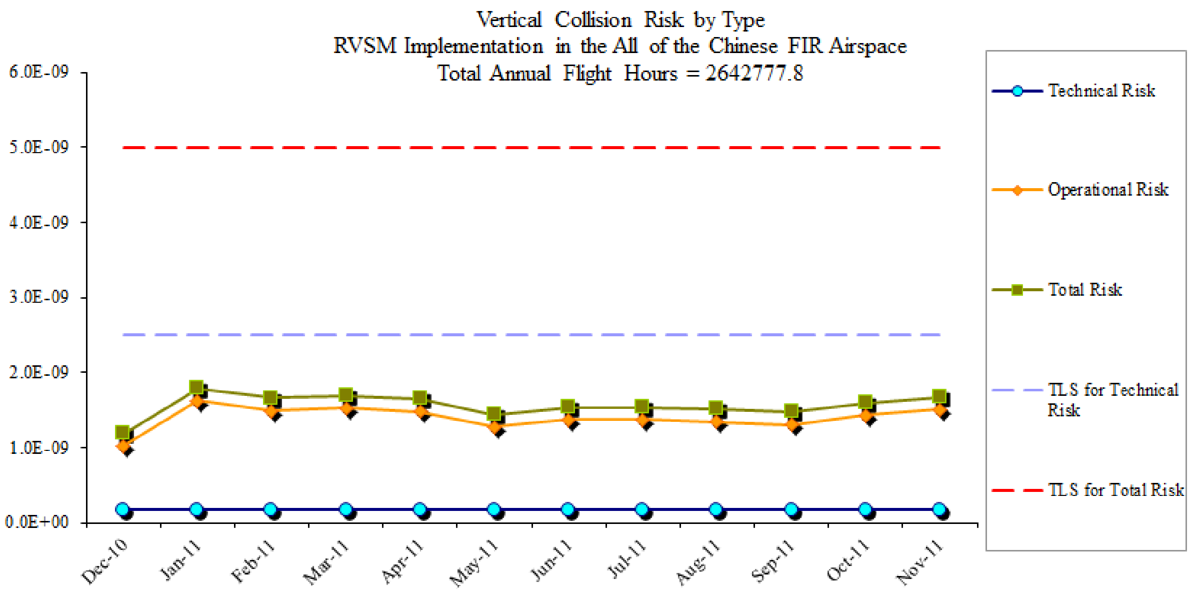

Figure 6: Trends of Risk Estimates for the RVSM Implementation in the Airspace of Chinese FIRs

4.5.4. Based on these collision risk estimates, both the estimates of 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} fatal accidents per flight hour.

ATTACHMENT B

AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN THE AIRSPACE OF PYONGYANG FLIGHT INFORMATION REGION DECEMBER 2010 - NOVEMBER 2011

Presented by

中国地区监控组织
CHINA REGIONAL MONITORING AGENCY

February 2011

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 1 December 2011 - 30 November 2011. 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} fatal accidents per flight hour, 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 1 December 2011 - 30 November 2011 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 two reports 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 2010 for the RVSM airspace of DPR Korea were used in the assessment of risk. Table 8 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	Manual	Received	Data completed

Table 8: Summary of Traffic Data of December 2010 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, there has been no report of a large height deviation for aircraft operating in the airspace of Pyongyang FIR.

2.3.2. To make a conservative estimate for the operational risk, China RMA applied the same operational risk value used in the preliminary assessment for Pyongyang FIR.

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.

3.3. The TSD of December 2010 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 9 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	2.46×10^{-8}	

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
	separated by the vertical separation minimum S_z are in vertical overlap.		
$P_y(0)$	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)
$\lvert\overline{\dot{y}}\rvert$	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	0.00861	
λ_h	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.03162	

Table 9: Estimate of the empirical Parameters in the CRM

Table 10 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	1781.2	Annual flight hours
E_z(same)	0.0	Same-direction vertical occupancies
E_z(opposite)	0.0035167	Opposite-direction vertical occupancies
Crossing pairs	120	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
$\overline{\lvert V\rvert}$	519.185 knots	Average absolute aircraft ground speed

Table 10: Estimate of the Parameters based on the collected TSD

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

4.1.1. Table 11 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 0.402 x 10^{-9} fatal accidents per flight hour. The operational risk estimate is 1.550 x10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 1.95 x10^{-9} fatal accidents per flight hour, which satisfies the globally agreed TLS value of 5 x 10^{-9} fatal accidents per flight hour.

RVSM Airspace of DPR Korea – estimated annual flying hours = 1781 hours *(note: estimated hours based on the December 2010 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	0.402 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	1.550 x10^{-9}	-	-
Total Risk	1.95 x10^{-9}	**5.0 x 10^{-9}**	**Below Overall TLS**

Table 11: Risk Estimates for the RVSM Implementation in the Airspace of DPR Korea

4.1.2. Figure 7 presents the trends of collision risk estimates for each month using the estimated LHD data since December 2010.

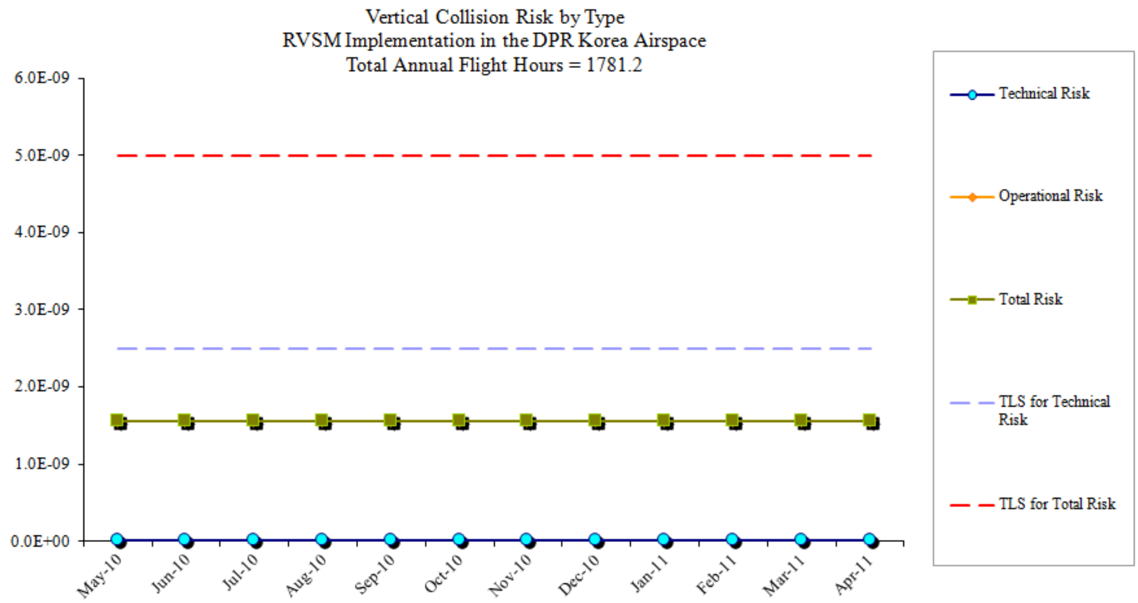

Figure 7: Trends of Risk Estimates for the RVSM Implementation in the Airspace of DPR Korea

4.1.3. 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} fatal accidents per flight hour.