

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 3: Reports from Asia/Pacific RMAs and EMAs

MAAR SAFETY REPORT

(Presented by Thailand)

Summary

This paper provides the results of the airspace safety oversight for the RVSM operation in Bay of Bengal (BOB), Western Pacific/South China Sea (WPAC/SCS), and Mongolian Airspace. The paper also proposes some actions in regards to Traffic Sample Data (TSD) and safety issues in the regions.

1. INTRODUCTION

1.1. This paper provides the executive summary of airspace safety oversight for the RVSM operation in Bay of Bengal (BOB), Western Pacific/South China Sea (WPAC/SCS), and Mongolian Airspace.

1.2. The reports of BOB, WPAC/SCS, and Mongolia are provided in Attachment 1, 2 and 3 respectively. Each report contains:

- Traffic Sample Data (TSD) and LHD reports used in risk estimation,
- summary of LHD occurrences and their associated risk,
- risk estimation parameters and results,
- further discussion including geographical location of LHDs and hot spots,
- Long Term Height-keeping Monitoring (LTHM) status, and
- an appendix containing details of LHD reports.

2. DISCUSSION

Executive Summary

2.1. **Table 1** summarizes Bay of Bengal (BOB) airspace RVSM technical, operational, and total risks. **Figure 1** presents collision risk estimate trends during the period from Jan 2014 to Dec 2014.

BOB Airspace – estimated annual flying hours = 2,110,809 hours							
(note: estimated hours based on Dec 2014 traffic sample data)							
Source of Risk Risk Estimation TLS Remarks							
RASMAG 19 Total Risk	13.47 x 10 ⁻⁹	5.0×10^{-9}	Above TLS				
Technical Risk	0.95 x 10 ⁻⁹	2.5 x 10 ⁻⁹	Below Technical TLS				

Operational Risk	17.78 x 10 ⁻⁹	-	-
Total Risk	18.73 x 10 ⁻⁹	5.0 x 10 ⁻⁹	Above TLS



 Table 1: BOB Airspace RVSM Risk Estimates

Figure 1: BOB Airspace RVSM Risk Estimate Trends

2.2. **Table 2** presents a summary of the LHD causes within BOB airspace from Jan 2014 until Dec 2014.

Code	LHD Category Description	No.
А	Flight crew fails to climb or descend the aircraft as cleared	0
В	Flight crew climbing or descending without ATC clearance	4
С	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	2
Е	ATC transfer of control coordination errors due to human factors	214
F	ATC transfer of control coordination errors due to technical issues	0
G	Aircraft contingency leading to sudden inability to maintain level	0
Н	Airborne equipment failure and unintentional or undetected level	0
	change	
Ι	Turbulence or other weather related cause	0
J	TCAS resolution advisory and flight crew correctly responds	1
Κ	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	0
М	Other	3
Total		224

 Table 2: Summary of LHD Causes within BOB Airspace

2.3. **Figure 2** provides the geographic location of risk bearing LHD reports within BOB Airspace during the assessment period.



Figure 2: BOB Airspace – Non-Nil LHD

2.4. **GADER**, a transfer-of-control point between Tehran and Kabul FIRs, remains one of the hot spots in the region in 2014. LHD reports in this area were sent to MIDRMA, and subsequently to Tehran ACC. Although MAAR has not received any feedback from Tehran ACC, the number of LHDs in this area reduced significantly in the last quarter of 2014 (3 LHDs) and first quarter of 2015 (0 LHDs).

5.1 **The transfer-of-control points along Kolkata and Yangon FIRs** continue to be the major hot spots in the region. In April 2015, Myanmar informed MAAR of the implementation status concerning these hot spots:

- Their ATM system upgrade will be completed in October 2015. The upgrade will integrate ADS-B surveillance data from Sittwe and Co Co Island, which will cover the surveillance gaps near the India-Myanmar border.
- ADS-B data sharing and communication service sharing between India and Myanmar have been agreed and the formal agreement was to be signed in CANSO Asia Pacific Conference during 6–8 May 2015.

• The implementation of AIDC with Kolkata, Chennai, and Bangkok ACCs will commence after October 2015 and is scheduled to be operational during the first quarter of 2016.

2.5. The transfer-of-control points along Chennai and Kuala Lumpur FIRs also remain to be hot spots in the region. There have been a series of AIDC trials between Chennai and Kuala Lumpur FIRs, but it is unclear when it will become operational.

2.6. With the unusually high risk in the BOB region, a short-term safety net could be achieved by making aircraft operators who operate over these hot spots aware of the situation. The flight crew can be made aware that the sooner the pilot contacts the accepting ACC, the less time duration that the aircraft will fly at a time and position unexpected by the accepting ATC unit, and therefore the less risk will incur for that flight.

2.7. Table 3 summarizes Western Pacific/South China Sea (WPAC/SCS) airspace RVSM technical, operational, and total risks. Figure 3 presents collision risk estimate trends during the period from Jan 2014 to Dec 2014.

WPAC/SCS Airspace – estimated annual flying hours = 1,511,839 hours								
(note: estima	ted hours based on Dec 2	2014 traffic sampl	le data)					
Source of Risk	Source of Risk Risk Estimation TLS Remarks							
RASMAG 19 Total Risk	5.22×10^{-9}	5.0×10^{-9}	Above TLS					
Technical Risk	1.16 x 10 ⁻⁹	2.5 x 10 ⁻⁹	Below Technical TLS					
Operational Risk	2.98 x 10 ⁻⁹	-	-					
Total Risk	4.14 x 10 ⁻⁹	5.0×10^{-9}	Below TLS					

7.0E-09 6.0E-09 - TLS for Total Risk 5.0E-09 Total Risk 4.0E-09 TLS for 3.0E-09 Technical Risk Technical Risk 2.0E-09 1.0E-09 Operational Risk 0.0E+00 Jan-14 Feb-14 Mar-14 May-14 Jun-14 Jul-14 Dec-14 Apr-14 Aug-14 Sep-14 Nov-14 Oct-14 Figure 3: WPAC/SCS Airspace RVSM Risk Estimate Trends

Table 3: WPAC/SCS Airspace RVSM Risk Estimates

2.8. Table 4 presents a summary of the LHD causes within WPAC/SCS airspace from Jan 2014 until Dec 2014.

Code	LHD Category Description	No.	
-			

Total		144
Μ	Other	2
L	Non-approved aircraft is provided with RVSM separation	0
Κ	TCAS resolution advisory and flight crew incorrectly responds	0
J	TCAS resolution advisory and flight crew correctly responds	1
Ι	Turbulence or other weather related cause	2
Η	Airborne equipment failure and unintentional or undetected level change	0
G	Aircraft contingency leading to sudden inability to maintain level	0
F	ATC transfer of control coordination errors due to technical issues	2
E	ATC transfer of control coordination errors due to human factors	133
D	ATC system loop error	1
С	Incorrect operation or interpretation of airborne equipment	0
В	Flight crew climbing or descending without ATC clearance	3
А	Flight crew fails to climb or descend the aircraft as cleared	0

 Table 4: Summary of LHD Causes within WPAC/SCS Airspace

2.9. **Figure 4** provides the geographic location of risk bearing LHD reports within WPAC/SCS Airspace during the assessment period.



Figure 4: WPAC/SCS Airspace – Non-Nil LHD

2.10. The transfer-of-control points along the Hong Kong - Manila FIR boundary, **NOMAN and SABNO**, remain the main hot spots in WPAC/SCS airspace.

2.11. The transfer-of-control points along the Singapore - Manila FIR boundary, LAXOR and VINIK, are no longer hot spots in the region since the previous year's risk in this area was due to a single long-duration LHD.

2.12. The number of occurrences at DOTMI (all occurred from flights being transferred from Guangzhou to Hong Kong) and OSANU (most occurred from flights being transferred from Manila to Kota Kinabalu) are relatively high, but the durations are low since the accepting ATS units have radar surveillance over these areas and, therefore, could detect the incorrect position before the flights entered their area of responsibility.

2.13. Even though the overall risk is below the TLS, the Philippines, Hong Kong, and Malaysia should still prioritize AIDC implementations between Hong Kong – Manila FIRs and Kota Kinabalu – Manila FIRs.

2.14. **Table 5** summarizes Mongolian airspace RVSM technical, operational, and total risks. **Figure 5** presents collision risk estimate trends during the period from Jan 2014 to Dec 2014.

Mongolian Airspace – estimated annual flying hours = 108,773 hours								
(note: estimated hours based on Dec 2014 traffic sample data)								
Source of Risk Risk Estimation TLS Remarks								
RASMAG 19 Total Risk	7.63 x 10 ⁻⁹	5.0×10^{-9}	Above TLS					
Technical Risk	0.96 x 10 ⁻⁹	2.5 x 10 ⁻⁹	Below Technical TLS					
Operational Risk	2.02 x 10 ⁻⁹	-	-					
Total Risk	2.98 x 10 ⁻⁹	5.0 x 10 ⁻⁹	Below Overall TLS					

 Table 5: Mongolian Airspace RVSM Risk Estimates



Figure 5: Mongolian Airspace RVSM Risk Estimate Trends

Code	LHD Category Description	No.
А	Flight crew fails to climb or descend the aircraft as cleared	0
В	Flight crew climbing or descending without ATC clearance	0
С	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	0
Е	ATC transfer of control coordination errors due to human factors	15
F	ATC transfer of control coordination errors due to technical issues	3
G	Aircraft contingency leading to sudden inability to maintain level	0
Н	Airborne equipment failure and unintentional or undetected level change	0
Ι	Turbulence or other weather related cause	0
J	TCAS resolution advisory and flight crew correctly responds	0
Κ	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	0
М	Other	0
Total		18

2.15. **Table 6** presents a summary of the LHD causes within Mongolian airspace from Jan 2014 until Dec 2014.

Table 6: Summary of LHD Causes within Mongolian Airspace

2.16. **Figure 6** provides the geographic location of risk bearing LHD reports within Mongolian Airspace during the assessment period.



Figure 6: WPAC/SCS Airspace – Non-Nil LHD

2.17. In terms of number of occurrences, the main hot spots in the Mongolian airspace remain the southeast boundary of Ulaanbaatar FIR next to Beijing FIR (NIXAL and INTIK) and the northwest boundary next to Krasnoyarsk FIR (DARNO). However, due to the reduction in LHD duration near NIXAL and INTIK, the risk in these locations were reduced to zero. (The LHD duration at NIXAL in 2013 was mostly contributed by a single 14-minute occurrence.)

2.18. Due to the high number of LHD occurrences near NIXAL and INTIK, Mongolia has extended their SSR coverage for approximately 30NM further from its boundary since December 2014.

3. ACTIONS BY THE MEETING

- 3.1 The meeting is invited to:
 - a) note the information contained in this paper;
 - b) discuss any relevant matters as appropriate.

Attachment 1

MONITORING AGENCY FOR ASIA REGION (MAAR)



Airspace Safety Review of RVSM in Bay of Bengal Airspace

January 2014 to December 2014

AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN THE BAY OF BENGAL AIRSPACE Assessment Period: January 2014 to December 2014

Prepared by Monitoring for Asia Region (MAAR) (An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

This report provides an airspace safety review of RVSM airspace risk in **Bay of Bengal (BOB)** airspace. The review is conducted based on a one-month traffic sample data (TSD) collected in **December 2014** and monthly Large Height Deviation (LHD) reports between **January 2014** and **December 2014** submitted by concerning States in the BOB region.

2. Data Sources

2.1. **Traffic Sample Data (TSD).** A TSD covering the month of December 2014 of aircraft operating in BOB airspace was used as required by ICAO regional agreement.

2.2. Large Height Deviation (LHD). Accumulative 12-month data set of LHD reports was covering January 2014 to December 2014. Table 1 indicates those FIRs which submitted LHD reports including nil returns. Appendix A provides details of LHD reports, including full description of some uncommon LHDs and LHDs with large duration.

FIR/ Month	Dhaka	Chennai	Delhi	Kolkata	Mumbai	Kuala Lumpur	Male	Yangon	Katmandu	Karachi	Lahore	Colombo	Bangkok
January	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
February	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
March	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
April	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
May	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
June	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
July	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
August	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
September	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
October	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
November	Х	Х	Х	Х	Х	X	Х	Х	Х	Х	Х	Х	Х
December	Х	Х	Х	Х	Χ	Х	Х	Х	Х	Х	Х	Х	Х

 Table 1: Summary of LHD Reports Submitted by FIRs

3. Summary of LHD Occurrences

3.1. **Table 2** and **Figure 1** summarize the number of Non-NIL LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed, and their associated operational risk by month from January 2014 to December 2014.

Month	No. of Non-NIL	LHD Duration	No. Levels	Operational
(2013)	LHD	(Min)	Crossed	Risk (x10 ⁻⁹)
January	16	63.0	0	1.66
February	23	97.0	0	2.55
March	19	69.0	0	1.82
April	14	28.0	0	0.74
May	23	76.0	0	1.94
June	22	11.0	11	2.51
July	9	21.0	0	0.55
August	18	77.5	0	2.04
September	45	31.0	0	0.82
October	16	33.5	0	0.88
November	11	43.0	1	1.47
December	8	11.0	0	0.79
Total	224	561	12	17.78

Table 2: Summary of LHD by Month for BOB Airspace



Figure 1: Summary of LHD Occurrences by Month for BOB Airspace

3.2. Compared to 2013, the number of non-nil LHD reports rose from 162 to 224. The total of LHD duration increased from 468 to 561 minutes.

• India and Myanmar are starting to directly send LHD reports to the other unit for further investigation.

3.3. **Table 3** and **Figure 2** summarize the number of LHD occurrences, the associated LHD duration (in minutes), and number of flight levels crossed without clearance, by LHD category from January 2014 to December 2014.

LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Uperauona I Risk (x10 ⁻ 9)
Α	Flight crew failing to climb/descend the aircraft as cleared	0	0.0	0	0.00
В	Flight crew climbing/descending without ATC Clearance	4	1.0	5	1.12
С	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-clearance etc)	0	0.0	0	0.00
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	2	0.0	6	1.13
E	Coordination errors in the ATC to ATC transfer or 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)	214	558. 0	0	14.6 3
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues	0	0.0	0	0.00
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	0	0.0	0	0.00
Н	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0.0	0	0.00
Ι	Deviation due to turbulence or other weather related cause	0	0.0	0	0.00
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	1	2.0		0.56
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0.0	0	0.00
L	An aircraft being provided with RVSM separation	0	0.0	0	0.00

LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Uperationa I Risk (x10 ⁻ 9)
	is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)				
М	Other – this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.	3	0.0	1	0.34
Total		224	561. 0	12	17.7 8

Table 3: Summary of LHD by LHD Category for BOB Airspace



Figure 2: Summary of LHD by LHD Category for BOB Airspace

3.4. Category E LHDs still account for most of LHD duration and occurrences in the region. These occurrences can be further categorized into the following sub-categories as depicted in **Figure 3**.



Figure 3: Sub-categories of Category-E LHDs for BOB Airspace

4. Risk Assessment and Safety Oversight

4.1. **Collision Risk Model (CRM) Parameters.** The value and the source of the parameters in the CRM used to estimate risk in the RVSM airspace are summarized in **Table 4**.

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
Т	Annual flight hours	1,678,868	431,941	Hour	Dec 2014 TSD
E _z (same)	Same-direction vertical occupancies	0.4449/ 0.0152	0.0759	-	
E _z (opposite)	Opposite-direction vertical occupancies	0.1988	0.0423	-	
λ_x	Average aircraft length	0.0294	0.0248	NM	
λ_y	Average aircraft wingspan	0.0271	0.0227	NM	
λ_z	Average aircraft height	0.0083	0.0073	NM	
λ_h	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0294	0.0248	NM	
Pz(0)	Probability of vertical overlap (with planned vertical separation equal to zero)	0.538	0.538	-	Conservative value used in previous assessments
$\overline{ \Delta V }$	Average relative along- track speed between aircraft on same direction routes	31.93	52.16	Knot	Dec 2014 TSD
	Average absolute aircraft ground speed	480	480	Knot	Conservative value used in previous assessments

Table 4: Estimates of the Parameters in the CRM for BOB Airspace

4.2. **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 5**. The technical risk **meets** the agreed TLS value of no more than 2.5×10^{-9} fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes. **The total risk <u>does not meet</u> the specified TLS value for these components of 5.0 x 10^{-9}**.

Bay of Bengal RVSM Airspace – estimated annual flying hours = 1,869,508 hours												
(note: estimated hours based on December 2014 traffic sample data)												
Source of Risk	Source of Risk Risk Estimation TLS Remarks											
Technical Risk	0.95 x 10 ⁻⁹	2.5 x 10 ⁻⁹	Below Technical TLS									
Operational Risk	Operational Risk 17.78 x 10 ⁻⁹											
Total Risk	18.73 x 10 ⁻⁹	5.0 x 10 ⁻⁹	Above Overall TLS									

 Table 5: Risk Estimates for BOB Airspace

4.3 **Figure 4** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.



Figure 4: Trends of Risk Estimates for BOB Airspace

4.4 A monthly LHD risk value is determined to provide real-time information on actual risk without reliance on historical high-time errors resident within the 12 month data sample. The data in **Figure 5** below shows that the monthly risks for all months except September 2014 are **significantly above** the average monthly risk of the annual risk of 5.0×10^{-9} (red line in **Figure 5** below, which is approximately 0.4167 x 10^{-9} fatal accidents per flight hour).



Figure 5: Monthly LHD Risk Estimates for BOB Airspace. Red line is the average monthly value for an annual risk of 5.0 x 10⁻⁹. Risk is measured in Fatal Accidents per Flight Hour (FAPFH).

5. Analysis of Operational Errors

5.2 **Figure 6** depicts geographic location of non-nil LHDs and hot spots in BOB airspace based on LHD reports from January to December 2014 where:

- the navy dotted line represents the frequency of occurrences at the labeled waypoint,
- the color of each circle represents the sum of minutes at incorrect flight level and the number of flight levels crossed without clearance (darker orange represents higher value) associated with LHDs occurring at or near the labeled waypoint,
- the area of the circle represents the sum of operational risk associated with LHDs occurring at or near the labeled waypoint, and
- the turquoise lines represent west-bound traffic movements while the orange lines represent east-bound traffic movements.



Figure 6: Geographical Location of LHDs in BOB Airspace

5.3 **GADER**, a transfer-of-control point between Tehran and Kabul FIRs, remains one of the hot spots in the region in 2014. LHD reports in this area were sent to MIDRMA, and subsequently to Tehran ACC. Although MAAR has not received any feedback from Tehran ACC,

the number of LHDs in this area reduced significantly in the last quarter of 2014 (3 LHDs) and first quarter of 2015 (0 LHDs).

5.4 **The transfer-of-control points along Kolkata and Yangon FIRs** continue to be the major hot spots in the region. In April 2015, Myanmar informed MAAR of the implementation status concerning these hot spots:

- Their ATM system upgrade will be completed in October 2015. The upgrade will integrate ADS-B surveillance data from Sittwe and Co Co Island, which will cover the surveillance gaps near the India-Myanmar border.
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- The implementation of AIDC with Kolkata, Chennai, and Bangkok ACCs will commence after October 2015 and is scheduled to be operational during the first quarter of 2016.

5.5 **The transfer-of-control points along Chennai and Kuala Lumpur FIRs** also remains to be hot spots in the region. There have been AIDC trials between Chennai and Kuala Lumpur FIRs, but it is unclear when it will become operational.

6. Long Term Height-keeping Monitoring (LTHM)

To meet the ICAO Annex 6 LTHM requirements, the MAAR undertakes a monitorin	ng
program. The current monitoring burden data for BOB States is detailed in Table 6 below.	-

State	Total RVSM Approved Airframes	Resultant Monitoring Burden	Total Airframes Remaining to be Monitored
Afghanistan (OA)	14	11	3
Bangladesh (VG)	24	19	13
Bhutan (VQ)	6	4	3
India (VA)	483	185	33
Malaysia (WM)	287	41	16
Maldives (VR)	6	5	0
Myanmar (VY)	12	6	0
Nepal (VN)	2	2	0
Pakistan (OP)	67	41	27
Sri Lanka (VC)	30	9	1
Thailand (VT)	298	99	41
Grand Total	1229	422	137

 Table 6:
 LTHM Burden

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause		
6/1/2014	GNL	FL380	FL380	1.0 min	E	No time revision		
7/1/2014	RMM	FL360	FL380	2.0 min	Е	No FL revision		
11/1/2014	UNF	FL290	FL350	7.0 min	E	ATC-LOA noncompliance (FL)		
12/1/2014	GNL	FL400	FL400	5.0 min	Е	No time revision		
12/1/2014	GNL	FL330	FL350	6.0 min	E	No FL revision		
13/1/2014	RXM	FL390	FL410	1.0 min	Е	No FL revision		
13/1/2014	RXM	FL390	FL390	2.0 min	Е	Negative transfer		
15/1/2014	CCR			0.0 min	Е	Negative transfer		
18/1/2014	GNL	FL320	FL320	19.0 min	E	Aircraft established contact with Chennai data-link at 0957 & reported estimate BASOP 1002. No estimate was passed by Yangon. No Breakdown in separation.		
19/1/2014	RXM	FL310	FL370	2.0 min	E	Negative transfer		
22/1/2014	RXM	FL370	FL370	2.0 min	E	Negative transfer		
25/1/2014	RMM	FL300	FL340	0.0 min	E	No FL revision		
25/1/2014	CCR	FL370	FL370	4.0 min	E	Negative transfer		
28/1/2014	GNL	FL360	FL360	0.0 min	E	No time revision		
28/1/2014	RMM	FL340	FL360	4.0 min	E	No FL revision		
29/1/2014	RMM	FL360	FL380	8.0 min	E	No time & FL revision		
1/2/2014	RMM	FL360	FL380	12.0 min	E	Aircraft established contact with Kolkata at 1052 & reported crossed CHILA at 1040, maintaining FL380. No level change was passed by Yangon. No Breakdown in separation.		
2/2/2014	RXM	FL350	FL350	2.0 min	E	Negative transfer		
3/2/2014	RMM	FL320	FL340	0.0 min	Е	No time & FL revision		
5/2/2014	RMM	FL280	FL320	0.0 min	E	No FL revision		
7/2/2014	GNL	FL300	FL340	0.0 min	E	No FL revision		
7/2/2014	CCR	FL300	FL340	0.0 min	Е	No FL revision		
7/2/2014	GNL	FL330	FL350	4.0 min	E	No FL revision		
7/2/2014	UNF	FL280	FL360	5.0 min	Е	ATC-LOA noncompliance (FL)		
9/2/2014	GNL	FL360	FL360	0.0 min	E	No time revision		
10/2/2014	UNF	FL270	FL290	5.0 min	Е	ATC-LOA noncompliance (FL)		
10/2/2014	UNF	FL270	FL290	5.0 min	E	ATC-LOA noncompliance (FL)		
11/2/2014	RMM	FL340	FL360	0.0 min	Е	No FL revision		
12/2/2014	UNF	FL270	FL370	10.0 min	E	ATC-LOA noncompliance (FL)		
15/2/2014	GNL	FL340	FL340	1.0 min	Е	No time revision		
16/2/2014	RXM	FL350	FL370	0.0 min	E	No FL revision		

Appendix A: Details of the Reported LHD Events in the BOB Airspace

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
19/2/2014	RMM	FL300	FL320	12.0 min	E	Aircraft established contact with Kolkata at 1843 and reported crossed IBITA at 1831, FL 320.
						No level change was passed by Yangon. No Breakdown in separation.
21/2/2014	RMM	FL300	FL320	8.0 min	E	No FL revision
22/2/2014	RXM	FL330	FL330	1.0 min	Е	No time revision
23/2/2014	RMM	FL340	FL360	15.0 min	E	Aircraft established contact with Kolkata at 1308 and reported crossed IBITA at 1253, maintaining FL 360. No level change was passed by Yangon. No Breakdown in separation.
25/2/2014	RMM	FL360	FL380	16.0 min	E	Aircraft established contact with Kolkata at 1145 & reported crossed RINDA/1129 maintaining FL380. No level change was passed by Yangon. No Breakdown in separation.
25/2/2014	RMM	FL280	FL340	0.0 min	E	No FL revision
25/2/2014	ULQ			0.0 min	Е	Negative transfer
27/2/2014	RXM	FL370	FL370	1.0 min	E	Negative transfer
1/3/2014	RMM	FL320	FL340	0.0 min	E	No FL revision
4/3/2014	RXM	FL310	FL390	0.0 min	Μ	Unknown
5/3/2014	GNL	FL360	FL320	0.0 min	E	No FL revision
5/3/2014	GNL	FL380	FL380	7.0 min	E	No time revision
6/3/2014	RXM	FL390	FL410	2.0 min	E	No FL revision
11/3/2014	GNL	FL380	FL380	2.0 min	E	No time revision
11/3/2014	CCR	FL350	FL350	0.0 min	E	Negative transfer
11/3/2014	RXM	FL370	FL390	1.0 min	E	No FL revision
12/3/2014	RXM			1.0 min	E	Negative transfer
15/3/2014	RMM	FL340	FL320	8.0 min	E	No FL revision
16/3/2014	UNF	FL290	FL330	5.0 min	E	ATC-LOA noncompliance (FL)
20/3/2014	RXM			1.0 min	E	Negative transfer
20/3/2014	UNF	FL290	FL330	5.0 min	E	ATC-LOA noncompliance (FL)
20/3/2014	RMM	FL300	FL320	11.0 min	E	Aircraft established contact with Kolkata at 0900 & reported TEBOV/0849 maintaining FL320. No level change was passed by Yangon. No Breakdown in separation.
22/3/2014	RMM	FL360	FL300	1.0 min	Е	No FL revision
23/3/2014	ULQ	FL340	FL360	1.0 min	В	Pilot-climb/descend without

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause		
						clearance		
24/3/2014	RXM	FL330	FL330	0.0 min	Μ	Failure to establish or maintain a		
						separation standard		
27/3/2014	UNF	FL290	FL370	8.0 min	E	ATC-LOA noncompliance (FL)		
29/3/2014	RMM	FL360	FL380	16.0 min	E	Aircraft established contact with		
						Kolkata at 1829, maintaining		
						FL380. Estimate received for		
						IBITA was 1813. No level change		
						was passed by Yangon. No		
1/4/2014	DVM	EL 270	EI 200	20	Г	Breakdown in separation		
1/4/2014	RXM	FL3/0	FL390	2.0 min	E	No FL revision		
3/4/2014	RAM	ET 200	FL350	1.0 min	E	Negative transfer		
3/4/2014	RMM DVM	FL380	FL360	0.0 min	E	No FL revision		
3/4/2014	RAM	EI 200	FL350	1.0 min	E	Negative transfer		
3/4/2014	RMM	FL320	FL340	0.0 min	E	No FL revision		
4/4/2014	RXM	FL350	FL330	1.0 min	E	No FL revision		
10/4/2014	UNF	FL290	FL350	5.0 min	E	ATC-LOA noncompliance (FL)		
13/4/2014	CCR	FL370	FL370	6.0 min	E	No time revision		
13/4/2014	RMM	FI 22 0	FL380	0.0 min	E	Negative transfer		
14/4/2014	RMM	FL320	FL340	3.0 min	E	No FL revision		
16/4/2014	RXM	FL350	FL3/0	1.0 min	E	No FL revision		
16/4/2014	GNL	FL340	FL360	0.0 min	E	No FL revision		
20/4/2014		FL390	FL3/0	8.0 min	E	ATC-LOA noncompliance (FL)		
28/4/2014	RMM	FL400	FL380	0.0 min	E	No FL revision		
4/5/2014	KMM	FL300	FL340	0.0 min	E	No FL revision		
5/5/2014	WMI	FL340	FL360	0.0 min	E	Negative transfer		
5/5/2014	GNL	FL360	FL300	0.0 min	E	No FL revision		
6/5/2014	RXM	FL330	FL350	1.0 min	E	No FL revision		
7/5/2014	GNL	FL320	FL380	0.0 min	E	No FL revision		
8/5/2014		FL350	FL390	3.0 min	E	NO FL revision		
10/5/2014	UNF	FL290	FL350	7.0 min	E	ATC-LOA noncompliance (FL)		
10/5/2014	UNF	FL290	FL310	3.0 min	E	ATC-LOA noncompliance (FL)		
11/5/2014	KMM	FL340	FL340	46.0 min	E	Aircraft established contact with		
						Kolkala HF and reported		
						111111111111111111111111111111111111		
						EL 340 Estimate received for		
						MIPAK/0226 FI 340 No Estimate		
						revision was passed by Yangon		
						No Breakdown in separation		
15/5/2014	GNL	FL380	FL380	0.0 min	E	Negative transfer		
15/5/2014	RMM		FL340	0.0 min	E	Negative transfer		
15/5/2014	RMM		FL320	3.0 min	E	Negative transfer		
18/5/2014	RMM	FL260	FL320	0.0 min	E	No FL revision		

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause			
20/5/2014	RMM	FL360	FL380	0.0 min	Е	No FL revision			
23/5/2014	RMM	FL320	FL340	0.0 min	Е	No FL revision			
23/5/2014	RMM	FL340	FL320	1.0 min	Е	No FL revision			
24/5/2014	GNL	FL400	FL380	0.0 min	Е	No FL revision			
25/5/2014	RXM	FL330	FL370	1.0 min	E	No FL revision			
27/5/2014	RXM		FL370	1.0 min	E	Negative transfer			
31/5/2014	RMM	FL340	FL320	0.0 min	Е	No FL revision			
31/5/2014	RXM		FL330	1.0 min	E	Negative transfer			
31/5/2014	UNF	FL290	FL350	7.0 min	E	ATC-LOA noncompliance (FL)			
31/5/2014	RMM	FL300	FL320	2.0 min	E	No FL revision			
1/6/2014	RMM	FL360	FL380	0.0 min	E	No FL revision			
1/6/2014	RMM	FL340	FL360	0.0 min	E	No FL revision			
2/6/2014	RMM	FL340	FL340	0.0 min	E	No FL revision			
2/6/2014	CCR			5.0 min	E	No time revision			
3/6/2014	UNF	FL280	FL320	5.0 min	E	ATC-LOA noncompliance (FL)			
3/6/2014	UNF	FL360	FL380	0.0 min	В	Unknown			
3/6/2014	UNF	FL360	FL380	0.0 min	В	Unknown			
3/6/2014	CCR			0.0 min	E	No time revision			
4/6/2014	RXM		FL350	1.0 min	E	Negative transfer			
6/6/2014	ULQ			0.0 min	E	Negative transfer			
6/6/2014	RMM	FL380	FL400	0.0 min	E	No time & FL revision			
11/6/2014	CCR	FL350	FL370	0.0 min	Е	No FL revision			
12/6/2014	RMM	FL360	FL380	0.0 min	E	No FL revision			
13/6/2014	RMM	FL340	FL360	0.0 min	E	No FL revision			
13/6/2014	RMM	FL320	FL340	0.0 min	E	No FL revision			
13/6/2014	RMM	FL300	FL320	0.0 min	E	No time & FL revision			
13/6/2014	RMM	FL340	FL360	0.0 min	E	No FL revision			
21/6/2014	WMT	FL340	FL345	0.0 min	Μ	Unknown			
24/6/2014	GNL	FL320	FL340	0.0 min	E	No FL revision			
27/6/2014	RMM	FL300	FL280	0.0 min	Е	No FL revision			
30/6/2014	UNF	FL330	FL345	0.0 min	D	ATC-incorrect clearance			
30/6/2014	UNF	FL330	FL345	0.0 min	D	ATC-incorrect clearance			
4/7/2014	UNF	FL290	FL330	3.0 min	Е	No FL & route revision			
6/7/2014	UNF	FL290	FL350	5.0 min	E	ATC-LOA noncompliance (FL)			
6/7/2014	UNF	FL280	FL360	7.0 min	E	ATC-LOA noncompliance (FL)			
8/7/2014	RMM	FL340	FL320	0.0 min	E	No FL revision			
9/7/2014	RXM	FL330	FL350	1.0 min	Е	No FL revision			
11/7/2014	CCR	FL350	FL370	0.0 min	E	Transfer with uncoordinated FL			
23/7/2014	GNL	FL370	FL350	5.0 min	E	No FL revision			
29/7/2014	CCR	FL350	FL390	0.0 min	E	No FL revision			
31/7/2014	RMM	FL360	FL380	0.0 min	Е	No FL revision			
7/8/2014	GNL	FL340	FL340	30.0 min	E	Aircraft established contact with			
						Chennai ADS at 0407 & reported			
						crossed DUBTA at 0355, a			

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause		
						revision of 44 minutes in time		
						estimate. No revision was given by		
						Kuala Lumpur. No Breakdown in		
0/0/2014		FL 27 0	FI 250	0.0 '	Б	separation.		
9/8/2014	UNF	FL270	FL350	8.0 min	E	ATC-LOA noncompliance (FL)		
9/8/2014		FL300	FI 240	0.0 min	E	No time revision		
10/8/2014	UNF	FL280	FL340	6.0 min	E	ATC-LOA noncompliance (FL)		
11/8/2014	RXM	FL330	FL350	1.0 min	E	No FL revision		
13/8/2014	GNL	FL400	FL400	1.0 min	E	No time revision		
16/8/2014	KMM CCD	FL360	FL380	0.0 min	E	No FL revision		
21/8/2014	CCR	FL320	FL320	3.0 min	E	No time revision		
22/8/2014			FL350	0.0 min	E	Negative transfer		
23/8/2014	KXM		FL350	0.5 min	E	Negative transfer		
23/8/2014	UNF	FL290	FL330	5.0 min	E	ATC-LOA noncompliance (FL)		
25/8/2014	RXM	FL370	FL390	2.0 min	E	No FL revision		
25/8/2014	RXM		FL350	1.0 min	E	Negative transfer		
26/8/2014	UNF	FL290	FL390	10.0 min	E	ATC-LOA noncompliance (FL)		
27/8/2014	RXM	FL390	FL370	1.0 min	E	No FL revision		
27/8/2014	UNF	FL290	FL350	6.0 min	E	ATC-LOA noncompliance (FL)		
31/8/2014	RXM	FL370	FL350	2.0 min	E	No FL revision		
31/8/2014	RXM	FL350	FL370	1.0 min	E	No FL revision		
1/9/2014	RXM	FL350	FL370	2.0 min	E	No FL revision		
2/9/2014	UNF	FL270	FL290	5.0 min	E	ATC-LOA noncompliance (FL)		
4/9/2014	RXM		FL390	0.5 min	E	Negative transfer		
4/9/2014	RXM		FL330	0.5 min	E	Negative transfer		
9/9/2014	RXM	FI 25 0	FL350	0.0 min	E	No FL revision		
9/9/2014	RXM	FL350	FL370	2.0 min	E	No FL revision		
9/9/2014	RXM	TT A A A A	FL370	0.5 min	E	Negative transfer		
10/9/2014	RMM	FL380	FL300	$0.0 \mathrm{min}$	E	No FL revision		
11/9/2014	RXM	FL350	FL370	2.0 min	E	No FL revision		
11/9/2014	RXM	FL330	FL330	0.5 min	E	No time revision		
11/9/2014	RXM	FL350	FL370	0.0 min	E	No FL revision		
11/9/2014	RXM		FL330	1.0 min	E	Negative transfer		
11/9/2014	RXM	TT A A A A	FL350	0.5 min	E	Negative transfer		
11/9/2014	RXM	FL390	FL390	2.0 min	E	Incorrect SSR code		
11/9/2014	RXM	FL390	FL390	1.0 min	E	No time revision		
11/9/2014	RMM	FL320	FL320	0.0 min	E	No time revision		
13/9/2014	GNL	FL400	FL400	1.0 min	E	No time revision		
13/9/2014	KMM	FL340	FL360	0.0 min	E	No FL revision		
14/9/2014	RXM	TH C1C	FL310	0.5 min	E	Negative transfer		
15/9/2014	RXM	FL310	FL330	0.5 min	E	No FL revision		
15/9/2014	GNL	FL410	FL390	0.0 min	E	No FL revision		
15/9/2014	KXM	FL390	FL390	0.5 min	E	Negative transfer		
15/9/2014	RXM	FL390	FL410	1.0 min	E	No FL revision		

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
15/9/2014	RXM		FL390	0.5 min	Е	Negative transfer
15/9/2014	RXM		FL330	0.5 min	Е	Negative transfer
18/9/2014	RXM		FL390	0.5 min	Е	Negative transfer
18/9/2014	RXM	FL410	FL410	0.5 min	Е	No time revision
18/9/2014	GNL	FL380	FL360	0.0 min	Е	No FL revision
18/9/2014	RXM	FL370	FL330	0.5 min	E	No FL revision
19/9/2014	RXM	FL410	FL410	1.0 min	Е	No time revision
19/9/2014	RXM		FL390	0.5 min	Е	Negative transfer
19/9/2014	RXM	FL350	FL370	0.5 min	E	No FL revision
19/9/2014	RXM	FL350	FL370	0.0 min	E	No FL revision
19/9/2014	RXM	FL330	FL350	2.0 min	E	No FL revision
19/9/2014	RXM	FL330	FL350	0.0 min	E	No FL revision
19/9/2014	RXM		FL350	0.5 min	E	Negative transfer
20/9/2014	RXM		FL370	0.0 min	Е	Negative transfer
20/9/2014	RXM	FL390	FL410	0.0 min	E	No FL revision
23/9/2014	ULQ	FL380	FL360	0.0 min	E	No FL revision
23/9/2014	RXM		FL410	0.5 min	E	Negative transfer
27/9/2014	RXM		FL330	0.0 min	E	Negative transfer
27/9/2014	RXM	FL350	FL370	1.0 min	E	No FL revision
27/9/2014	RXM		FL330	1.0 min	E	Negative transfer
27/9/2014	RXM		FL410	0.0 min	E	Negative transfer
27/9/2014	RXM		FL410	0.5 min	E	Negative transfer
1/10/2014	RXM	FL370	FL390	0.5 min	E	No FL revision
1/10/2014	RXM	FL350	FL370	1.0 min	E	No FL revision
1/10/2014	RXM	FL310	FL350	0.5 min	E	No FL revision
2/10/2014	RXM		FL370	0.5 min	E	Negative transfer
4/10/2014	GNL	FL280	FL360	0.0 min	E	No FL revision
4/10/2014	RXM		FL350	1.0 min	E	Negative transfer
9/10/2014	RXM	FL330	FL350	0.0 min	Е	No FL revision
10/10/2014	RMM	FL360	FL380	0.0 min	E	No FL revision
11/10/2014	GNL	FL360	FL340	6.0 min	Е	No FL revision
15/10/2014	UNF	FL270	FL350	8.0 min	Е	ATC-LOA noncompliance (FL)
17/10/2014	CCR	FL370	FL330	0.0 min	Е	No FL revision
21/10/2014	CCR	FL370	FL330	0.0 min	E	No time revision
23/10/2014	UNF	FL270	FL290	3.0 min	E	ATC-LOA noncompliance (FL)
28/10/2014	GNL	FL340	FL340	12.0 min	E	Aircraft established contact with
						HF at 1430, reported estimate PPB 1432 maintaining F340. No estimate was given by Yangon. No Breakdown in separation.
30/10/2014	RXM		FL370	0.5 min	Е	Negative transfer
30/10/2014	RXM		FL390	0.5 min	Е	Negative transfer
3/11/2014	RXM		FL390	0.0 min	Е	Negative transfer
6/11/2014	RXM	FL390	FL370	0.0 min	E	No FL revision

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
11/11/2014	RXM	FL350	FL370	0.0 min	Е	No FL revision
13/11/2014	RMM	FL340	FL360	0.0 min	Е	No FL revision
14/11/2014	UNF	FL270	FL290	4.0 min	Е	ATC-LOA noncompliance (FL)
17/11/2014	GNL	FL390	FL350	0.0 min	Е	Negative transfer
17/11/2014	ULQ	FL390	FL350	0.0 min	E	No FL revision
17/11/2014	RMM	FL360	FL340	38.0 min	E	Aircraft established contact with Kolkata at 2056 & reported crossed RINDA at 2018, Maintaining FL340. No level change was given by Yangon. No Breakdown in separation.
19/11/2014	RXM	FL370	FL390	0.0 min	Е	No FL revision
22/11/2014	CCR	FL410	FL410	1.0 min	Е	Negative transfer
27/11/2014	WMT	FL340	FL346	0.0 min	В	Pilot-climb/descend without clearance
5/12/2014	RXM	FL410	FL410	0.0 min	Е	No time revision
9/12/2014	RXM	FL330	FL330	0.0 min	Е	Negative transfer
9/12/2014	RXM	FL390	FL390	0.0 min	Е	No time revision
18/12/2014	ULQ	FL360	FL380	4.0 min	E	No FL revision
20/12/2014	CCR			0.0 min	E	No time revision
25/12/2014	RMM	FL320	FL380	5.0 min	E	No FL revision
29/12/2014	RMM	FL340	FL360	0.0 min	Е	No FL revision
30/12/2014	UNF	FL370	FL360	2.0 min	J	Unknown

Attachment 2

MONITORING AGENCY FOR ASIA REGION (MAAR)



Airspace Safety Review of RVSM in Western Pacific/South China Sea Airspace

January 2014 to December 2014

AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN THE WESTERN PACIFIC/SOUTH CHINA SEA AIRSPACE Assessment Period: January 2014 to December 2014

Prepared by Monitoring for Asia Region (MAAR) (An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

This report provides an airspace safety review of RVSM airspace risk in Western Pacific/South China Sea (WPAC/SCS) airspace. The review is conducted based on a one-month traffic sample data (TSD) collected in December 2014 and monthly Large Height Deviation (LHD) reports between January 2014 and December 2014 submitted by concerning States in the WPAC/SCS region.

2. Data Sources

2.1. **Traffic Sample Data (TSD).** A TSD covering the month of December 2014 of aircraft operating in WPAC/SCS airspace was used as required by ICAO regional agreement.

2.2. Large Height Deviation (LHD). A cumulative 12-month data set of LHD reports was, covering January 2014 to December 2014. Table 1 indicates those FIRs which submitted LHD reports including nil returns. Appendix A provides details of LHD reports, including full description of LHDs with large duration.

FIR/ Month	Phnom Penh	Sanya	Hong Kong	Vientian e	Kota Kinabalu	Kuala Lumpur	Manila	Singapor e	Bangkok	Hanoi	Ho Chi Minh
January	Х	Х	X	Х	X	X	Х	Х	Х	Х	Х
February	Х	Х	X	Х	X	X	Х	Х	Х	Х	Х
March	X	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
April	X	Х	Х	Х	X	Х	Х	Х	Х	Х	Х
May	Х	Х	X	Х	X	X	Х	Х	Х	Х	Х
June	X	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
July	X	Х	X	Х	X	Х	Х	Х	Х	Х	Х
August	X	Х	X	Х	X	Х	Х	Х	Х	Х	Х
September	X	Х	X	Х	X	Х	Х	Х	Х	Х	Х
October	X	Х	X	Х	X	Х	Х	Х	Х	Х	Х
November	X	Х	X	X	X	X	X	X	Х	X	X
December	X	Х	X	X	X	X	Х	X	Х	X	X

 Table 1: Summary of LHD Reports Submitted by FIRs

3. Summary of LHD Occurrences

3.1. **Table 2** and **Figure 1** summarize the number of Non-NIL LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed, and their associated operational risk by month from January 2014 to December 2014.

Month	No. of Non-NIL	LHD Duration	No. Levels	Operational
(2014)	LHD	(Min)	Crossed	Risk (x10 ⁻⁹)
January	11	7.0		0.20
February	19	29.0		0.79
March	8	13.0		0.33
April	10	2.0		0.06
May	8	6.0		0.16
June	11	7.0	1	0.23
July	8	6.0		0.17
August	19	21.0	4	0.68
September	10	0.0		0.00
October	14	3.0		0.07
November	11	3.0	4	0.22
December	15	2.0	1	0.08
Total	144	99	10	2.98

 Table 2: Summary of LHD by Month for WPAC/SCS Airspace



Figure 1: Summary of LHD Occurrences by Month for WPAC/SCS Airspace

3.2. Compared to 2013, the number of non-nil LHD reports rose from 133 to 144. However, the total of LHD duration reduced from 186 to 144 minutes.

3.3. Please note that States sometimes do not include LHD durations in the reports. In the case that MAAR could not obtain this information from follow-up queries, the durations were estimated based on the type of surveillance and the historical duration values of that location.

3.4. **Table 3** and **Figure 2** summarize the number of LHD occurrences, the associated LHD duration (in minutes), and number of flight levels crossed without clearance, by LHD category from January 2014 to December 2014.

LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Operation al Risk (x10 ⁻⁹)
Α	Flight crew failing to climb/descend the aircraft as cleared	0	0.0	0	0.00
В	Flight crew climbing/descending without ATC Clearance	3	1.0	2	0.09
С	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-clearance etc)	0	0.0	0	0.00
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	1	0.0	0	0.00
E	Coordination errors in the ATC to ATC transfer or 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)	133	90.0	4	2.53
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues	2	2.0	0	0.05
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	0	0.0	0	0.00
Н	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0.0	0	0.00
Ι	Deviation due to turbulence or other weather related cause	2	5.0	1	0.17
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	1	1.0	3	0.13
K	Deviation due to TCAS resolution advisory, flight	0	0.0	0	0.00

	crew incorrectly following the resolution advisory				
	An aircraft being provided with RVSM separation	0	0.0	0	0.00
L	is not RVSM approved (e.g. flight plan indicating				
	RVSM approval but aircraft not approved, ATC				
	misinterpretation of flight plan)				
	Other – this includes situations of flights	2	0.0	0	0.00
	operating (including climbing/descending) in				
Μ	airspace where flight crews are unable to establish				
	normal air-ground communications with the				
	responsible ATS unit.				
Total		144	99.0	10	2.98

 Table 3: Summary of LHD by LHD Category for WPAC/SCS Airspace



Figure 2: Summary of LHD by LHD Category for WPAC/SCS Airspace

3.5. Category E LHDs still account for most of LHD duration and occurrences in the region. These occurrences can be further categorized into the following sub-categories as depicted in **Figure 3**.



Figure 3: Sub-categories of Category-E LHDs for WPAC/SCS Airspace

4. Risk Assessment and Safety Oversight

4.1. **Collision Risk Model (CRM) Parameters.** The value and the source of the parameters in the CRM used to estimate risk in the RVSM airspace are summarized in **Table 4**.

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
Т	Annual flight hours	960,903	550,936	Hour	Dec 2014 TSD
E _z (same)	Same-direction vertical occupancies	0.3380/ 0.0499	0.3150	-	
E _z (opposite)	Opposite-direction vertical occupancies	0.3113	0.0085	-	
λ_{x}	Average aircraft length	0.0265	0.0286	NM	
λ_y	Average aircraft wingspan	0.0244	0.0265	NM	
λ_z	Average aircraft height	0.0076	0.0081	NM	
λ_h	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0265	0.0286	NM	
Pz(0)	Probability of vertical overlap (with planned vertical separation equal to zero)	0.538	0.538	-	Conservative value used in previous assessments
$\overline{ \Delta V }$	Average relative along- track speed between aircraft on same direction routes	31.97	27.44	Knot	Dec 2014 TSD
	Average absolute aircraft ground speed	480	480	Knot	Conservative value used in previous assessments

Table 4: Estimates of the Parameters in the CRM for WPAC/SCS Airspace

4.2. **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 5**. The technical risk **meets** the agreed TLS value of no more than 2.5×10^{-9} fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes. **The total risk <u>meets</u> the specified TLS value for these components of 5.0 x 10⁻⁹**.

Western Pacific/South China Sea RVSM Airspace – estimated annual flying hours = 1,581,192 hours								
(note: estima	(note: estimated hours based on December 2014 traffic sample data)							
Source of Risk	Risk Estimation	TLS	Remarks					
Technical Risk	1.16 x 10 ⁻⁹	2.5 x 10 ⁻⁹	Below Technical TLS					
Operational Risk	2.98 x 10 ⁻⁹	-	-					
Total Risk	4.14 x 10 ⁻⁹	5.0 x 10 ⁻⁹	Below Overall TLS					

Table 5: Risk Estimates for WPAC/SCS Airspace

4.3 **Figure 4** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.



Figure 4: Trends of Risk Estimates for WPAC/SCS Airspace

4.4 A monthly LHD risk value is determined to provide real-time information on actual risk without reliance on historical high-time errors resident within the 12 month data sample. The data in **Figure 5** below shows the monthly risks for the month of **February and August 2014** are **above** the average monthly risk of the annual risk of 5.0×10^{-9} (red line in **Figure 5** below, which is approximately 0.4167×10^{-9} fatal accidents per flight hour).



Figure 5: Monthly LHD Risk Estimates for WPAC/SCS Airspace. Red line is the average monthly value for an annual risk of 5.0 x 10⁻⁹. Risk is measured in Fatal Accidents per Flight Hour (FAPFH).

5. Analysis of Operational Errors

5.6 **Figure 6** depicts geographic location of risk bearing LHDs and hot spots in WPAC/SCS airspace based on LHD reports from January to December 2014 where:

- the navy dotted line represents the frequency of occurrences at the labeled waypoint,
- the color of each circle represents the sum of minutes at incorrect flight level and the number of flight levels crossed without clearance (darker orange represents higher value) associated with LHDs occurring at or near the labeled waypoint, and
- the area of the circle represents the sum of operational risk associated with LHDs occurring at or near the labeled waypoint, and
- the turquoise lines represent west-bound traffic movements while the orange lines represent east-bound traffic movements.



Figure 6: Geographical Location of LHDs in WPAC/SCS Airspace

5.7 The transfer-of-control points along the Hong Kong - Manila FIR boundary, **NOMAN** and **SABNO**, remain the main hot spots in WPAC/SCS airspace.

5.8 The transfer-of-control points along the Singapore - Manila FIR boundary, LAXOR and VINIK, are no longer hot spots in the region since the previous year's risk in this area was due to a single long-duration LHD.

5.9 The number of occurrences at DOTMI (all occurred from flights being transferred from Guangzhou to Hong Kong) and OSANU (most occurred from flights being transferred from Manila to Kota Kinabalu) are relatively high, but the durations are low since the accepting ATS

units have radar surveillance over these areas and, therefore, could detect the incorrect position before the flights entered their area of responsibility.

5.10 Even though the overall risk is below the TLS, the Philippines, Hong Kong, and Malaysia should still prioritize AIDC implementations between Hong Kong – Manila FIRs and Kota Kinabalu – Manila FIRs.

6. Long Term Height-keeping Monitoring (LTHM)

To meet the ICAO Annex 6 LTHM requirements, the MAAR undertakes a monitoring program. The current monitoring burden data for WPAC/SCS States is detailed in **Table 6** below.

State	Total RVSM Approved Airframes	Resultant Monitoring Burden	Total Airframes Remaining to be Monitored
Brunei (WB)	13	8	0
Cambodia (VD)	9	6	2
Hong Kong, China (VH)	266	50	2
Laos (VL)	4	2	0
Macau, China (VM)	17	3	0
Malaysia (WM)	287	41	16
Philippines (RP)	198	60	29
Singapore (WS)	198	23	2
Taiwan, China (RC)	191	46	0
Thailand (VT)	298	99	41
Viet Nam (VV)	100	12	2
Grand Total	1581	350	94

 Table 6: LTHM Burden

3/1/2014VEQFL3700.0 minENegative transfer7/1/2014FPLFL330FL3301.0 minENegative transfer7/1/2014FPLFL360FL3600.0 minMPilot-naccurate time estimate15/1/2014VEQFL340FL3801.0 minENo FL revision16/1/2014EOAFL380FL3602.0 minENo FL revision16/1/2014FOAFL400FL3802.0 minENo FL revision21/1/2014FPLFL380FL3600.0 minENo FL revision25/1/2014VEQFL320FL2800.0 minENo FL revision30/1/2014VEQFL320FL2800.0 minENo FL revision31/1/2014VEQFL3801.0 minENo FL revision1/2/2014VEQFL380FL3002.0 minENo FL revision1/2/2014VEQFL380FL3002.0 minENo FL revision2/2/2014VEQFL380FL3000.0 minENo FL revision3/2/2014VEQFL380FL3000.0 minENo FL revision3/2/2014FPLFL360FL3600.0 minENo FL revision3/2/2014FPLFL360FL3600.0 minENo FL revision1/2/2014FPLFL360FL3600.0 minENo FL revision1/2/2014FPLFL360FL3600.0 minE<	Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
7/1/2014 FPL FL330 FL330 1.0 min E Negative transfer $7/1/2014$ FPL FL360 FL360 0.0 min M Pilot-inaccurate time estimate $15/1/2014$ VEQ FL340 FL380 1.0 min E No FL revision $16/1/2014$ EOA FL400 FL380 2.0 min E No FL revision $16/1/2014$ EOA FL400 FL380 2.0 min E No FL revision $21/1/2014$ VEQ FL320 FL300 0.0 min E No FL revision $30/1/2014$ VEQ FL320 FL280 0.0 min E No FL revision $31/1/2014$ VEQ FL380 FL380 1.0 min E No FL revision $32/2014$ VEQ FL380 FL380 1.0 min E No FL revision $3/2/2014$ VEQ FL380 FL380 1.0 min E No FL revision $3/2/2014$ FPL FL360 FL360 0.0	3/1/2014	VEQ		FL370	0.0 min	Е	Negative transfer
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17/2/2014FPLFL300FL300FL300Floor $17/2/2014$ FPLFL360FL3501.0 minENo FL revision $20/2/2014$ VEQS11001.0 minENegative transfer $21/2/2014$ FPLFL310FL3501.0 minENo FL revision $24/2/2014$ FPLFL380FL3401.0 minENo FL revision $24/2/2014$ VEQS1100S11601.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $24/2/2014$ FPLFL350FL38010.0 minENo FL revision $24/2/2014$ FPLFL430FL38010.0 minENo FL revision $25/2/2014$ EOAFL380FL4004.0 minIUnknown $28/2/2014$ EOAFL380FL4004.0 minIUnknown $4/3/2014$ EOAFL360FL4002.0 minENo FL revision $7/3/2014$ FPLFL360FL4001.0 minENo fL revision $11/3/2014$ VEQFL410FL3400.0 minENo FL revision $11/3/2014$ JHD	17/2/2014	FPL	FL380	FL380	1.0 min	E	Negative transfer
1022014VEQS11001.0 minENegative transfer $21/2/2014$ FPLFL310FL3501.0 minENo FL revision $24/2/2014$ FPLFL380FL3401.0 minENo FL revision $24/2/2014$ VEQS1100S11601.0 minENo FL revision $24/2/2014$ VEQS1100S11601.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $25/2/2014$ EOAFL38010.0 minENo FL revision $25/2/2014$ EOAFL380FL4004.0 minI $28/2/2014$ EOAFL380FL4004.0 minI $4/3/2014$ EOAFL360FL4002.0 minE $4/3/2014$ FPLFL360FL4001.0 minE $7/3/2014$ FPLFL340FL3401.0 minE $11/3/2014$ VEQFL410FL3400.0 minE $11/3/2014$ FPLFL410FL3401.0 minE $14/3/2014$ JHDT7.0 minENo time revision	17/2/2014	FPL	FL360	FL350	1.0 min	E	No FL revision
21/2/2014FPLFL310FL3501.0 minENo FL revision $24/2/2014$ FPLFL380FL3401.0 minENo FL revision $24/2/2014$ VEQS1100S11601.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $24/2/2014$ FPLFL350FL3600.0 minENo FL revision $25/2/2014$ EOAFL38010.0 minENegative transfer $27/2/2014$ FPLFL430FL3803.0 minENo FL revision $28/2/2014$ EOAFL380FL4004.0 minIUnknown $4/3/2014$ EOAFL400FL4002.0 minENegative transfer $5/3/2014$ FPLFL360FL4001.0 minENo FL revision $7/3/2014$ FPLFL340FL3401.0 minENo FL revision $11/3/2014$ VEQFL410FL3400.0 minENo FL revision $11/3/2014$ FPLFL410FL3401.0 minENo FL revision $11/3/2014$ JHDT7.0 minENo time revision	20/2/2014	VEO		S1100	1.0 min	E	Negative transfer
24/2/2014 FPL FL380 FL340 1.0 min E No FL revision 24/2/2014 VEQ S1100 S1160 1.0 min E No FL revision 24/2/2014 VEQ S1100 S1160 1.0 min E No FL revision 24/2/2014 FPL FL350 FL360 0.0 min E No FL revision 24/2/2014 FPL FL350 FL360 0.0 min E No FL revision 25/2/2014 EOA FL380 10.0 min E No FL revision 28/2/2014 EOA FL380 FL400 4.0 min I Unknown 4/3/2014 EOA FL360 FL400 2.0 min E Negative transfer 5/3/2014 FPL FL360 FL400 1.0 min E No fL revision 11/3/2014 VEQ FL410 FL340 0.0 min E No fL revision 11/3/2014 VEQ FL410 FL340 1.0 min E No FL revision	21/2/2014	FPL	FL310	FL350	1.0 min	E	No FL revision
24/2/2014 VEQ S1100 S1160 1.0 min E No FL revision 24/2/2014 FPL FL350 FL360 0.0 min E No FL revision 25/2/2014 EOA FL350 FL360 10.0 min E No FL revision 25/2/2014 EOA FL380 10.0 min E No FL revision 27/2/2014 FPL FL430 FL380 3.0 min E No FL revision 28/2/2014 EOA FL380 FL400 4.0 min I Unknown 4/3/2014 EOA FL400 FL400 2.0 min E No FL revision 7/3/2014 FPL FL360 FL400 1.0 min E No FL revision 11/3/2014 VEQ FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision <	24/2/2014	FPL	FL380	FL340	1.0 min	E	No FL revision
24/2/2014FPLFL350FL3600.0 minENo FL revision $25/2/2014$ EOAFL380 $10.0 min$ ENo FL revision $25/2/2014$ EOAFL430FL380 $10.0 min$ ENegative transfer $27/2/2014$ FPLFL430FL380 $3.0 min$ ENo FL revision $28/2/2014$ EOAFL430FL400 $4.0 min$ IUnknown $4/3/2014$ EOAFL400FL400 $2.0 min$ ENegative transfer $5/3/2014$ FPLFL360FL400 $1.0 min$ ENo FL revision $7/3/2014$ FPLFL340FL340 $1.0 min$ ENo FL revision $11/3/2014$ VEQFL410FL340 $0.0 min$ ENo FL revision $11/3/2014$ FPLFL410FL340 $1.0 min$ ENo FL revision $14/3/2014$ JHD	24/2/2014	VEO	S1100	S1160	1.0 min	E	No FL revision
25/2/2014EOAFL300FL300FL300Flance $25/2/2014$ EOAFL380 $10.0 min$ ENegative transfer $27/2/2014$ FPLFL430FL380 $3.0 min$ ENo FL revision $28/2/2014$ EOAFL380FL400 $4.0 min$ IUnknown $4/3/2014$ EOAFL400FL400 $2.0 min$ ENegative transfer $5/3/2014$ FPLFL360FL400 $1.0 min$ ENo FL revision $7/3/2014$ FPLFL340FL340 $1.0 min$ ENo time revision $11/3/2014$ VEQFL410FL340 $0.0 min$ ENo FL revision $11/3/2014$ FPLFL410FL340 $1.0 min$ ENo FL revision $11/3/2014$ JHDT $7.0 min$ ENo time revision	24/2/2014	FPL	FL350	FL360	0.0 min	E	No FL revision
27/2/2014 FPL FL430 FL380 3.0 min E No FL revision 28/2/2014 EOA FL380 FL400 4.0 min I Unknown 4/3/2014 EOA FL400 FL400 2.0 min E Negative transfer 5/3/2014 EOA FL400 FL400 1.0 min E No FL revision 7/3/2014 FPL FL360 FL400 1.0 min E No fL revision 11/3/2014 FPL FL340 FL340 1.0 min E No fL revision 11/3/2014 VEQ FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 14/3/2014 JHD VE 7.0 min E No time revision	25/2/2014	EOA		FL380	10.0 min	E	Negative transfer
28/2/2014 EOA FL300 FL400 4.0 min I Unknown 4/3/2014 EOA FL400 FL400 2.0 min E Negative transfer 5/3/2014 FPL FL360 FL400 1.0 min E No FL revision 7/3/2014 FPL FL360 FL400 1.0 min E No fL revision 11/3/2014 FPL FL340 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 14/3/2014 JHD V 7.0 min E No time revision	27/2/2014	FPL	FL430	FL380	3.0 min	E	No FL revision
4/3/2014 EOA FL400 FL400 2.0 min E Negative transfer 5/3/2014 FPL FL360 FL400 1.0 min E Negative transfer 5/3/2014 FPL FL360 FL400 1.0 min E No FL revision 7/3/2014 FPL FL340 FL340 1.0 min E No time revision 11/3/2014 VEQ FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 11/3/2014 JHD FL410 FL340 1.0 min E No FL revision	28/2/2014	EOA	FL380	FL400	4.0 min	I	Unknown
5/3/2014 FPL FL360 FL400 1.0 min E No FL revision 7/3/2014 FPL FL340 FL340 1.0 min E No FL revision 11/3/2014 FPL FL340 FL340 0.0 min E No FL revision 11/3/2014 VEQ FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 14/3/2014 JHD 7.0 min E No time revision	4/3/2014	EOA	FL400	FL400	2.0 min	E	Negative transfer
7/3/2014 FPL FL340 FL340 1.0 min E No time revision 11/3/2014 VEQ FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 14/3/2014 JHD	5/3/2014	FPL	FL360	FL400	1 0 min	E	No FL revision
11/3/2014 VEQ FL410 FL340 0.0 min E No FL revision 11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 14/3/2014 JHD V Y Y Y Y Y	7/3/2014	FPL	FL340	FL340	1.0 min	E	No time revision
11/3/2014 FPL FL410 FL340 1.0 min E No FL revision 14/3/2014 JHD 7.0 min E No time revision	11/3/2014	VEO	FL410	FL340	0.0 min	E	No FL revision
$\frac{14/3}{2014} JHD \qquad \qquad 12000 He = 100000000000000000000000000000000000$	11/3/2014	FPL	FL 410	FL340	1.0 min	E	No FL revision
	14/3/2014	IHD	12110	1 2010	7 () min	E	No time revision
24/3/2014 FPL FL350 FL350 0.0 min E Negative transfer	24/3/2014	FPL	FL350	FL350	0.0 min	E	Negative transfer
25/3/2014 FPL FL330 FL370 1.0 min E No FL revision	25/3/2014	FPI	FL330	FL370	1 0 min	E	No FL revision
3/4/2014 VEO FL361 FL351 0.0 min E No FL revision	3/4/2014	VEO	FL361	FL351	0.0 min	E	No FL revision
7/4/2014 MMK FL350 FL360 0.0 min E No FL revision	7/4/2014	MMK	FL350	FL360	0.0 min	E	No FL revision
11/4/2014 VEO FL381 FL361 0.0 min E No FL revision	11/4/2014	VEO	FL381	FL361	0.0 min	E	No FL revision

Appendix A: Details of the Re	ported LHD Events in	the WPAC/SCS Airspace	ce
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Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
13/4/2014	FPL	FL380	FL380	0.0 min	Е	No time revision
14/4/2014	MMK			0.0 min	E	No time revision
14/4/2014	MMK			0.0 min	Е	No time revision
15/4/2014	MMK	FL330	FL370	0.0 min	E	No FL revision
15/4/2014	VEQ	FL340	FL380	1.0 min	Е	No FL revision
19/4/2014	VEQ	FL340	FL300	0.0 min	Е	No FL revision
22/4/2014	FPL	FL370	FL370	1.0 min	Е	Negative transfer
4/5/2014	VEQ		FL400	0.0 min	Е	Negative transfer
7/5/2014	VEQ	FL380	FL340	0.0 min	Е	No FL revision
9/5/2014	VEQ	FL340	FL380	0.0 min	Е	No FL revision
14/5/2014	FPL			1.0 min	Е	Negative transfer
14/5/2014	FPL	FL380	FL380	3.0 min	Е	No time revision
16/5/2014	FPL			2.0 min	Е	Negative transfer
18/5/2014	FPL	FL410	FL400	0.0 min	E	No FL revision or transferred with wrong FL
19/5/2014	MMK	FL380	FL340	0.0 min	Е	No FL revision
2/6/2014	MMK	FL370	FL400	0.0 min	Е	Transfer with wrong FL
3/6/2014	FPL	FL340	FL380	0.0 min	E	Readback-hearback
5/6/2014	VEO	FL370	FL310	0.0 min	E	Transfer with wrong FL
8/6/2014	FPL	FL310	FL310	3.0 min	Ē	No time revision
12/6/2014	VEO		FI.410	0.0 min	E	Negative transfer
13/6/2014	MMK		12.10	0.0 min	Ē	No time revision
14/6/2014	VEO	FL401	FL411	1.0 min	В	Pilot-climb/descend without
15/5/2014	1 TEO	EL QOO	FX 0.50		D	clearance
15/6/2014	VEQ	FL380	FL350	0.0 min	D	Pilot-ATC miscommunication
20/6/2014	FPL	FL330	FL330	3.0 min	E	Negative transfer
21/6/2014	VEQ	FL360	FL300	0.0 min	E	Transfer with wrong FL
29/6/2014	FPL	FL340	FL320	0.0 min	E	No FL revision
3/7/2014	VEQ	FL401	FL411	0.0 min	E	No FL revision
5/7/2014	WMT	FL380	FL360	0.0 min	E	No FL revision
5/7/2014	WMT	FL360	FL380	0.0 min	E	No FL revision
5/7/2014	FPL	FL330	FL330	2.0 min	E	Readback-hearback
7/7/2014	MMK			0.0 min	E	No time revision
16/7/2014	FPL	FL290	FL290	3.0 min	E	No time revision
18/7/2014	FPL	FL370	FL270	1.0 min	E	Transfer with wrong FL
23/7/2014	FPL	FL320	FL340	0.0 min	E	Readback-hearback
1/8/2014	FPL		FL290	8.0 min	E	Negative transfer
3/8/2014	EOA	FL380	FL368	0.0 min	E	No FL revision
3/8/2014	VEQ	FL320	FL280	1.0 min	E	No FL revision
3/8/2014	EOA	FL360	FL352	0.0 min	E	No FL revision
4/8/2014	EOA	FL390	FL330	2.0 min	E	No FL revision
6/8/2014	VEQ	FL381	FL381	0.0 min	E	No time revision
7/8/2014	VEQ	FL380	FL360	3.0 min	E	No FL revision
7/8/2014	FPL	FL290	FL290	5.0 min	E	No time revision

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
7/8/2014	VEQ	FL370	FL410	0.0 min	Е	No FL revision
8/8/2014	VEQ		FL360	0.0 min	Е	Negative transfer
8/8/2014	MMK	FL400	FL400	0.0 min	Е	No time revision
11/8/2014	FPL	FL380	FL380	0.0 min	E	ATC-inaccurate time estimate
12/8/2014	VEQ		FL360	0.0 min	E	Negative transfer
14/8/2014	FPL	FL390	FL390	0.0 min	E	No time revision
14/8/2014	VEQ		FL320	0.0 min	Е	Negative transfer
22/8/2014	FPL	FL370	FL370	0.0 min	Е	Negative transfer
25/8/2014	ZQF	FL390	FL410	2.0 min	Е	No FL revision
30/8/2014	MMK	FL340	FL380	0.0 min	E	Readback-hearback
31/8/2014	VEQ	FL370	FL410	0.0 min	E	No FL revision
4/9/2014	FPL	FL350	FL340	0.0 min	Е	No FL revision
4/9/2014	VEQ		FL331	0.0 min	Е	Negative transfer
6/9/2014	MMK		FL330	0.0 min	E	Negative transfer
10/9/2014	FPL	FL380	FL380	0.0 min	Е	No time revision
12/9/2014	VEQ	FL350	FL360	0.0 min	Е	No FL revision
16/9/2014	VEQ	FL320	FL360	0.0 min	Е	Negative transfer
23/9/2014	FPL	FL340	FL380	0.0 min	Е	Readback-hearback
23/9/2014	VEQ	FL380	FL340	0.0 min	Е	No FL revision
24/9/2014	MMK			0.0 min	Е	No time revision
29/9/2014	MMK	FL310	FL350	0.0 min	Е	No FL revision
1/10/2014	MMK	FL300	FL380	0.0 min	Е	No FL revision
5/10/2014	FPL	FL350	FL350	0.0 min	Е	No time revision
7/10/2014	VEQ	FL390	FL360	0.0 min	Е	No FL revision
7/10/2014	FPL	FL370	FL330	0.0 min	Е	No FL revision
10/10/2014	VEQ		FL391	0.0 min	E	Negative transfer
11/10/2014	VEQ		FL320	0.0 min	Е	Negative transfer
12/10/2014	FPL	FL350	FL350	0.0 min	E	No time revision
12/10/2014	FPL	FL350	FL390	1.0 min	Е	No FL revision
13/10/2014	EOA	FL400	FL400	1.0 min	Е	Readback-hearback
13/10/2014	EOA	FL360	FL360	1.0 min	Е	Readback-hearback
14/10/2014	VEQ	FL330	FL370	0.0 min	Е	Transfer with wrong FL
14/10/2014	MMK			0.0 min	Е	No time revision
21/10/2014	MMK			0.0 min	Е	Negative transfer
28/10/2014	VEQ	FL400	FL380	0.0 min	Е	No FL revision
3/11/2014	FPL	FL330	FL330	1.0 min	E	Negative transfer
8/11/2014	WMT	FL390	FL393	1.0 min	Ι	Unknown
8/11/2014	WMT	FL400	FL418	1.0 min	J	Unknown
13/11/2014	MMK			0.0 min	Е	No time revision
14/11/2014	MMK	FL390	FL350	0.0 min	E	Readback-hearback
16/11/2014	MMK		FL350	0.0 min	Е	Negative transfer
17/11/2014	FPL	FL380	FL380	0.0 min	E	No time revision
22/11/2014	MMK	FL350	FL310	0.0 min	Е	No FL revision

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
25/11/2014	FPL	FL380	FL340	0.0 min	E	No FL revision
26/11/2014	VEQ		FL360	0.0 min	E	Negative transfer
27/11/2014	VEQ	FL340	FL300	0.0 min	E	No FL revision
4/12/2014	MMK			0.0 min	E	No time revision
4/12/2014	VEQ		FL370	0.0 min	F	Negative transfer
4/12/2014	MMK			0.0 min	E	No time revision
4/12/2014	EOA	FL360	FL400	0.0 min	E	No FL revision
4/12/2014	VEQ		FL390	2.0 min	F	Negative transfer
7/12/2014	VEQ	FL350	FL370	0.0 min	E	No FL revision
7/12/2014	VEQ	FL380	FL400	0.0 min	В	Unknown
9/12/2014	VEQ		FL331	0.0 min	E	Negative transfer
13/12/2014	VEQ		FL320	0.0 min	E	Negative transfer
14/12/2014	VEQ	FL340	FL380	0.0 min	E	No FL revision
15/12/2014	CCR	FL360	FL360	0.0 min	E	No time revision
17/12/2014	WMT	FL310	FL316	0.0 min	В	Unknown
18/12/2014	JHD	FL360	FL350	0.0 min	E	Negative transfer
18/12/2014	VEQ	FL340	FL380	0.0 min	E	No FL revision
24/12/2014	FPL	FL340	FL340	0.0 min	E	Negative transfer

Attachment 3

MONITORING AGENCY FOR ASIA REGION (MAAR)



Airspace Safety Review of RVSM in Mongolian Airspace

January 2014 to December 2014

AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN THE MONGOLIAN AIRSPACE Assessment Period: January 2014 to December 2014

Prepared by Monitoring for Asia Region (MAAR) (An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

This report provides an airspace safety review of RVSM airspace risk in **Mongolian Airspace**. The review is conducted based on a one-month traffic sample data (TSD) collected in **December 2014** and monthly Large Height Deviation (LHD) reports between **January 2014** and **December 2014** submitted by Mongolia.

2. Data Sources

2.1. **Traffic Sample Data (TSD).** A TSD covering the month of December 2014 of aircraft operating in Mongolian Airspace was used as required by ICAO regional agreement.

2.2. Large Height Deviation (LHD). A cumulative 12-month data set of LHD reports was, covering January 2014 to December 2014. Table 1 indicates Ulaanbaatar FIR which submitted LHD reports including nil returns. Appendix A provides details of LHD reports.

FIR/ Month	Ulaanbaatar
January	Х
February	Х
March	Х
April	Х
May	Х
June	Х
July	Х
August	Х
September	Х
October	X
November	Х
December	X

 Table 1: Summary of LHD Reports Submitted by the FIR

3. Summary of LHD Occurrences

3.1. **Table 2** and **Figure 1** summarize the number of Non-NIL LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed, and their associated operational risk by month from January 2014 to December 2014.

Month	No. of Non-NIL	LHD Duration	No. Levels	Operational	
(2014)	LHD	(Min)	Crossed	Risk (x10 ⁻⁹)	
January	0	0.0	0	0.00	
February	0	0.0	0	0.00	
March	1	0.8	0	0.51	
April	4	1.6	0	1.01	
May	2	0.0	0	0.00	
June	0	0.0	0	0.00	
July	0	0.0	0	0.00	
August	0	0.0	0	0.00	
September	9	0.8	0	0.51	
October	2	0.0	0	0.00	
November	0	0.0	0	0.00	
December	0	0.0	0	0.00	
Total	18	3.2	0	2.02	

Table 2: Summary of LHD by Month for Mongolian Airspace



Figure 1: Summary of LHD Occurrences by Month for Mongolian Airspace

- Even though the number of LHD reports in 2014 doubled from 2013, the total LHD duration slightly decreased because of a 2013 single event whose duration was 14 minutes.
- Originally, all LHDs were reported with duration 'less than a minute', which MAAR used 0.8 to quantify this duration. However, MAAR was informed by the Chief of Safety and Quality Assurance section of Air Traffic Service of Mongolia that LHDs occurrences near Ulaanbaatar Beijing FIRs were resolved before aircraft entered the Mongolian Airspace. Therefore, the durations of LHDs at NIXAL and INTIK were modified to zero instead.

3.2. **Table 3** and **Figure 2** summarize the number of LHD occurrences, the associated LHD duration (in minutes), and number of flight levels crossed without clearance, by LHD category from January 2014 to December 2014.

LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Uperauon al Risk (x10 ⁻⁹)
Α	Flight crew failing to climb/descend the aircraft as cleared	0	0.0	0	0.00
В	Flight crew climbing/descending without ATC Clearance	0	0.0	0	0.00
С	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-clearance etc)	0	0.0	0	0.00
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	0	0.0	0	0.00
E	Coordination errors in the ATC to ATC transfer or 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)	15	3.2	0	2.02
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues	3	0.0	0	0.00
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	0	0.0	0	0.00
Н	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0.0	0	0.00
Ι	Deviation due to turbulence or other weather related cause	0	0.0	0	0.00
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	0	0.0	0	0.00
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0.0	0	0.00
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)	0	0.0	0	0.00
М	Other – this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.	0	0.0	0	0.00
Total		18	3.2	0	2.02



Table 3: Summary of LHD by LHD Category for Mongolian Airspace



3.3. Category E LHDs account for all of LHD duration and occurrences in Mongolian airspace, resulted in 2.02×10^{-9} FAPFH.

3.4. The cause of all LHD reports was that no flight level revision was received, as detailed in Appendix A.

4. Risk Assessment and Safety Oversight

4.1. **Collision Risk Model (CRM) Parameters.** The value and the source of the parameters in the CRM used to estimate risk in the RVSM airspace are summarized in **Table 4**.

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
Т	Annual flight hours	106,825	5,719	Hour	Dec 2014 TSD
E _z (same)	Same-direction vertical occupancies	0.5396/ 0.0016	0.0000	-	
E _z (opposite)	Opposite-direction vertical occupancies	0.1764	0.0806	-	
λ_{x}	Average aircraft length	0.0346	0.0329	NM	
λ_y	Average aircraft wingspan	0.0321	0.0302	NM	
λ_z	Average aircraft height	0.0094	0.0090	NM	
λ_h	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0346	0.0329	NM	
Pz(0)	Probability of vertical overlap (with planned vertical separation equal to zero)	0.538	0.538	-	More conservative value used in previous assessments

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
$\overline{ \Delta V }$	Average relative along-track speed between aircraft on same direction routes	33.95	33.95	Knot	Dec 2014 TSD
	Average absolute aircraft ground speed	480	480	Knot	More conservative value used in previous assessments

 Table 4: Estimates of the Parameters in the CRM for Mongolian Airspace

4.2. **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 5**. The technical risk **meets** the agreed TLS value of no more than 2.5×10^{9} fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes. **The total risk <u>meets</u> the specified TLS value for these components of 5.0 x 10⁻⁹**.

Mongolia RVSM Airspace						
– estimated annual flying hours = 108,773 hours						
(note: estimated hours based on December 2014 traffic sample data)						
Source of Risk	Risk Estimation	TLS	Remarks			
Technical Risk	0.96 x 10 ⁻⁹	2.5 x 10 ⁻⁹	Below Technical TLS			
Operational Risk	2.02 x 10 ⁻⁹	-	-			
Total Risk 2.98 x 10 ⁻⁹ 5.0 x 10 ⁻⁹ Below Overall TLS						

 Table 5: Risk Estimates for Mongolian Airspace

4.3. **Figure 3** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.



Figure 3: Trends of Risk Estimates for Mongolian Airspace

4.4. A monthly LHD risk value is determined to provide real-time information on actual risk without reliance on historical high-time errors resident within the 12 month data sample. The data in **Figure 4** below shows that one LHD occurrence in Mongolian airspace causes risk to be <u>above</u> the average monthly risk of the annual risk of 5.0×10^{-9} (red line in **Figure 4** below, which is approximately 0.4167 x 10^{-9} fatal accidents per flight hour).



Figure 4: Monthly LHD Risk Estimates for Mongolian Airspace. Red line is the average monthly value for an annual risk of 5.0 x 10⁻⁹. Risk is measured in Fatal Accidents per Flight Hour (FAPFH).

5. Analysis of Operational Errors

5.1 **Figure 6** depicts geographic location of LHDs and hot spots in Mongolian Airspace based on LHD reports from January to December 2014 where:

- the navy dotted line represents the frequency of occurrences at the labeled waypoint,
- the color of each circle represents the sum of minutes at incorrect flight level and the number of flight levels crossed without clearance (darker orange represents higher value) associated with LHDs occurring at or near the labeled waypoint,
- the area of the circle represents the sum of operational risk associated with LHDs occurring at or near the labeled waypoint, and
- the turquoise lines represent west-bound traffic movements while the orange lines represent east-bound traffic movements.



Figure 6: Geographical Location of LHDs in Mongolian Airspace

5.2 In terms of number of occurrences, the main hot spots in the Mongolian airspace remain the southeast boundary of Ulaanbaatar FIR next to Beijing FIR (NIXAL and INTIK) and the northwest boundary next to Krasnoyarsk FIR (DARNO). The hot spots are the gates of the major traffic flows in

the airspace. However, due to the reduction in LHD duration near NIXAL and INTIK, the risk in these locations were reduced to zero. (The LHD duration at NIXAL in 2013 was mostly contributed by a single 14-minute occurrence.)

5.3 Due to the high number of LHD occurrences near NIXAL and INTIK, Mongolia has extended their SSR coverage for approximately 30NM further from its boundary since December 2014.

5.4 Please note that the Mongolian airspace has relatively high impact factors, which means that there is higher risk per 1 minute of LHD. This is because the Mongolian RVSM airspace has relatively high occupancy and large average aircraft size compared to other regions since almost all RVSM traffic is overflying long-haul flights. Therefore, the total risk is extremely sensitive to the reported LHD durations.

6. Long Term Height-keeping Monitoring (LTHM)

To meet the ICAO Annex 6 LTHM requirements, the MAAR undertakes a monitoring program. The current monitoring burden data for Mongolia States is detailed in **Table 7** below.

State	Total RVSM	Resultant	Total Airframes
	Approved	Monitoring	Remaining to be
	Airframes	Burden	Monitored
Mongolia (ZM)	5	4	0

 Table 7: LTHM Burden

Date	Assigned FL	Observe/ Reported FL	Duration at Incorrect FL	Category	Cause
25/3/2014	351	371	0.8	E	No FL revision
2/4/2014	351	371	0.8	Е	No FL revision
5/4/2014	331	351	0.8	Е	No FL revision
25/4/2014	321	341	0.0	Е	No FL revision
25/4/2014	321	341	0.0	Е	No FL revision
23/5/2014	301	276	0.0	Е	No FL revision
23/5/2014	361	381	0.0	Е	No FL revision
1/9/2014	321	341	0.0	Е	No FL revision
9/9/2014	321	341	0.0	E	No FL revision
18/9/2014	276	301	0.0	E	No FL revision
18/9/2014	301	321	0.0	E	No FL revision
24/9/2014	331	351	0.8	E	No FL revision
27/9/2014	361	341	0.0	E	No FL revision
28/9/2014	301	341	0.0	F	No FL revision
28/9/2014	341	361	0.0	F	No FL revision
28/9/2014	301	361	0.0	F	No FL revision
14/10/2014	301	321	0.0	E	No FL revision
14/10/2014	301	321	0.0	E	No FL revision

Appendix A: Details of the Reported LHD Events in the Mongolian Airspace

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