



*International Civil Aviation Organization*

**The Nineteenth Meeting of the Regional Airspace Safety Monitoring  
Advisory Group (RASMAG/19)**

Pattaya, Thailand, 27-30 May 2014

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**MAAR SAFETY REPORT**

(Presented by Monitoring Agency for Asia Region)

**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 proposed some actions in regards to Traffic Sample Data (TSD) and safety issues in the regions.

**1. INTRODUCTION**

- 1.1. This paper provides the airspace safety oversight for the RVSM operation in Bay of Bengal (BOB), Western Pacific/South China Sea (WPAC/SCS), and Mongolia.
- 1.2. The reports are provided in **Attachment 1, 2 and 3** respectively. Each report contains:
- the executive summary, including risk estimates of the assessed region, operational risk by Large Height Deviation (LHD) category, 12-month cumulative operational risk trend by LHD category, and summary of discussion,
  - 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**

Traffic Sample Data

- 2.1. MAAR encounters quite a number of problems with December 2013 Traffic Sample Data (TSD). The problems include very late submission, TSD template not being followed, and TSD containing numerous errors and typos.
- 2.2. The main cause of this problem seems to lie upon the fact that many States still rely heavily on manual processing of their TSDs.
- 2.3. As a result, MAAR would like to encourage States that do not have an automated TSD generation capability to submit their raw FPL messages instead of the conventional-format TSDs.

MAAR is currently using this approach with Manila, Male, and Dhaka FIRs, which has been proven very successful since it greatly reduced the resources required to prepare the TSDs for States and to validate the TSDs for MAAR. Please note that even though FPLs do not represent actual traffic movement, the parameters derived from the FPLs are acceptable in terms of risk estimation.

2.4. In this connection, MAAR would like to propose a Draft Conclusion to be presented for consideration by the meeting and approval by APANPIRG:

**RASMAG Draft Conclusion 19/X: Submission of FPLs as Traffic Sample Data (TSD)**

That, the States under MAAR's area of responsibility that do not have an automated TSD generation capability are urged to submit their raw FPL messages to MAAR instead of the conventional TSDs.

LHD Mitigation

2.5. Due to the high level of operational risk in Bay of Bengal (BOB) airspace, LHD occurrences in this region should be carefully investigated by the suitable APANPIRG Group. A preliminary analysis suggests that the following domains should be taken into consideration:

- The ATC-to-ATC communication channel and procedure for transferring an aircraft and the revisions of flight information.
- The surveillance coverage of the hot-spot areas. Surveillance service for the accepting ATC unit should significantly reduce the duration of LHDs. The better the surveillance, the faster the accepting ATC unit can detect and manage the unexpected traffic.
- ADS-C/CPDLC service will also help reduce the LHD's duration as the aircraft's position is typically reported to the accepting ATC unit at the transfer-of-control point.
- The reporting procedure for the flight crew before entering the FIR. If the pilot reports to the accepting ACC before the transfer of control point, the less chance that the aircraft will fly at a flight level unexpected by the accepting ATC unit.
- ATC automation system's human-machine interface. For States that plan to acquire or upgrade their ATC automation system, especially the systems that utilize electronic strips environment, some consideration should be taken into a design of human-machine interface that will help remind the air traffic controller of the transferring ACC unit to send flight information revision to the accepting ATC unit when necessary.

2.6. The above items could also be considered and implemented not only in BOB airspace, but also in other portions of airspace as region-wide risk mitigation measures.

**3. ACTIONS BY THE MEETING**

3.1 The meeting is invited to:

- a) note the information contained in this paper;
- b) discuss and finalize the Draft Conclusion;
- c) identify a suitable body to further investigate the occurrences in BOB airspace and to find the appropriate risk mitigation measures; and
- d) discuss any relevant matters as appropriate.

**MONITORING AGENCY FOR ASIA REGION (MAAR)**



**Airspace Safety Review of RVSM in  
Bay of Bengal Airspace**

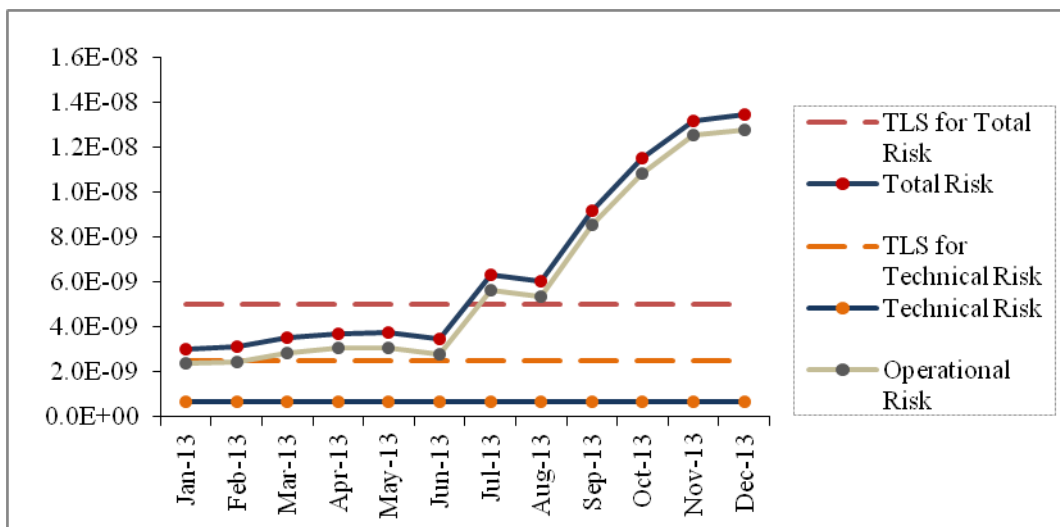
**January 2013 to December 2013**

### Executive Summary

For the period 1<sup>st</sup> January 2013 to 31<sup>st</sup> December 2013 inclusive, the total risk in Bay of Bengal (BOB) airspace does not meet the agreed Target Level of Safety (TLS) value of  $5.0 \times 10^{-9}$ . Table A summarizes RVSM technical, operational and total risks. Figure A presents collision risk estimate trends using the appropriate cumulative 12-month data set of LHD reports.

Bay of Bengal RVSM Airspace – estimated annual flying hours = 1,869,508 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	$0.65 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$12.82 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>13.47 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Above Overall TLS</b>

**Table A: Risk Estimates for BOB Airspace**



**Figure A: Trends of Risk Estimates for BOB Airspace**

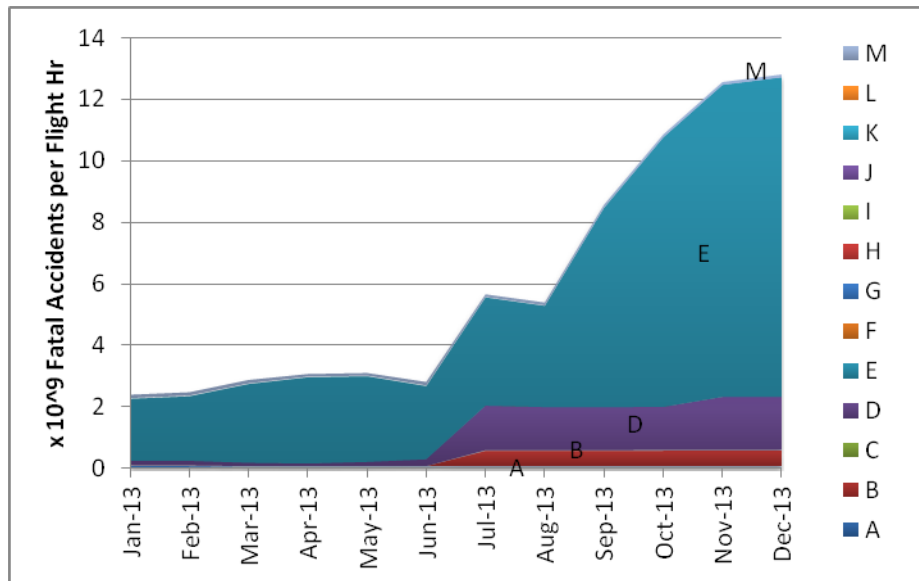
Table B presents a summary of operational risk associated with Large Height Deviation (LHD) reports by LHD category within BOB airspace from January 2013 to December 2013.

Code	LHD Category	Operational Risk (x 10 <sup>-9</sup> )
A	Flight crew fails to climb or descend the aircraft as cleared	0.08
B	Flight crew climbing or descending without ATC clearance	1.48
C	Incorrect operation or interpretation of airborne equipment	-
D	ATC system loop error	0.71
E	ATC transfer of control coordination errors due to human factors	10.39
F	ATC transfer of control coordination errors due to technical issues	-
G	Aircraft contingency leading to sudden inability to maintain level	-
H	Airborne equipment failure and unintentional or undetected level Change	-

Code	LHD Category	Operational Risk (x 10 <sup>-9</sup> )
I	Turbulence or other weather related cause	-
J	TCAS resolution advisory and flight crew correctly responds	0.00
K	TCAS resolution advisory and flight crew incorrectly responds	-
L	An aircraft being provided with RVSM separation is not RVSM Approved	-
M	Other	0.16
<b>Total</b>		<b>12.82</b>

**Table B: Summary of Operational Risk by LHD Category for BOB Airspace**

**Figure B** provides the 12-month cumulative operational risk by LHD category for BOB airspace from January 2013 to December 2013 showing Category E LHDs as the main contributor to the total operational risk.



**Figure B: Trends of Operational Risk by LHD Category for BOB Airspace**

The main hot spots in BOB airspace are:

- the transfer-of-control points along the Kolkata - Yangon FIR boundary,
- the transfer-of-control points along the Chennai - Yangon FIR boundary, and
- the transfer-of-control points along the Chennai - Kuala Lumpur FIR boundary.

The recent increase in LHD reports is likely due to the initiative taken by AAI and BOBASMA to increase the awareness among controllers on safety issues and also MAAR's forwarding of LHD reports to States of the transferring ACCs.

Deficiencies in communication and surveillance services may also be a factor that contributes to the large sum of LHD durations. The LHD occurrences in BOB region should be further investigated by the suitable APANPIRG Group.

Releasing aircraft at flight levels conflicting with airspace restrictions is the most common problem in Kabul FIR. The duration of this type of LHDs is rising in year 2014, therefore, this concern should be raised among the relevant parties.

## AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN THE BAY OF BENGAL AIRSPACE

**Assessment Period: January 2013 to December 2013**

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 2013** and monthly Large Height Deviation (LHD) reports between **January 2013** and **December 2013** submitted by concerning States in the BOB region.

### 2. Data Sources

2.1. **Traffic Sample Data (TSD).** A TSD covering the month of December 2013 of aircraft operating in BOB airspace was used as required by ICAO regional agreement. *For this assessed period, Kuala Lumpur did not submit their TSD; therefore, the 2012 Kuala Lumpur TSD was used instead.*

2.2. **Large Height Deviation (LHD).** Accumulative 12-month data set of LHD reports was, covering January 2013 to December 2013. **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	X	X	X	X	X	X	X	X	X	X	X	X	X
February	X	X	X	X	X	X	X	X	X	X	X	X	X
March	X	X	X	X	X	X	X	X	X	X	X	X	X
April	X	X	X	X	X	X	X	X	X	X	X	X	X
May	X	X	X	X	X	X	X	X	X	X	X	X	X
June	X	X	X	X	X	X	X	X	X	X	X	X	X
July	X	X	X	X	X	X	X	X	X	X	X	X	X
August	X	X	X	X	X	X	X	X	X	X	X	X	X
September	X	X	X	X	X	X	X	X	X	X	X	X	X
October	X	X	X	X	X	X	X	X	X	X	X	X	X
November	X	X	X	X	X	X	X	X	X	X	X	X	X
December	X	X	X	X	X	X	X	X	X	X	X	X	X

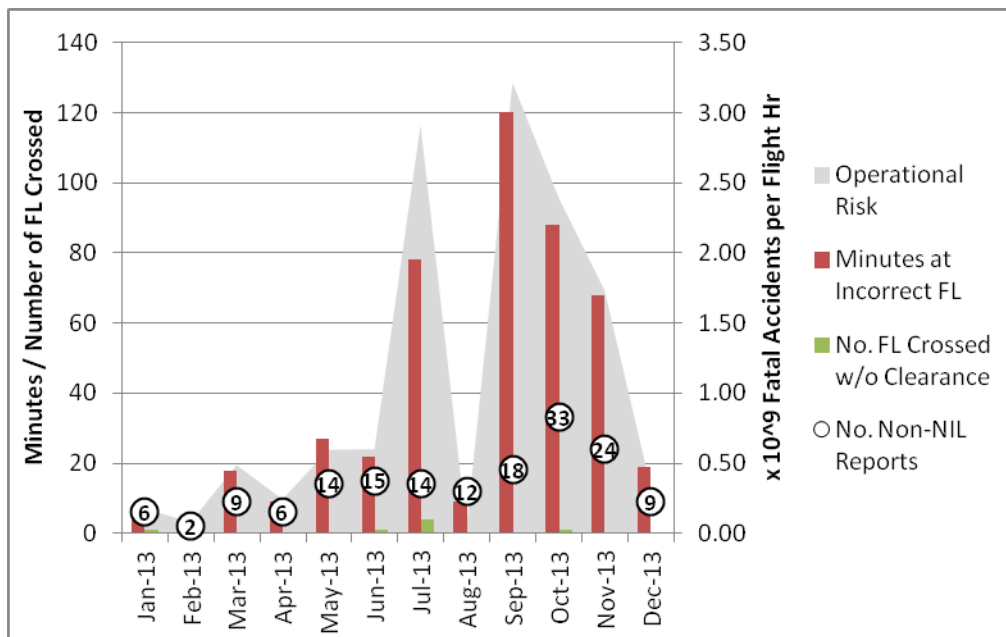
**Table 1:** Summary of LHD Reports Submitted by FIRs

### 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 2013 to December 2013.

Month (2013)	No. of Non-NIL LHD	LHD Duration (Min)	No. Levels Crossed	Operational Risk ( $\times 10^{-9}$ )
January	6	7.0	1	0.18
February	2	3.0	0	0.08
March	9	18.0	0	0.49
April	6	9.0	0	0.24
May	14	27.0	0	0.60
June	15	22.0	1	0.60
July	14	78.0	4	2.91
August	12	9.0	0	0.04
September	18	120.0	0	3.21
October	33	88.0	1	2.40
November	24	68.0	0	1.73
December	9	19.0	0	0.33
<b>Total</b>	<b>162</b>	<b>468.0</b>	<b>7</b>	<b>12.82</b>

**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 2012, the number of non-nil LHD reports rose from 46 to 162. The total of LHD duration increased 4 folds, 116.5 to 468 minutes.



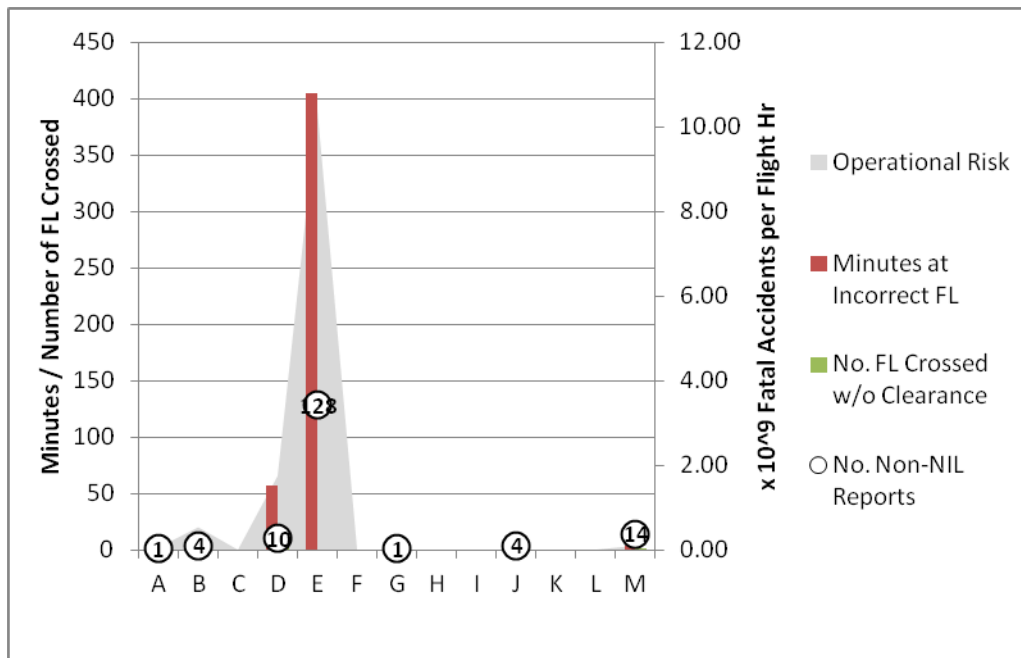
- This increase is likely due to the initiative taken by AAI and BOBASMA to increase the awareness among controllers on safety issues as presented in RASMAG MAWG/1 WP/22.
- The reporting rate also increased when MAAR started sending LHD reports to States of the transferring ACCs.
- There were 15 occurrences (totaling 152 minutes) that the transferring ACC investigated and claimed that they already sent the transfer messages and the necessary time or flight level revisions. For some occurrences, the aircraft did not even change flight levels and stayed at the transferred flight levels throughout the FIR. These incidents could be further investigated by the suitable APANPIRG Group or a smaller sub-group in order to find the root cause of this problem.

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 2013 to December 2013.

LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Operational Risk ( $\times 10^{-9}$ )
<b>A</b>	Flight crew failing to climb/descend the aircraft as cleared	2	3.0	0	0.08
<b>B</b>	Flight crew climbing/descending without ATC Clearance	3	35.0	3	1.48
<b>C</b>	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
<b>D</b>	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	8	17.0	3	0.71
<b>E</b>	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)	128	405.0	0	10.39
<b>F</b>	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
<b>G</b>	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	1	0.0	0	0.00
<b>H</b>	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0.0	0	0.00
<b>I</b>	Deviation due to turbulence or other weather related cause	0	0.0	0	0.00
<b>J</b>	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	4	0.0	0	0.00
<b>K</b>	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0.0	0	0.00
<b>L</b>	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

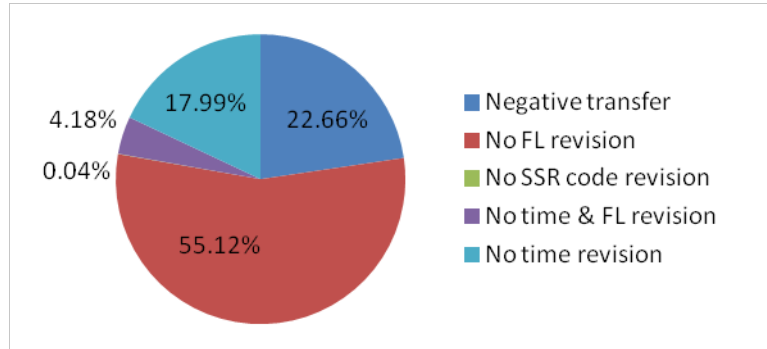
LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Operational Risk (x10 <sup>-9</sup> )
M	Other – this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.	16	8.0	1	0.16
<b>Total</b>		<b>162</b>	<b>468.0</b>	<b>7</b>	<b>12.82</b>

**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

3.5. Another distinctive group of LHDs is the LHDs that are prevalent in the Kabul FIR. Since the Kabul FIR has many restrictions over traffic entering the FIR, most LHDs involve neighboring ACCs releasing aircraft at flight levels that are not allowed as specified in the LOA. Even though this group of LHDs does not currently contribute to a large portion of risk in the BOB region in this assessed period, the concern should still be raised among relevant parties as the duration of this type of LHDs is rising in the first quarter of 2014.

#### 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 5**.

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
T	Annual flight hours	1,506,592	362,915	Hour	Dec 2013 TSD
$E_z(\text{same})$	Same-direction vertical occupancies	0.3750/ 0.0125	0.0427	-	
$E_z(\text{opposite})$	Opposite-direction vertical occupancies	0.1354	0.0099	-	
$\lambda_x$	Average aircraft length	0.0292	0.0243	NM	
$\lambda_y$	Average aircraft wingspan	0.0267	0.0220	NM	
$\lambda_z$	Average aircraft height	0.0082	0.0072	NM	
$\lambda_h$	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0292	0.0243	NM	
$P_z(0)$	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	35.32/ 48.43	55.94	Knot	Dec 2013 TSD
$ \overline{V} $	Average absolute aircraft ground speed	480	480	Knot	Conservative value used in previous assessments

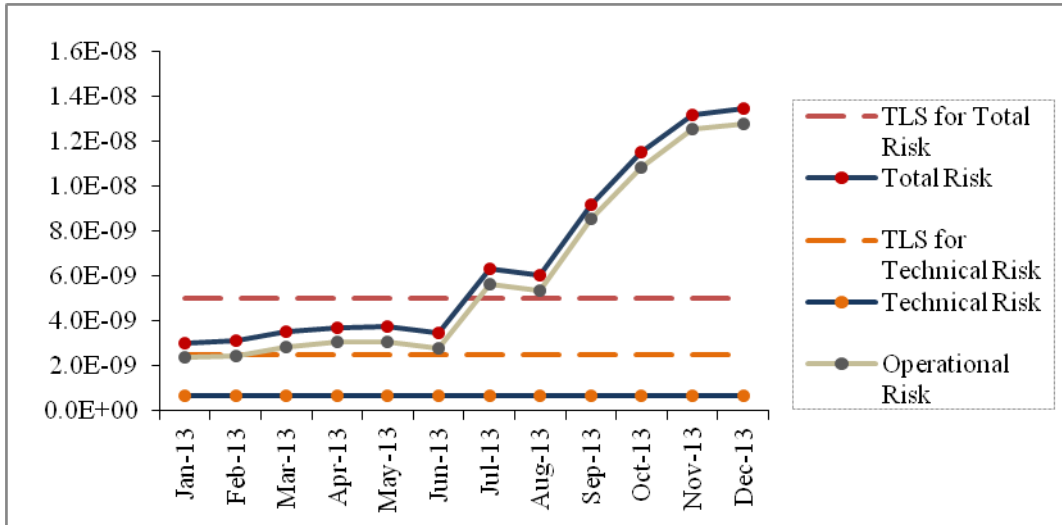
**Table 5:** Estimates of the Parameters in the CRM for BOB Airspace

4.2. **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 6**. The technical risk **meets** the agreed TLS value of no more than  $2.5 \times 10^{-9}$  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 does not meet the specified TLS value for these components of  $5.0 \times 10^{-9}$ .**

Bay of Bengal RVSM Airspace – estimated annual flying hours = 1,869,508 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
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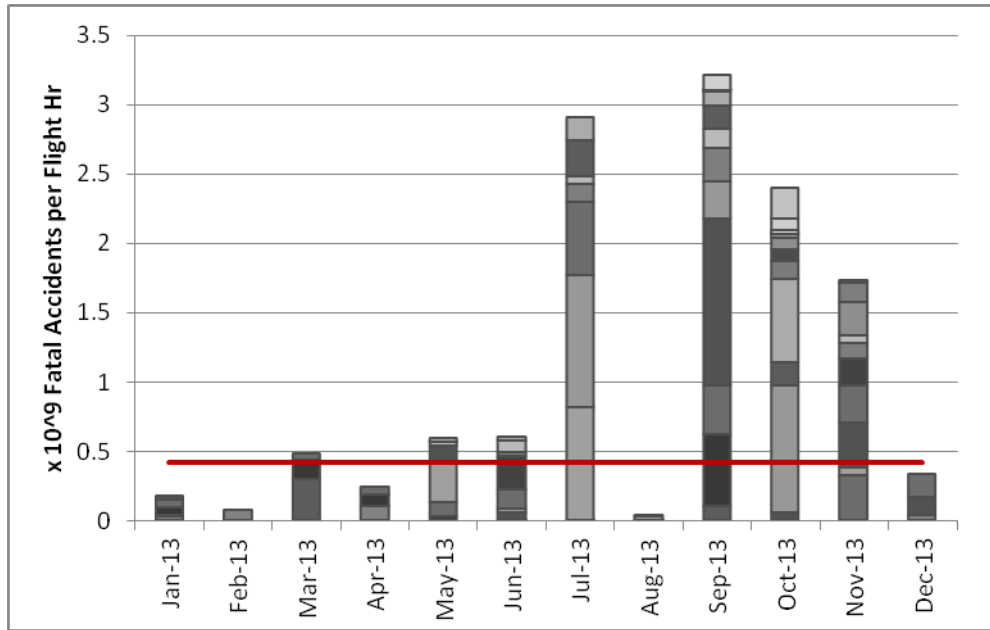
**Table 6: Risk Estimates for BOB Airspace**

4.3 **Figure 5** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.



**Figure 5: 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 6** below shows the monthly risks for the month of **July, September, October, November 2013** are **significantly above** the average monthly risk of the annual risk of  $5.0 \times 10^{-9}$  (red line in **Figure 6** below, which is approximately  $0.4167 \times 10^{-9}$  fatal accidents per flight hour).



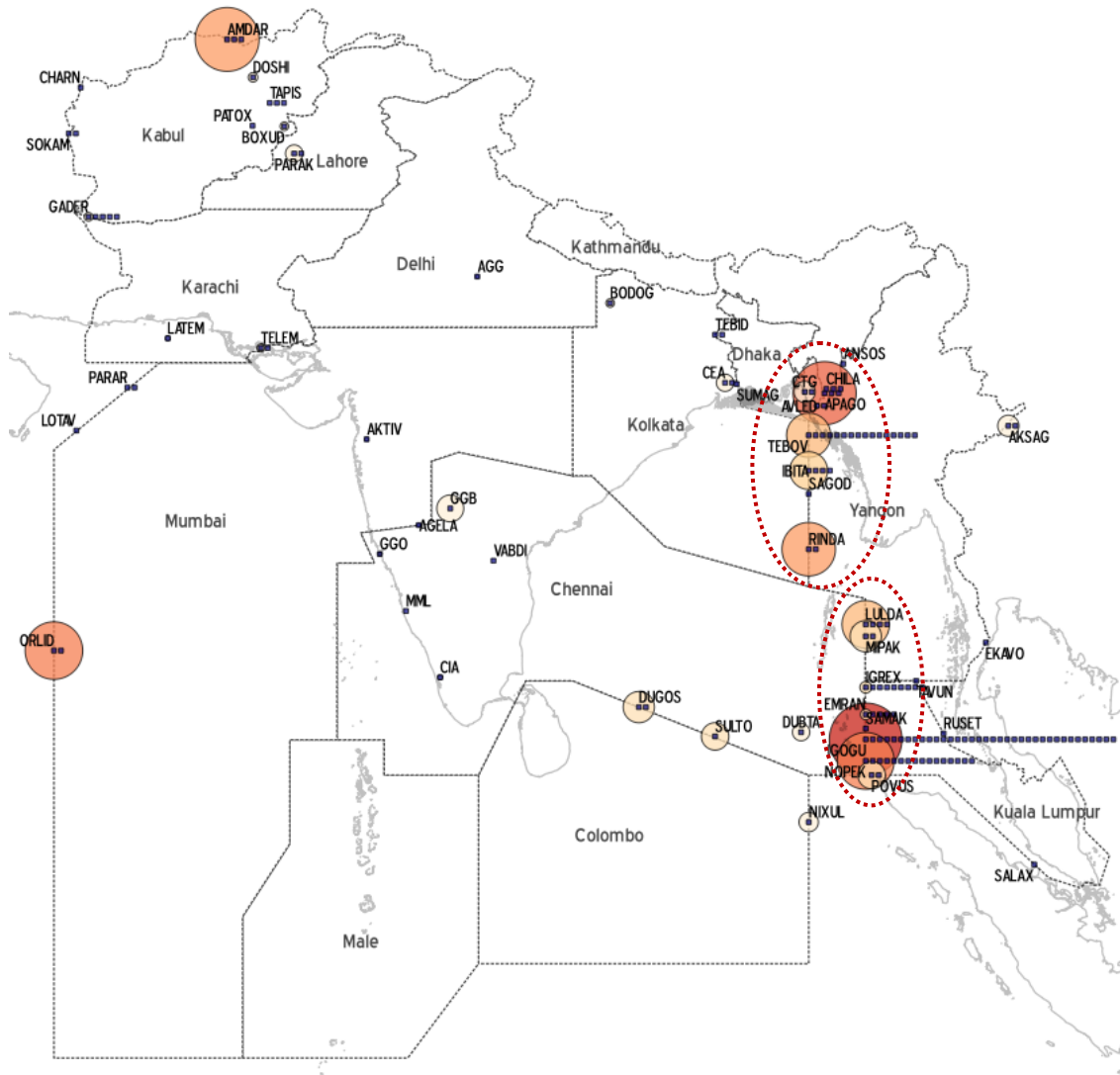
**Figure 6: Monthly LHD Risk Estimates for BOB Airspace.**

Red line is the average monthly value for an annual risk of  $5.0 \times 10^{-9}$ . Risk is measured in Fatal Accidents per Flight Hour (FAPFH).

## 5. Analysis of Operational Errors

5.1 **Figure 7** depicts geographic location of risk bearing LHDs and hot spots in BOB airspace based on LHD reports from January to December 2013 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.

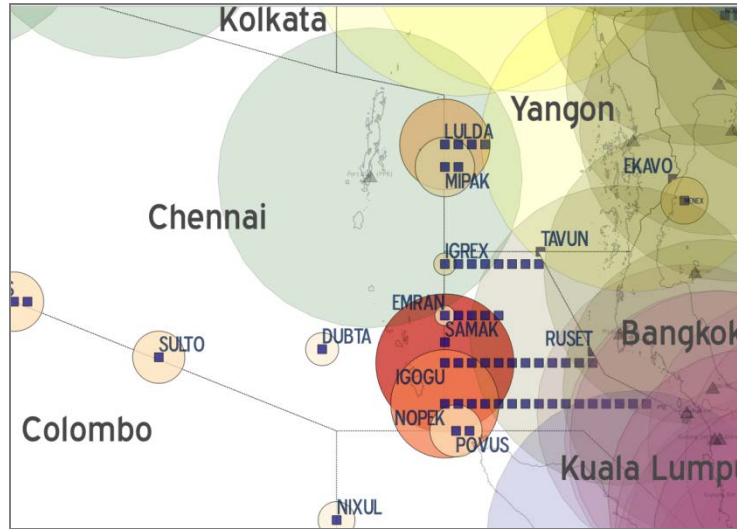


**Figure 7:** Geographical Location of LHDs in BOB Airspace

5.2 The main hot spots in BOB airspace are:

- the transfer-of-control points along the Kolkata - Yangon FIR boundary,
- the transfer-of-control points along the Chennai - Yangon FIR boundary, and
- the transfer-of-control points along the Chennai - Kuala Lumpur FIR boundary.

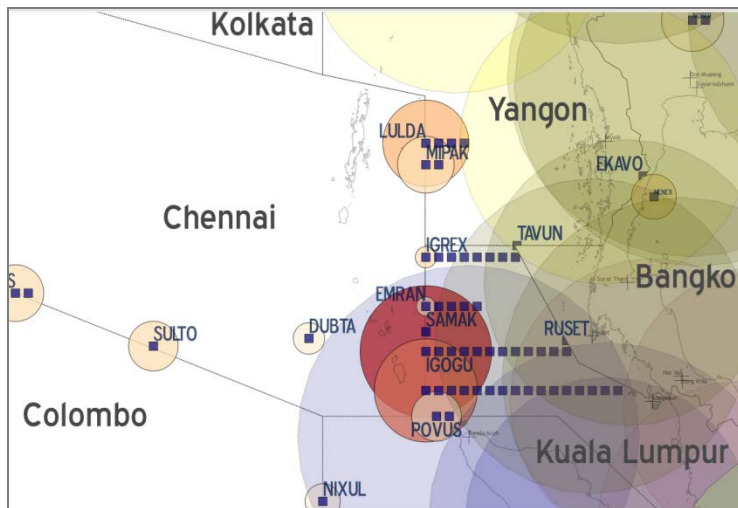
5.3 Further analysis shows that some of the waypoints associated with relatively large LHD durations (darker orange) are situated outside of VHF coverage as shown in **Figure 8**.



**Figure 8:** LHDs at Waypoints along Chennai - Kuala Lumpur FIR Boundary with VHF Approximate Coverage (Opaque Circles)

(Colors of opaque circles represent different States who own the facilities.)

5.4 **Figure 9** shows that these same waypoints are under the coverage of Banda Aceh SSR radar (purple), whose surveillance data is not likely to be accessible by Chennai and Kuala Lumpur ACCs.



**Figure 9:** LHDs at Waypoints along Chennai - Kuala Lumpur FIR Boundary with SSR Approximate Coverage (Opaque Circles)

(Colors of opaque circles represent different States who own the facilities.)

5.5 These findings could indicate that deficiencies in air-ground communication and surveillance services may be contributable to the large sum of LHD durations in this area.

**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 BOB States is detailed in **Table 7** below.

<b>State</b>	<b>Total RVSM Approved Airframes</b>	<b>Resultant Monitoring Burden</b>	<b>Total Airframes Remaining to be Monitored</b>
Afghanistan (OA)	21	14	4
Bangladesh (VG)	23	18	14
Bhutan (VQ)	3	2	1
India (VA)	599	206	44
Malaysia (WM)	258	43	19
Maldives (VR)	4	4	0
Myanmar (VY)	14	8	3
Nepal (VN)	2	2	2
Pakistan (OP)	55	34	23
Sri Lanka (VC)	25	8	0
Thailand (VT)	311	102	52
<b>Grand Total</b>	<b>1315</b>	<b>441</b>	<b>162</b>

**Table 7: LTHM Burden**



**Appendix A: Details of the Reported LHD Events**

Date	Source	Assigned FL	Observe/ Reported FL	Duration at Incorrect FL	Category	Cause
9/1/2013	XYN	FL340	FL344	0 min	M	ATC-reroute to uncontrolled airspace
11/1/2013	CDM	FL350	FL350	2 min	D	ATC-incorrect clearance
11/1/2013	JHD	FL370	FL356	2 min	D	ATC-incorrect clearance
17/1/2013	JHD	FL250	FL305	2 min	A	Pilot-not climb/descend as cleared
19/1/2013	SDY	FL390	FL390	0 min	E	No time revision
22/1/2013	XYN	FL360	FL354	1 min	M	TCAS RA correctly followed
19/2/2013	SDY	FL330	FL330	3 min	E	Negative transfer
28/2/2013	SDY	FL370	FL370	0 min	E	No time revision
1/3/2013	SDY	FL370	FL390	0 min	E	No time revision
4/3/2013	CDM	FL400	FL375	11 min	E	Negative transfer
6/3/2013	SDY	FL330	FL330	5 min	E	No time revision
11/3/2013	CDM	FL280	FL280	0 min	E	No time revision
17/3/2013	CDM	FL300	FL300	0 min	E	No time revision
21/3/2013	XYN	FL340	FL340	0 min	M	Failure to establish or maintain a separation standard
21/3/2013	XYN	FL320	FL320	0 min	M	Failure to establish or maintain a separation standard
21/3/2013	SDY	FL330	FL330	2 min	E	Negative transfer
26/3/2013	SDY	FL370	FL370	0 min	E	No time revision
13/4/2013	CDM	FL340	FL340	4 min	E	No time revision
20/4/2013	SDY	FL390	FL390	0 min	E	No time revision
23/4/2013	CDM	FL300	FL300	3 min	E	No time revision
24/4/2013	CDM	FL360	FL360	2 min	E	No time revision
24/4/2013	CDM	FL340	FL340	0 min	E	No time revision
28/4/2013	CDM	FL360	FL360	0 min	E	No time revision
5/5/2013	CDM	FL320	FL320	0 min	E	No time revision
6/5/2013	XYN	FL350	FL290	0 min	M	ATC-LOA noncompliance (FL): AC1 was assigned the incorrect flight level for landing in Afghanistan. AC1 entered Kabul FIR via SOKAM at FL350, an over-flight altitude. The aircraft should have been at FL290 or below IAW the LOA for aircraft landing in Afghanistan.
7/5/2013	JQS	FL350	FL354	1 min	D	ATC-incorrect clearance
9/5/2013	CDM	FL360	FL360	4 min	E	No time revision
10/5/2013	CDM	FL370	FL370	10 min	E	Negative transfer
14/5/2013	OYM	UNK	FL360	5 min	E	Negative transfer
15/5/2013	CDM	FL340	FL340	0 min	E	No time revision
18/5/2013	CDM	FL380	FL380	0 min	E	No time revision
19/5/2013	WWG	FL340	FL360	0 min	B	Pilot-climb/descend without clearance
23/5/2013	CDM	FL360	FL350	0 min	E	No FL revision

Date	Source	Assigned FL	Observe/ Reported FL	Duration at Incorrect FL	Category	Cause
24/5/2013	CDM	FL300	FL300	5 min	E	No time revision
27/5/2013	SDY	FL310	FL310	1 min	E	No SSR code revision
27/5/2013	JHD	FL360	FL345	1 min	D	ATC-incorrect clearance
27/5/2013	CDM	FL380	FL380	0 min	E	No time revision
1/6/2013	WWW	FL310	FL300	0 min	D	Pilot follows instructions given to another aircraft
2/6/2013	SDY	FL330	FL350	0 min	E	No FL revision
2/6/2013	SDY	FL350	FL330	0 min	E	No FL revision
4/6/2013	SDY	FL350	FL310	0 min	E	No FL revision
6/6/2013	SDY	FL390	FL390	0 min	E	No time revision
7/6/2013	SDY	FL350	FL350	2 min	E	No time revision
7/6/2013	XYN	FL350	FL290	1 min	M	ATC-LOA noncompliance (FL)
7/6/2013	SDY	FL390	FL390	5 min	E	No time revision
12/6/2013	SDY	FL390	FL390	9 min	E	No time revision
12/6/2013	SDY	FL390	FL390	1 min	E	No time revision
13/6/2013	JQS	FL330	FL340	3 min	D	Pilot follows instructions given to another aircraft
17/6/2013	SDY	FL330	FL330	0 min	E	No time revision
17/6/2013	SDY	FL350	FL350	1 min	E	No time revision
20/6/2013	CDM	FL400	FL400	0 min	E	No time revision
25/6/2013	SDY	FL410	FL410	0 min	E	No time revision
2/7/2013	CDM	FL350	FL362	0 min	B	Pilot-climb/descend without clearance
3/7/2013	XYN	FL340	FL333	0 min	J	TCAS TA followed
5/7/2013	CDM	FL300	FL330	0 min	E	No FL revision
7/7/2013	CDM	FL320	FL360	0 min	E	No FL revision
8/7/2013	CDM	UNK	FL320	30 min	E	Negative transfer: aircraft established contact with ACC2HF at 2240 & reported estimate SADAP 2250, waypoint 40 minutes inside the FIR. No estimate received from ACC1. No Breakdown in separation. ACC1 Comment: revised estimate has been sent by AFTN at 2343UTC.
8/7/2013	CDM	FL300	FL293	0 min	J	TCAS RA correctly followed
9/7/2013	XYN	FL370	FL350	35 min	D	Pilot-climb/descend without clearance: (AMDAR-SITAX, southbound) Pilot reported over AMDAR/M875 at FL370. Flight plan data information coordinated with ACC1 for FL370. After communications transfer, ACC1 informed ACC2 that the aircraft was at FL350. The aircraft contacted ACC1 over AMDAR/reported at FL370. Audio recording confirmed the inaccurate flight

Date	Source	Assigned FL	Observe/ Reported FL	Duration at Incorrect FL	Category	Cause
						level report.
9/7/2013	XYN	FL370	FL350	0 min	B	Pilot-climb/descend without clearance
9/7/2013	CDM	FL400	FL400	0 min	E	No time revision
15/7/2013	SDY	FL370	FL370	5 min	E	Negative transfer
19/7/2013	SDY	FL350	FL350	2 min	E	No time revision
26/7/2013	CDM	FL330	FL319	0 min	D	Readback-hearback
28/7/2013	SDY	FL330	FL370	6 min	E	No FL revision
29/7/2013	SDY	FL390	FL410	0 min	E	No FL revision
4/8/2013	CQV	FL300	FL361	1 min	D	ATC-incorrect clearance
11/8/2013	SDY	FL370	FL370	0 min	E	Negative transfer
16/8/2013	TTV	FL370	FL374	2 min	M	Unknown
19/8/2013	CDM	FL300	FL300	0 min	E	No time revision
19/8/2013	CDM	FL340	FL340	3 min	E	No time revision
19/8/2013	CDM	FL300	FL300	0 min	E	No time revision
20/8/2013	CDM	FL300	FL340	0 min	E	No time & FL revision
21/8/2013	XYN	FL290	FL390	0 min	M	ATC-LOA noncompliance (FL)
27/8/2013	CDM	FL340	FL340	0 min	E	No time revision
28/8/2013	JHD	FL380	FL360	0 min	E	No FL revision
29/8/2013	CDM	FL360	FL360	0 min	E	No time revision
30/8/2013	CDM	FL300	FL300	3 min	E	No time revision
3/9/2013	JHD	FL300	FL320	0 min	E	No FL revision
4/9/2013	JHD	FL380	FL360	4 min	E	No FL revision
5/9/2013	JHD	FL340	FL320	19 min	E	No FL revision
6/9/2013	JHD	FL380	FL340	13 min	E	No FL revision
7/9/2013	XYN	FL290	FL370	0 min	M	ATC-LOA noncompliance (FL)
11/9/2013	WWW	FL330	FL390	44 min	E	No FL revision: no level change was given by the transferring ATS unit. No breakdown in separation.
14/9/2013	SDY	FL360	FL350	10 min	E	No FL revision
15/9/2013	CDM	FL300	FL300	0 min	E	Negative transfer
19/9/2013	XYN	FL290	FL330	0 min	M	ATC-LOA noncompliance (FL)
20/9/2013	CDM	FL320	FL340	9 min	E	No time & FL revision
21/9/2013	JHD	FL300	FL340	5 min	E	No FL revision
22/9/2013	CDM	FL380	FL380	6 min	E	No time revision
23/9/2013	CDM	FL380	FL380	4 min	E	No time revision
23/9/2013	BHQ	FL330	FL330	1 min	E	Negative transfer
25/9/2013	JHD	UNK	FL380	0 min	E	Negative transfer
28/9/2013	BHQ	FL330	FL330	1 min	E	Negative transfer
29/9/2013	SDY	FL410	FL410	4 min	E	No time revision
30/9/2013	JHD	FL340	FL360	0 min	E	No FL revision
1/10/2013	BHQ	FL330	FL350	0 min	E	No FL revision
1/10/2013	BHQ	FL330	FL330	0 min	E	No time revision
3/10/2013	WWW	FL330	FL350	0 min	E	No FL revision

Date	Source	Assigned FL	Observe/ Reported FL	Duration at Incorrect FL	Category	Cause
4/10/2013	JHD	FL320	FL340	0 min	E	No FL revision
5/10/2013	XYN	FL290	FL370	0 min	M	ATC-LOA noncompliance (FL)
6/10/2013	JHD	FL300	FL320	2 min	E	No FL revision
6/10/2013	JHD	FL340	FL400	34 min	E	No FL revision: no level change was given by ACC1. No Breakdown in separation. ACC1 Comment: entered the FIR with FL380. Climbed FL400 and transferred with FL400, not FL340
7/10/2013	JHD	FL340	FL430	0 min	E	No FL revision
9/10/2013	CDM	FL310	FL317	0 min	J	TCAS RA correctly followed
10/10/2013	CDM	FL340	FL320	0 min	E	No FL revision
10/10/2013	JHD	FL320	FL360	0 min	E	No FL revision
10/10/2013	JHD	UNK	FL360	6 min	E	Negative transfer
11/10/2013	JHD	FL340	FL360	22 min	E	No FL revision
13/10/2013	SDY	FL350	FL350	5 min	E	No time revision
14/10/2013	BHQ	FL320	FL320	3 min	E	Negative transfer
14/10/2013	BHQ	FL300	FL320	3 min	E	No FL revision
19/10/2013	XYN	FL290	FL330	0 min	M	ATC-LOA noncompliance (FL)
19/10/2013	JHD	FL340	FL320	0 min	E	No FL revision
19/10/2013	JHD	FL320	FL360	0 min	E	No FL revision
21/10/2013	CDM	FL360	FL340	1 min	E	No FL revision
21/10/2013	JHD	FL360	FL320	0 min	E	No FL revision
23/10/2013	BHQ	FL350	FL370	0 min	E	No FL revision
25/10/2013	JHD	FL340	FL360	0 min	E	No FL revision
25/10/2013	WWW	FL380	FL380-	0 min	B	Pilot-climb/descend without clearance
25/10/2013	JHD	FL360	FL320	0 min	E	No FL revision
26/10/2013	SDY	UNK	UNK	0 min	E	No time revision
26/10/2013	SDY	UNK	FL370	0 min	E	Negative transfer
28/10/2013	JHD	FL340	FL360	0 min	E	No FL revision
28/10/2013	BHQ	FL330	FL350	0 min	E	No FL revision
29/10/2013	SDY	UNK	FL370	0 min	E	No time revision
29/10/2013	JHD	FL360	FL380	1 min	E	No FL revision
30/10/2013	CDM	FL360	FL340	3 min	E	No FL revision
31/10/2013	JHD	UNK	FL320	8 min	E	Negative transfer
3/11/2013	XYN	FL350	FL355	0 min	J	TCAS RA correctly followed
4/11/2013	SDY	FL370	FL370	0 min	E	No time revision
7/11/2013	SDY	FL370	FL370	0 min	E	Negative transfer
8/11/2013	JHD	FL360	FL380	12 min	E	No FL revision
9/11/2013	JHD	UNK	FL360	2 min	E	Negative transfer
11/11/2013	CDM	FL330	FL350	12 min	D	Readback-hearback
12/11/2013	JHD	UNK	FL360	0 min	E	Negative transfer
13/11/2013	CDM	FL400	FL400	10 min	E	No time revision
18/11/2013	CDM	FL300	FL380	7 min	E	No time & FL revision

Date	Source	Assigned FL	Observe/ Reported FL	Duration at Incorrect FL	Category	Cause
20/11/2013	CDM	FL330	FL370	4 min	E	No FL revision
21/11/2013	JHD	FL380	FL360	2 min	E	No FL revision
22/11/2013	XYN	FL310	FL320	0 min	M	ATC-LOA noncompliance (FL)
23/11/2013	CDM	FL300	FL380	0 min	E	No time & FL revision
24/11/2013	BHQ	FL360	FL100	0 min	G	Pressurization Failure
25/11/2013	XYN	FL270	FL390	0 min	M	ATC-LOA noncompliance (FL)
25/11/2013	JHD	FL340	FL380	9 min	E	No FL revision
26/11/2013	SDY	FL320	FL340	0 min	E	No FL revision
27/11/2013	JHD	FL300	FL320	5 min	E	No FL revision
27/11/2013	CDM	FL380	FL380	0 min	E	No time revision
27/11/2013	CDM	FL400	FL400	0 min	E	No time revision
28/11/2013	SDY	FL350	FL370	0 min	E	No FL revision
29/11/2013	WWW	FL350	FL370	2 min	E	No FL revision
29/11/2013	WWW	FL250	FL370	3 min	E	No FL revision
30/11/2013	SDY	UNK	FL370	0 min	E	Negative transfer
1/12/2013	SDY	UNK	FL350	8 min	E	Negative transfer
2/12/2013	WWW	FL350	FL390	0 min	E	No FL revision
6/12/2013	WWW	UNK	FL330	0 min	E	No FL revision
12/12/2013	JHD	FL380	FL360	0 min	E	No FL revision
14/12/2013	JHD	FL320	FL340	0 min	E	No FL revision
15/12/2013	JHD	FL360	FL320	5 min	E	No FL revision
16/12/2013	WWW	FL350	FL330	0 min	E	No FL revision
19/12/2013	JHD	FL300	FL340	6 min	E	No FL revision
28/12/2013	CDM	FL340	FL400	0 min	E	Unknown

**MONITORING AGENCY FOR ASIA REGION (MAAR)**



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

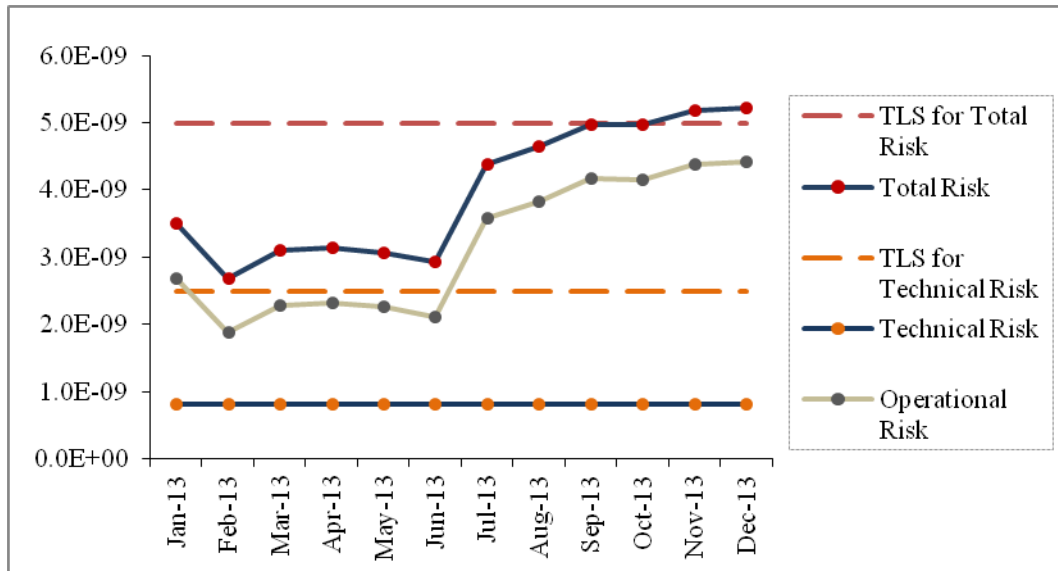
**January 2013 to December 2013**

**Executive Summary**

For the period 1<sup>st</sup> January 2013 to 31<sup>st</sup> December 2013 inclusive, the total risk in **Western Pacific/South China Sea (WPAC/SCS) airspace** does not meet the agreed Target Level of Safety (TLS) value of  $5.0 \times 10^{-9}$ . **Table A** summarizes RVSM technical, operational and total risks. **Figure A** presents collision risk estimate trends using the appropriate cumulative 12-month data set of LHD reports.

Western Pacific/South China Sea RVSM Airspace – estimated annual flying hours = 1,581,192 hours <i>(note: estimated hours based on December 2013 traffic sample data)</i>			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	$0.81 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$4.41 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>5.22 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Above Overall TLS</b>

**Table A: Risk Estimates for WPAC/SCS Airspace**



**Figure A: Trends of Risk Estimates for WPAC/SCS Airspace**

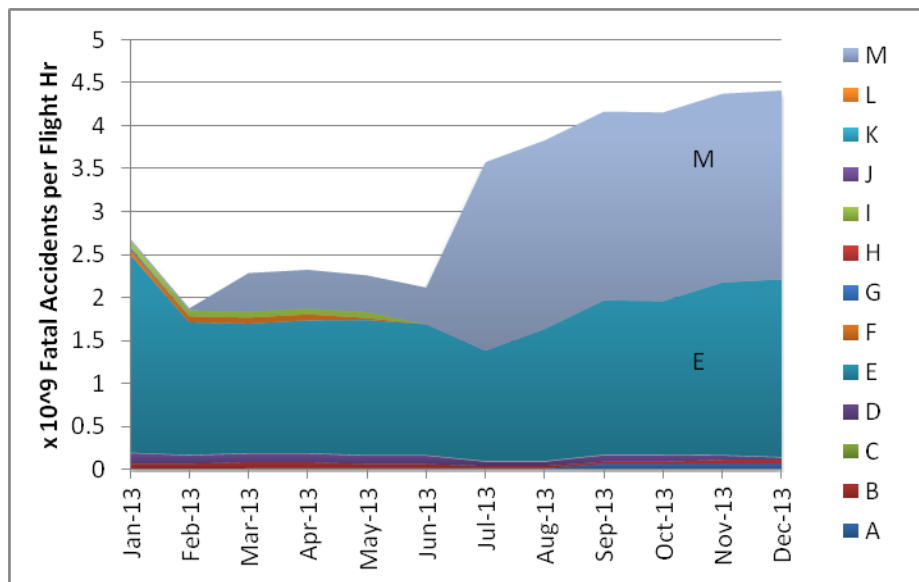
**Table B** presents a summary of operational risk associated with Large Height Deviation (LHD) reports by LHD category within WPAC/SCS airspace from January 2013 to December 2013.

Code	LHD Category	Operational Risk ( $\times 10^{-9}$ )
A	Flight crew fails to climb or descend the aircraft as cleared	0.07
B	Flight crew climbing or descending without ATC clearance	0.05
C	Incorrect operation or interpretation of airborne equipment	-
D	ATC system loop error	0.02
E	ATC transfer of control coordination errors due to human factors	2.07
F	ATC transfer of control coordination errors due to technical issues	-
G	Aircraft contingency leading to sudden inability to maintain level	-

Code	LHD Category	Operational Risk (x 10 <sup>-9</sup> )
H	Airborne equipment failure and unintentional or undetected level Change	-
I	Turbulence or other weather related cause	-
J	TCAS resolution advisory and flight crew correctly responds	-
K	TCAS resolution advisory and flight crew incorrectly responds	-
L	An aircraft being provided with RVSM separation is not RVSM Approved	-
M	Other	2.20
<b>Total</b>		<b>4.41</b>

**Table B: Summary of Operational Risk by LHD Category for WPAC/SCS Airspace**

**Figure B** provides the 12-month cumulative operational risk by LHD category for WPAC/SCS airspace from January 2013 to December 2013 showing Category E and Category M LHDs as the main contributor to the total operational risk.



**Figure B: Trends of Operational Risk by LHD Category for WPAC/SCS Airspace**

The sudden increase in operational risk in July 2013 was due to a single Category-M LHD of duration 77 minutes. This event accounts for 1.55 x 10<sup>-9</sup> FAPFH. Without this event's duration, the total risk would have been 3.67 x 10<sup>-9</sup> FAPFH.

The main hot spots in WPAC/SCS are:

- the transfer-of-control points along the Hong Kong - Manila FIR boundary, NOMAN and SABNO, and
- the transfer-of-control points along the Singapore - Manila FIR boundary, LAXOR and VINIK. (LHDs at VINIK are from coordination between Kota Kinabalu and Manila ACCs).



**AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN  
THE WESTERN PACIFIC/SOUTH CHINA SEA AIRSPACE  
Assessment Period: January 2013 to December 2013**

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 2013** and monthly Large Height Deviation (LHD) reports between **January 2013** and **December 2013** 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 2013 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 2013 to December 2013. **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	Vientiane	Kota Kinabalu	Kuala Lumpur	Manila	Singapore	Bangkok	Hanoi	Ho Chi Minh
January	X	X	X	X	X	X	X	X	X	X	X
February	X	X	X	X	X	X	X	X	X	X	X
March	X	X	X	X	X	X	X	X	X	X	X
April	X	X	X	X	X	X	X	X	X	X	X
May	X	X	X	X	X	X	X	X	X	X	X
June	X	X	X	X	X	X	X	X	X	X	X
July	X	X	X	X	X	X	X	X	X	X	X
August	X	X	X	X	X	X	X	X	X	X	X
September	X	X	X	X	X	X	X	X	X	X	X
October	X	X	X	X	X	X	X	X	X	X	X
November	X	X	X	X	X	X	X	X	X	X	X
December	X	X	X	-	X	X	X	X	X	X	X

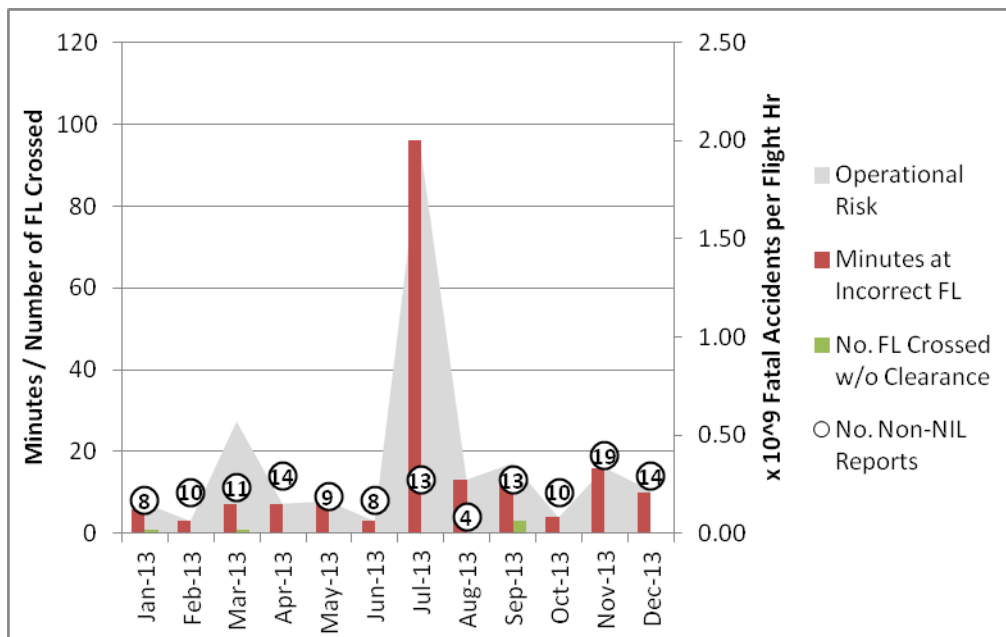
**Table 1:** Summary of LHD Reports Submitted by FIRs

### 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 2013 to December 2013.

Month (2013)	No. of Non-NIL LHD	LHD Duration (Min)	No. Levels Crossed	Operational Risk ( $\times 10^{-9}$ )
January	8	6.0	1	0.16
February	10	3.0	0	0.06
March	11	7.0	1	0.57
April	14	7.0	0	0.15
May	9	8.0	0	0.16
June	8	3.0	0	0.06
July	13	96.0	0	1.97
August	4	13.0	0	0.28
September	13	13.0	3	0.36
October	10	4.0	0	0.08
November	19	16.0	0	0.34
December	14	10.0	0	0.22
<b>Total</b>	<b>133</b>	<b>186</b>	<b>5</b>	<b>4.41</b>

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



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

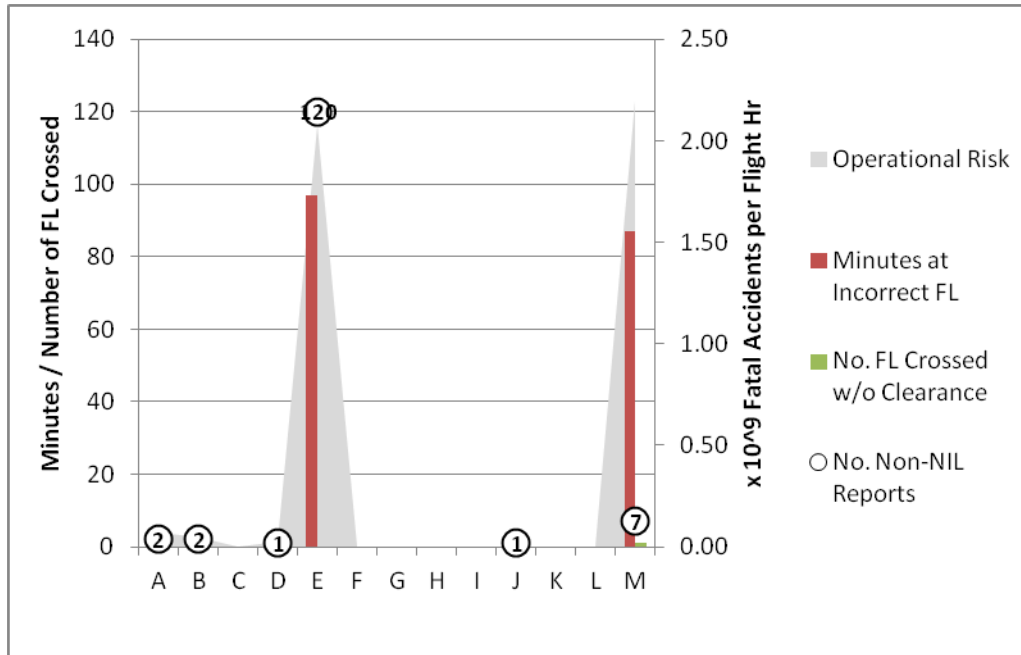
3.2. Compared to 2012, the number of non-nil LHD reports rose from 95 to 133. The total of LHD duration increased 2 folds, 93 to 186 minutes.

- The sharp increase in LHD duration was due to a single Category-M event near LAXOR, whose duration was deemed to be 77 minutes (please refer to the event’s detailed description in **Appendix A**).

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 2013 to December 2013.

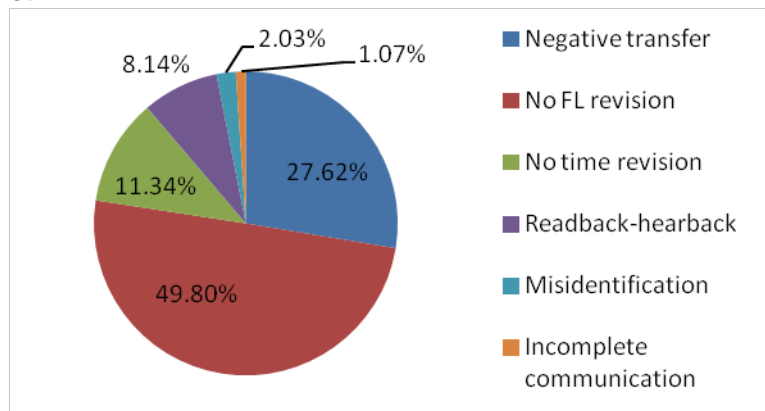
LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Operational Risk (x10 <sup>-9</sup> )
<b>A</b>	Flight crew failing to climb/descend the aircraft as cleared	2	1.0	2	0.07
<b>B</b>	Flight crew climbing/descending without ATC Clearance	2	1.0	1	0.05
<b>C</b>	Incorrect 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
<b>D</b>	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	1	0.0	1	0.02
<b>E</b>	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)	120	97.0	0	2.07
<b>F</b>	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
<b>G</b>	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	1	0.0	0	0.00
<b>H</b>	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0.0	0	0.00
<b>I</b>	Deviation due to turbulence or other weather related cause	0	0.0	0	0.00
<b>J</b>	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	1	0.0	0	0.00
<b>K</b>	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0.0	0	0.00
<b>L</b>	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
<b>M</b>	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.	7	87.0	1	2.20
<b>Total</b>		<b>133</b>	<b>186.0</b>	<b>5</b>	<b>4.41</b>

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



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

3.4. 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 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 5**.

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
T	Annual flight hours	1,053,671	527,521	Hour	Dec 2013 TSD
$E_z(\text{same})$	Same-direction vertical occupancies	0.2898/ 0.0256	0.4089	-	
$E_z(\text{opposite})$	Opposite-direction vertical occupancies	0.2011	0.0118	-	
$\lambda_x$	Average aircraft length	0.0267	0.0295	NM	
$\lambda_y$	Average aircraft wingspan	0.0244	0.0271	NM	
$\lambda_z$	Average aircraft height	0.0077	0.0082	NM	
$\lambda_h$	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0267	0.0295	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	30.57/ 31.65	16.33	Knot	Dec 2013 TSD
$ \overline{V} $	Average absolute aircraft ground speed	480	480	Knot	Conservative value used in previous assessments

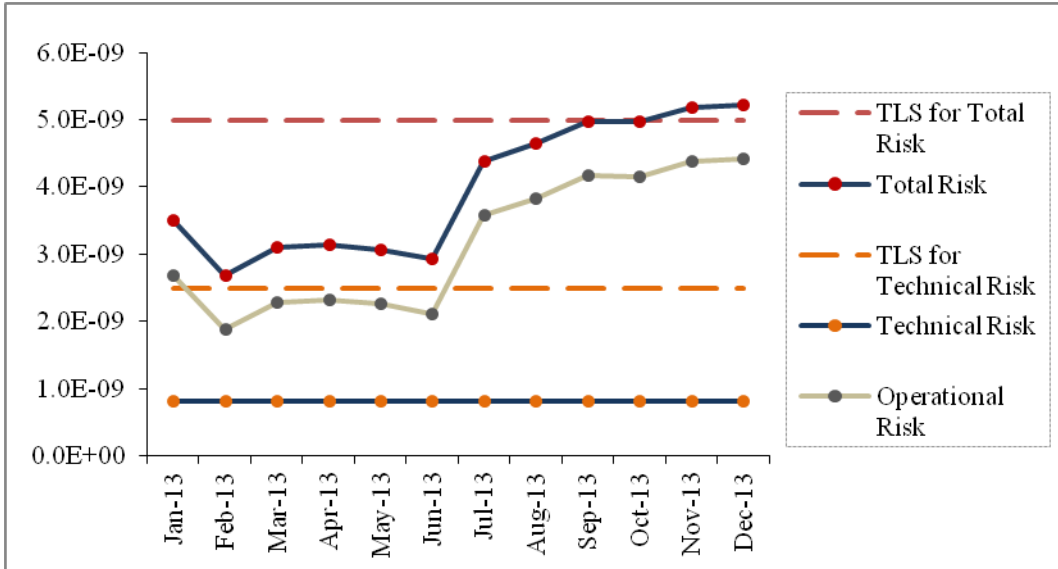
**Table 5:** Estimates of the Parameters in the CRM for WPAC/SCS Airspace

4.2. **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 6**. The technical risk **meets** the agreed TLS value of no more than  $2.5 \times 10^{-9}$  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 does not meet the specified TLS value for these components of  $5.0 \times 10^{-9}$ .**

Western Pacific/South China Sea RVSM Airspace – estimated annual flying hours = 1,581,192 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	$0.81 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$4.41 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>5.22 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Above Overall TLS</b>

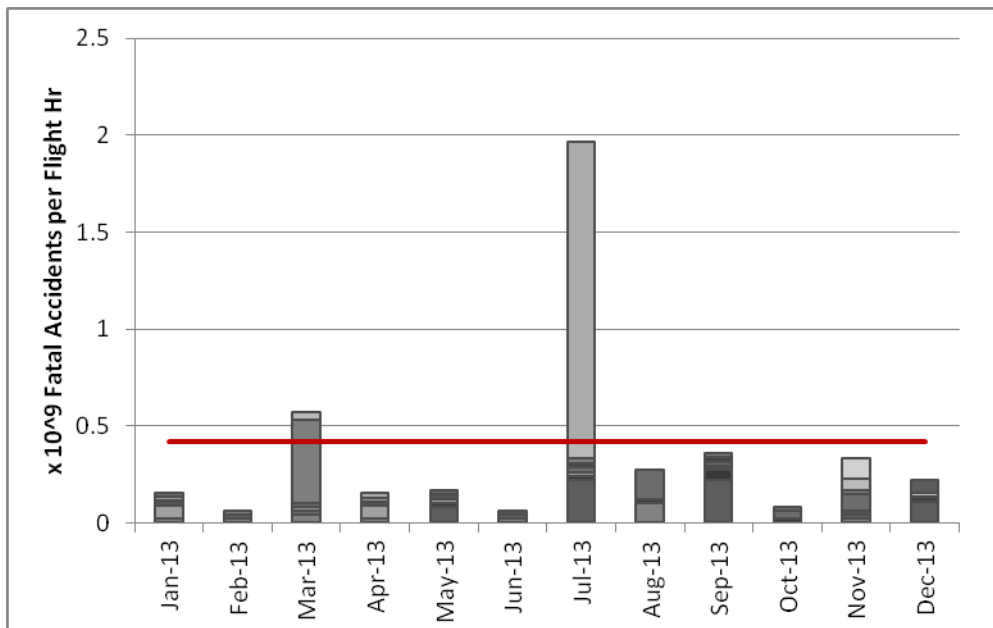
**Table 6:** Risk Estimates for WPAC/SCS Airspace

4.3 **Figure 5** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.



**Figure 5: 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 6** below shows the monthly risks for the month of **March and July 2013** are **above** the average monthly risk of the annual risk of  $5.0 \times 10^{-9}$  (red line in **Figure 6** below, which is approximately  $0.4167 \times 10^{-9}$  fatal accidents per flight hour).



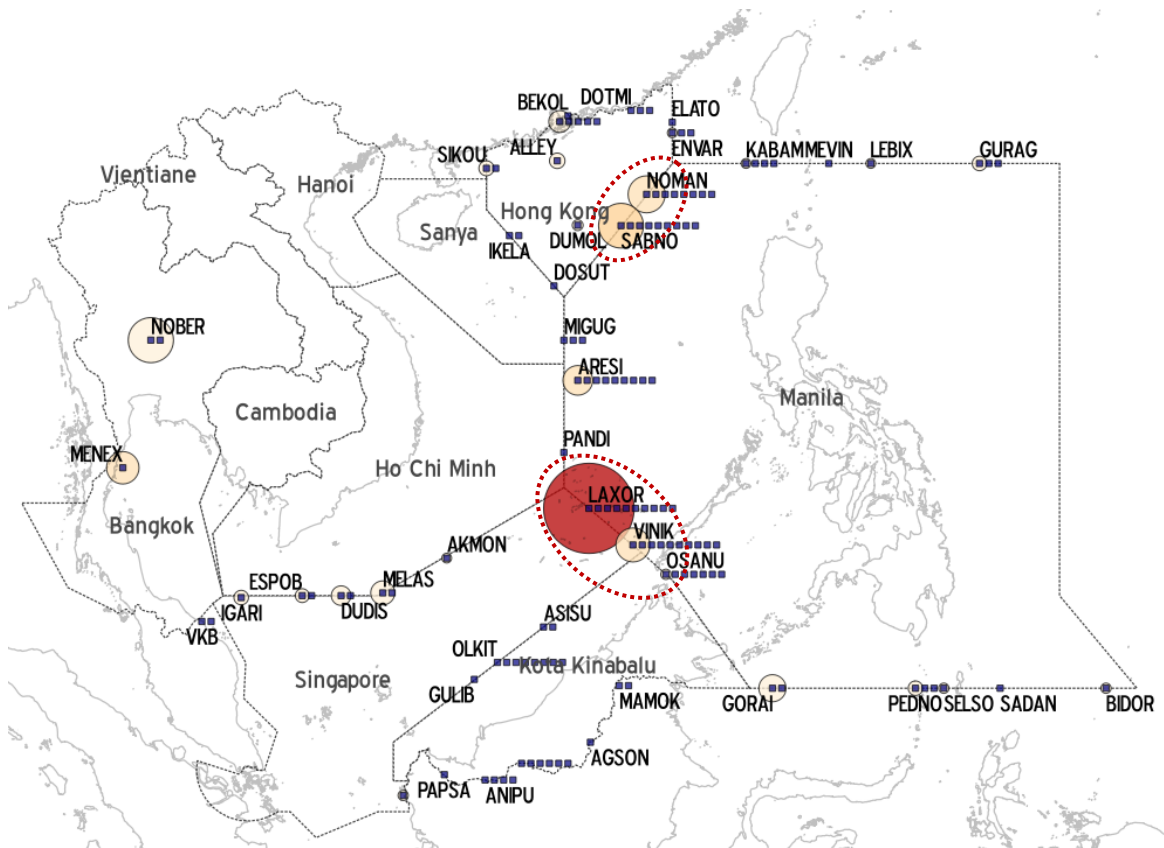
**Figure 6: Monthly LHD Risk Estimates for WPAC/SCS Airspace.**

Red line is the average monthly value for an annual risk of  $5.0 \times 10^{-9}$ . Risk is measured in Fatal Accidents per Flight Hour (FAPFH).

## 5. Analysis of Operational Errors

5.6 **Figure 7** depicts geographic location of risk bearing LHDs and hot spots in WPAC/SCS airspace based on LHD reports from January to December 2013 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.



**Figure 7:** Geographical Location of LHDs in WPAC/SCS Airspace

5.7 The main hot spots in WPAC/SCS airspace are:

- the transfer-of-control points along the Hong Kong - Manila FIR boundary, NOMAN and SABNO, and
- the transfer-of-control points along the Singapore - Manila FIR boundary, LAXOR and VINIK. (LHDs at VINIK are from coordination between Kota Kinabalu and Manila ACCs).

5.8 At NOMAN and SABNO, LHDs occurring in Hong Kong FIR all have duration zero or one minute while LHDs occurring in Manila FIR typically have longer duration. This may be due to the fact that Hong Kong ACC has both SSR and VHF coverage in this area while Manila FIR does not.

5.9 Risk at LAXOR is mostly contributed by a single event. Without the 77-min LHD, the risk would be relatively low (approximately  $0.16 \times 10^{-9}$ ) despite the high number of occurrences.

5.10 VINIK is a transfer of control point between Kota Kinabalu and Manila ACCs for north-southbound traffic. A 5-min LHD contributing to most risk at this location was attributed to a negative transfer and the pilot giving the position report after the aircraft entered the accepting FIR.

## 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 7** below.

State	Total RVSM Approved Airframes	Resultant Monitoring Burden	Total Airframes Remaining to be Monitored
Brunei (WB)	13	8	0
Cambodia (VD)	5	4	0
Hong Kong, China (VH)	255	53	2
Laos (VL)	4	2	0
Macau, China (VM)	20	7	3
Malaysia (WM)	258	43	19
Philippines (RP)	164	59	23
Singapore (WS)	193	31	0
Taiwan, China (RC)	180	40	7
Thailand (VT)	311	102	52
Viet Nam (VV)	91	12	2
<b>Grand Total</b>	<b>1494</b>	<b>361</b>	<b>108</b>

**Table 7: LTHM Burden**



**Appendix A: Details of the Reported LHD Events**

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
2/1/2013	YCP	FL371	FL391	1 min	E	Readback-hearback
10/1/2013	WWG	FL400	FL380	0 min	E	Misidentification
10/1/2013	WWG	FL380	FL400	0 min	E	Misidentification
12/1/2013	TFI	FL320	FL320	0 min	E	No time revision
18/1/2013	DTI	FL330	FL330	3 min	E	Negative transfer
24/1/2013	YCP	FL301	FL320	0 min	B	Pilot-climb/descend without clearance
25/1/2013	YCP	FL370	FL410	1 min	E	Misidentification
25/1/2013	DTI	FL410	FL410	1 min	E	Readback-hearback
1/2/2013	NNB	FL390	FL390	1 min	E	Readback-hearback
5/2/2013	YCP	FL340	FL380	1 min	E	No FL revision
6/2/2013	DTI	FL340	FL340	0 min	E	No time revision
7/2/2013	DTI	FL340	FL340	0 min	E	Negative transfer
10/2/2013	YCP	UNK	FL370	0 min	E	Negative transfer
12/2/2013	DTI	FL370	FL370	0 min	E	Readback-hearback
16/2/2013	RQN	FL380	FL340	0 min	E	No FL revision
20/2/2013	RQN	FL300	FL340	0 min	E	Readback-hearback
24/2/2013	DTI	FL370	FL370	0 min	E	No time revision
25/2/2013	YCP	FL340	FL300	1 min	E	No FL revision
2/3/2013	NNB	UNK	FL410	2 min	E	Negative transfer
2/3/2013	RQN	FL360	FL360	0 min	E	No time revision
17/3/2013	TFI	FL350	FL350	0 min	E	No time revision
19/3/2013	YCP	FL311	FL301	1 min	E	No FL revision
21/3/2013	YCP	FL350	FL310	0 min	E	Misidentification
21/3/2013	YCP	FL310	FL330	0 min	E	Misidentification
25/3/2013	DTI	FL350	FL320	1 min	E	No FL revision
25/3/2013	NNB	FL360	FL350	1 min	A	CPDLC-Clearance not sent/received
26/3/2013	WWG	FL360	FL360+	0 min	J	TCAS RA correctly followed
26/3/2013	WWG	FL350+	FL350-	0 min	M	Pilot-ATC miscommunication
30/3/2013	DTI	FL320	FL360	2 min	E	No FL revision
1/4/2013	DTI	FL380	FL340	1 min	E	No FL revision
1/4/2013	DTI	FL370	FL370	0 min	E	No time revision
4/4/2013	DTI	FL390	FL390	0 min	E	No time revision
6/4/2013	RQN	FL350	FL350	0 min	E	No time revision
9/4/2013	DTI	FL340	FL350	3 min	E	No FL revision
10/4/2013	DTI	FL370	FL330	1 min	E	No FL revision
15/4/2013	DTI	FL350	FL320	1 min	E	No FL revision
17/4/2013	YCP	UNK	FL360	0 min	E	Negative transfer
17/4/2013	YCP	UNK	FL341	0 min	E	Negative transfer
25/4/2013	DTI	FL390	FL390	0 min	E	Negative transfer

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
28/4/2013	DTI	FL370	FL370	0 min	E	No time revision
28/4/2013	DTI	FL370	UNK	0 min	E	Negative transfer
30/4/2013	DTI	FL330	FL370	1 min	E	No FL revision
/4/2013	RQN	FL330	FL390	0 min	E	No time revision
1/5/2013	DTI	FL390	FL390	0 min	E	No time revision
2/5/2013	YCP	FL381	FL361	4 min	E	No FL revision
4/5/2013	NNB	FL360	FL390	1 min	E	No FL revision
5/5/2013	DTI	FL400	FL400	0 min	E	No time revision
7/5/2013	DTI	FL330	FL370	1 min	E	No FL revision
10/5/2013	DTI	FL340	FL340	1 min	E	Misidentification
17/5/2013	DTI	FL350	FL340	0 min	E	Did not make the transition
20/5/2013	NNB	FL360	FL320	1 min	E	Readback-hearback
30/5/2013	RQN	FL380	FL380	0 min	E	Negative transfer
1/6/2013	NNB	FL340	FL380	1 min	E	No FL revision
6/6/2013	NNB	FL390	FL350	1 min	E	No FL revision
18/6/2013	DTI	FL390	FL390	0 min	E	No time revision
18/6/2013	RQN	FL400	FL400	0 min	E	No time revision
18/6/2013	DTI	FL400	FL400	0 min	E	No time revision
21/6/2013	DTI	FL380	FL360	1 min	E	Readback-hearback
22/6/2013	RQN	FL350	FL330	0 min	E	Transferred with wrong FL
23/6/2013	RQN	UNK	UNK	0 min	E	No time revision
7/7/2013	DTI	FL340	FL340	0 min	E	Readback-hearback
8/7/2013	WWG	UNK	FL370	10 min	M	ATC-Incorrect strip marking
13/7/2013	DTI	FL370	FL370	1 min	E	Readback-hearback
18/7/2013	TFI	FL350	FL350	0 min	E	No time revision
23/7/2013	RQN	UNK	UNK	0 min	E	No time revision
23/7/2013	RQN	UNK	UNK	0 min	E	No time revision
25/7/2013	DTI	FL350	FL350	1 min	E	No time revision
26/7/2013	YCP	FL300	FL280	1 min	E	No FL revision
27/7/2013	YCP	FL300	FL340	1 min	E	Incomplete communication
29/7/2013	DTI	FL310	FL350	1 min	E	No FL revision
30/7/2013	DTI	FL370	FL370	4 min	E	Negative transfer
31/7/2013	DTI	FL350	FL360	0 min	E	No FL revision
31/7/2013	NNB	FL350	FL360	77 min	M	At 0736UTC, ACC1 passed estimate for AC1 as estimating LAXOR 0913UTC at FL350 but later the aircraft was re-cleared to FL360. ACC1 failed to revise the flight level to FL360 to ACC2. There is no traffic conflict at FL360 at LAXOR. We have found that although the aircraft was re-cleared to F360, the subsequent flight strips did not reflect that the

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
						controllers were aware of the FL change. Therefore the 77 minutes of LHD occurred in ACC1.
4/8/2013	NNB	FL360	FL350	5 min	E	No FL revision
11/8/2013	DTI	FL310	FL310	0 min	E	Readback-hearback
13/8/2013	DTI	FL400	FL400	1 min	E	Negative transfer
22/8/2013	DTI	FL390	FL350	7 min	E	No FL revision
13/9/2013	RQN	UNK	FL350	0 min	E	Negative transfer
15/9/2013	DTI	FL370	FL370	10 min	E	Negative transfer
17/9/2013	YCP	FL320	FL334	0 min	A	Pilot-Not climb/descend as cleared
18/9/2013	RQN	UNK	UNK	0 min	E	No time revision
19/9/2013	RQN	UNK	UNK	0 min	E	Wrong estimate
20/9/2013	YCP	FL360	FL350	0 min	D	Pilot-ATC miscommunication
21/9/2013	RQN	UNK	UNK	0 min	E	No time revision
26/9/2013	DTI	FL380	FL380	1 min	E	No time revision
26/9/2013	DTI	FL400	FL400	1 min	E	No time revision
26/9/2013	DTI	FL380	FL360	1 min	E	No FL revision
26/9/2013	YCP	UNK	FL410	0 min	E	Negative transfer
27/9/2013	RQN	UNK	UNK	0 min	E	No time revision
30/9/2013	RQN	UNK	UNK	0 min	E	No time revision
5/10/2013	YCP	UNK	FL360	0 min	E	Negative transfer
14/10/2013	YCP	UNK	FL320	0 min	E	Negative transfer
15/10/2013	DTI	FL400	FL400	1 min	E	No time revision
17/10/2013	NNB	FL390	FL400	2 min	E	Readback-hearback
18/10/2013	YCP	UNK	FLS1010	0 min	E	Negative transfer
21/10/2013	YCP	FL390	FL360	0 min	E	No FL revision
23/10/2013	RQN	UNK	UNK	0 min	E	Negative transfer
27/10/2013	DTI	FL340	FL340	1 min	E	No time revision
28/10/2013	RQN	UNK	UNK	0 min	E	Negative transfer
31/10/2013	YCP	UNK	FL381	0 min	E	Negative transfer
1/11/2013	DTI	FL360	FL380	1 min	B	Pilot-climb/descend without clearance
3/11/2013	DTI	FL360	FL350	1 min	E	No FL revision
5/11/2013	RQN	UNK	UNK	0 min	E	No time revision
5/11/2013	DTI	FL340	FL340	0 min	M	Pilot-inaccurate time estimate
5/11/2013	RQN	UNK	UNK	0 min	M	Pilot-inaccurate time estimate
11/11/2013	DTI	FL340	FL340	1 min	E	No time revision
11/11/2013	TFI	FL360	FL390	0 min	E	No FL revision
11/11/2013	DTI	FL360	FL390	4 min	E	No FL revision
11/11/2013	DTI	FL390	FL390	0 min	M	Pilot-inaccurate time estimate
14/11/2013	DTI	FL350	FL370	1 min	E	No FL revision
16/11/2013	NNB	FL330	FL320	3 min	E	No FL revision
17/11/2013	RQN	UNK	UNK	0 min	E	No time revision

Date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Category	Cause
17/11/2013	RQN	UNK	UNK	0 min	E	No time revision
17/11/2013	RQN	UNK	UNK	0 min	E	No time revision
17/11/2013	YCP	FL280	FL320	0 min	E	No FL revision
18/11/2013	YCP	FL370	FL410	0 min	E	No FL revision
18/11/2013	DTI	FL330	FL330	5 min	E	No time revision
20/11/2013	RQN	FL350	FL390	0 min	E	No FL revision
28/11/2013	RQN	UNK	FL410	0 min	E	Negative transfer
1/12/2013	RQN	FL380	FL380	0 min	E	No time revision
8/12/2013	DTI	FL380	FL380	5 min	E	Negative transfer
12/12/2013	DTI	FL380	FL380	0 min	E	No time revision
12/12/2013	RQN	FL350	FL390	0 min	E	No FL revision
12/12/2013	RQN	FL370	FL360	0 min	E	No FL revision
14/12/2013	RQN	UNK	FL390	0 min	E	Negative transfer
18/12/2013	RQN	FL370	FL370	0 min	E	No time revision
19/12/2013	YCP	FL381	FL341	0 min	E	No FL revision
20/12/2013	DTI	FL380	FL380	1 min	E	Negative transfer
20/12/2013	DTI	FL350	FL350	0 min	M	Unknown
21/12/2013	DTI	FL380	FL360	1 min	E	No FL revision
24/12/2013	DTI	FL370	FL360	3 min	E	No FL revision
28/12/2013	RQN	FL370	FL370	0 min	E	No time revision
31/12/2013	YCP	UNK	FL340	0 min	E	No time revision

**MONITORING AGENCY FOR ASIA REGION (MAAR)**



**Airspace Safety Review of RVSM in  
Mongolia Airspace**

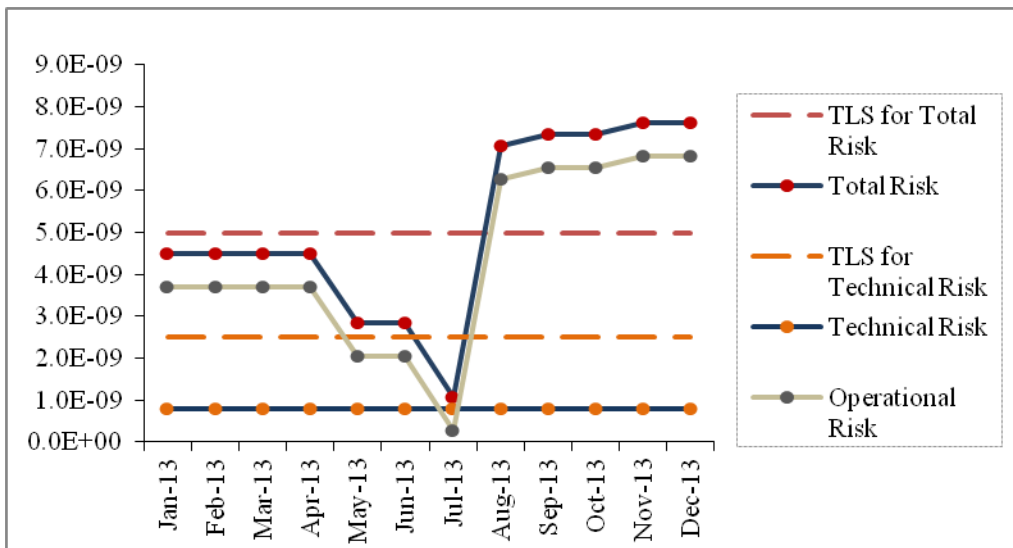
**January 2013 to December 2013**

**Executive Summary**

For the period 1<sup>st</sup> January 2013 to 31<sup>st</sup> December 2013 inclusive, the total risk in **Mongolia** airspace does not meet the agreed Target Level of Safety (TLS) value of  $5.0 \times 10^{-9}$ . **Table A** summarizes RVSM technical, operational and total risks. **Figure A** presents collision risk estimate trends using the appropriate cumulative 12-month data set of LHD reports.

Mongolia RVSM Airspace – estimated annual flying hours = 108,773 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	$0.79 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$6.84 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>7.63 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Above Overall TLS</b>

**Table A: Risk Estimates for Mongolia Airspace**



**Figure A: Trends of Risk Estimates for Mongolia Airspace**

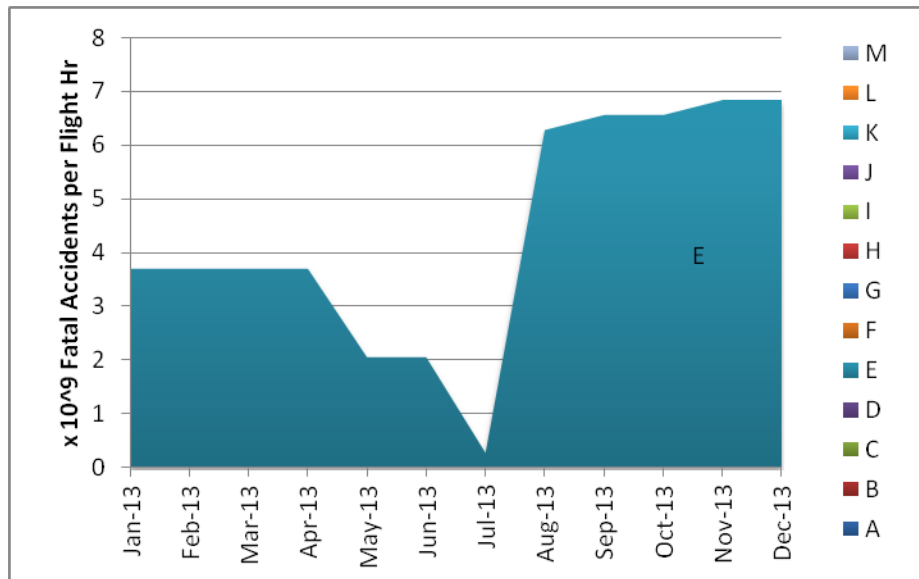
**Table B** presents a summary of operational risk associated with Large Height Deviation (LHD) reports by LHD category within **Mongolia** airspace from January 2013 to December 2013.

Code	LHD Category	Operational Risk (x 10 <sup>-9</sup> )
A	Flight crew fails to climb or descend the aircraft as cleared	-
B	Flight crew climbing or descending without ATC clearance	-
C	Incorrect operation or interpretation of airborne equipment	-
D	ATC system loop error	-
E	ATC transfer of control coordination errors due to human factors	6.84
F	ATC transfer of control coordination errors due to technical issues	-
G	Aircraft contingency leading to sudden inability to maintain level	-
H	Airborne equipment failure and unintentional or undetected level Change	-

Code	LHD Category	Operational Risk (x 10 <sup>-9</sup> )
I	Turbulence or other weather related cause	-
J	TCAS resolution advisory and flight crew correctly responds	-
K	TCAS resolution advisory and flight crew incorrectly responds	-
L	An aircraft being provided with RVSM separation is not RVSM Approved	-
M	Other	-
<b>Total</b>		<b>6.84</b>

**Table B: Summary of Operational Risk by LHD Category for Mongolia Airspace**

**Figure B** provides the 12-month cumulative operational risk by LHD category for Mongolia airspace from January 2013 to December 2013 showing Category E and Category D LHDs as the main contributor to the total operational risk.



**Figure B: Trends of Operational Risk by LHD Category for Mongolia Airspace**

The increase in operational risk in August 2013 was due to a single Category-E LHD of duration 14 minutes. This event accounts for  $4.89 \times 10^{-9}$  FAPFH.

The main hot spot in Mongolia is the southwest boundary of Ulaanbaatar FIR next to Beijing FIR, NIXAL and INTIK, where the main risk-bearing event occurred.

## AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN THE MONGOLIA AIRSPACE

Assessment Period: January 2013 to December 2013

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

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### 1. Introduction

This report provides an airspace safety review of RVSM airspace risk in **Mongolia** airspace. The review is conducted based on a one-month traffic sample data (TSD) collected in **December 2013** and monthly Large Height Deviation (LHD) reports between **January 2013** and **December 2013** submitted by concerning States in the Mongolia region.

#### 1. Data Sources

1.1. **Traffic Sample Data (TSD)**. A TSD covering the month of December 2013 of aircraft operating in Mongolia airspace was used as required by ICAO regional agreement.

1.2. **Large Height Deviation (LHD)**. A cumulative 12-month data set of LHD reports was, covering January 2013 to December 2013. **Table 1** indicates Ulaanbaatar FIR which submitted LHD reports including nil returns. **Appendix A** provides details of LHD reports.

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

**Table 1:** Summary of LHD Reports Submitted by the FIR

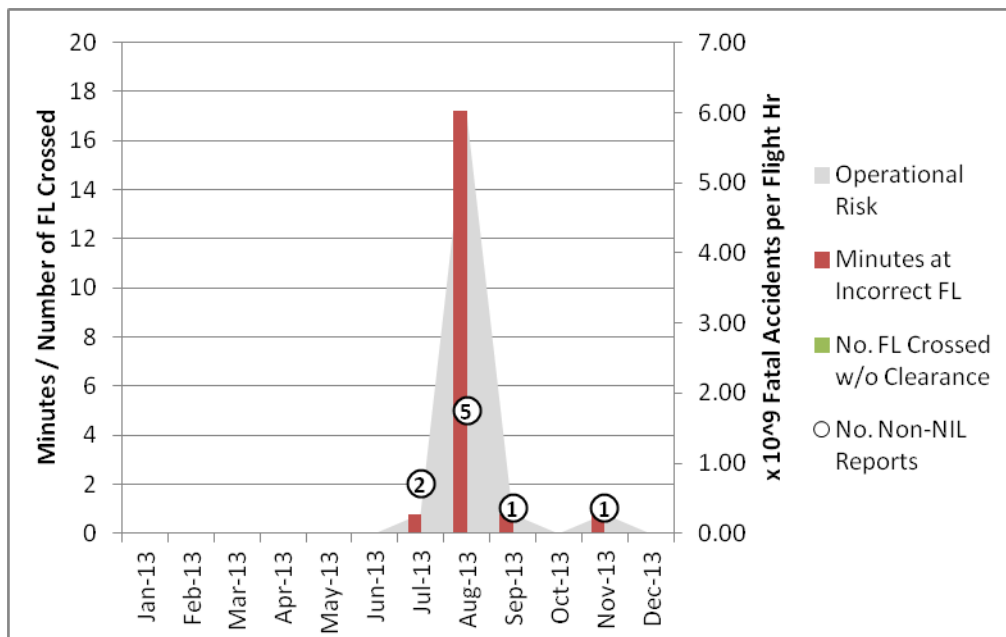


## 2. Summary of LHD Occurrences

2.1. **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 2013 to December 2013.

Month (2013)	No. of Non-NIL LHD	LHD Duration (Min)	No. Levels Crossed	Operational Risk ( $\times 10^{-9}$ )
January	0	0.0	0	0.00
February	0	0.0	0	0.00
March	0	0.0	0	0.00
April	0	0.0	0	0.00
May	0	0.0	0	0.00
June	0	0.0	0	0.00
July	2	1.8	0	4.18
August	5	17.2	0	6.00
September	1	0.8	0	0.28
October	0	0.0	0	0.00
November	1	0.8	0	0.28
December	0	0.0	0	0.00
<b>Total</b>	<b>9</b>	<b>20.6</b>	<b>0</b>	<b>10.74</b>

**Table 2:** Summary of LHD by Month for Mongolia Airspace



**Figure 1:** Summary of LHD Occurrences by Month for Mongolia Airspace

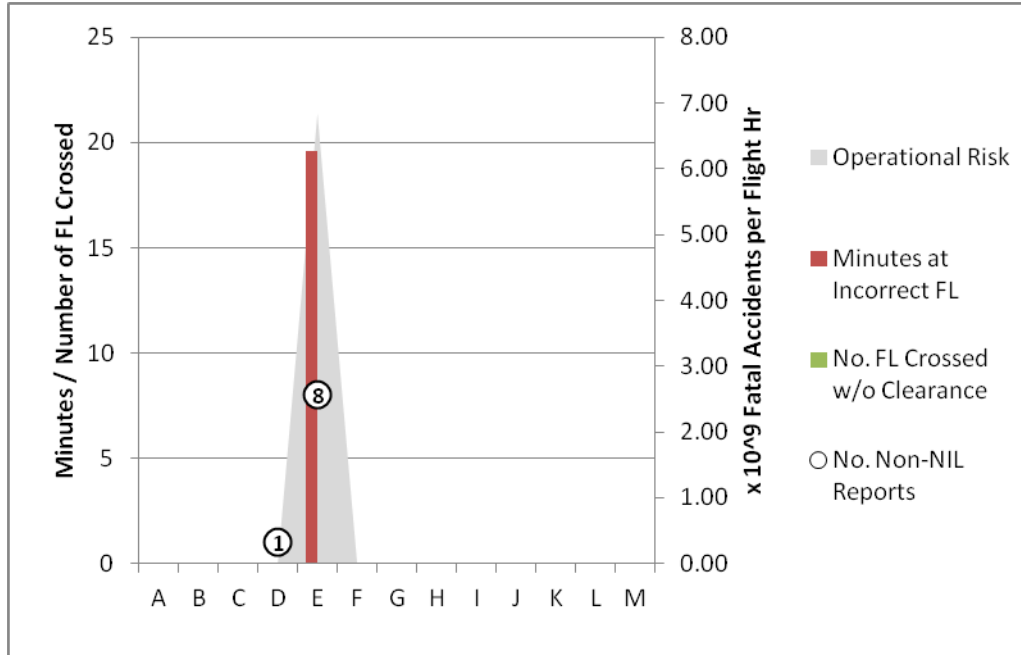
2.2. Compared to 2012, the total of LHD duration increased approximately 2 folds, 8 to 20.6 minutes, while the number of reports remains roughly the same.

- The sharp increase in LHD duration was due to a single Category-E event near INTIK, whose duration was 14 minutes.

2.3. **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 2013 to December 2013.

LHD Category Code	LHD Category Description	No. of LHDs	LHD Duration (Min)	No. levels crossed	Operational Risk (x10 <sup>-9</sup> )
<b>A</b>	Flight crew failing to climb/descend the aircraft as cleared	0	0.0	0	0.00
<b>B</b>	Flight crew climbing/descending without ATC Clearance	0	0.0	0	0.00
<b>C</b>	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
<b>D</b>	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	1	0.0	0	0.00
<b>E</b>	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)	8	19.6	0	6.84
<b>F</b>	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
<b>G</b>	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
<b>H</b>	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0.0	0	0.00
<b>I</b>	Deviation due to turbulence or other weather related cause	0	0.0	0	0.00
<b>J</b>	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	0	0.0	0	0.00
<b>K</b>	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0.0	0	0.00
<b>L</b>	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
<b>M</b>	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
<b>Total</b>		<b>9</b>	<b>19.6</b>	<b>0</b>	<b>6.84</b>

**Table 3:** Summary of LHD by LHD Category for Mongolia Airspace



**Figure 2:** Summary of LHD by LHD Category for Mongolia Airspace

2.4. The biggest risk-bearing LHD was a single Category-E LHD of duration 14 minutes. This event accounts for  $4.89 \times 10^{-9}$  FAPFH.

### 3. Risk Assessment and Safety Oversight

3.1. **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 5**.

Parameter	Description	Value Bi-Dir	Value Uni-Dir	Unit	Based On
T	Annual flight hours	104,593	4,180	Hour	Dec 2013 TSD
$E_z(\text{same})$	Same-direction vertical occupancies	0.4061/ 0.0033	0.0140	-	
$E_z(\text{opposite})$	Opposite-direction vertical occupancies	0.1437	0.0000	-	
$\lambda_x$	Average aircraft length	0.0273	0.0273	NM	
$\lambda_y$	Average aircraft wingspan	0.0250	0.0250	NM	
$\lambda_z$	Average aircraft height	0.0079	0.0079	NM	
$\lambda_h$	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0273	0.0273	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
$ \Delta V $	Average relative along-track speed between aircraft on same direction routes	21.66/ 40.82	40.82	Knot	Dec 2013 TSD
$ \bar{V} $	Average absolute aircraft ground speed	480	480	Knot	More conservative value used in previous assessments

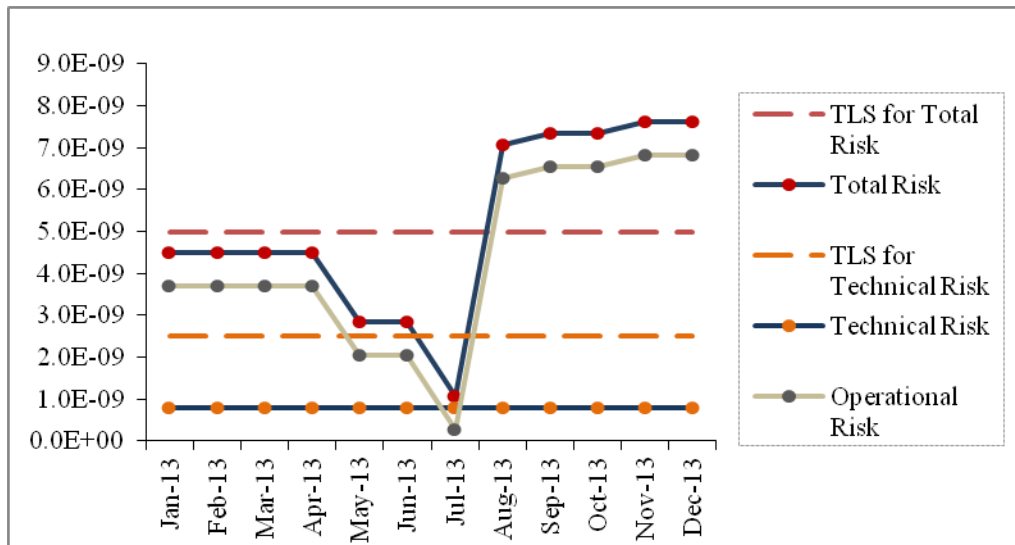
**Table 5:** Estimates of the Parameters in the CRM for Mongolia Airspace

3.2. **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 6**. The technical risk **meets** the agreed TLS value of no more than  $2.5 \times 10^{-9}$  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 does not meet the specified TLS value for these components of  $5.0 \times 10^{-9}$ .**

Mongolia RVSM Airspace – estimated annual flying hours = 108,773 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	$0.79 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$6.84 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>7.63 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Above Overall TLS</b>

**Table 6:** Risk Estimates for Mongolia Airspace

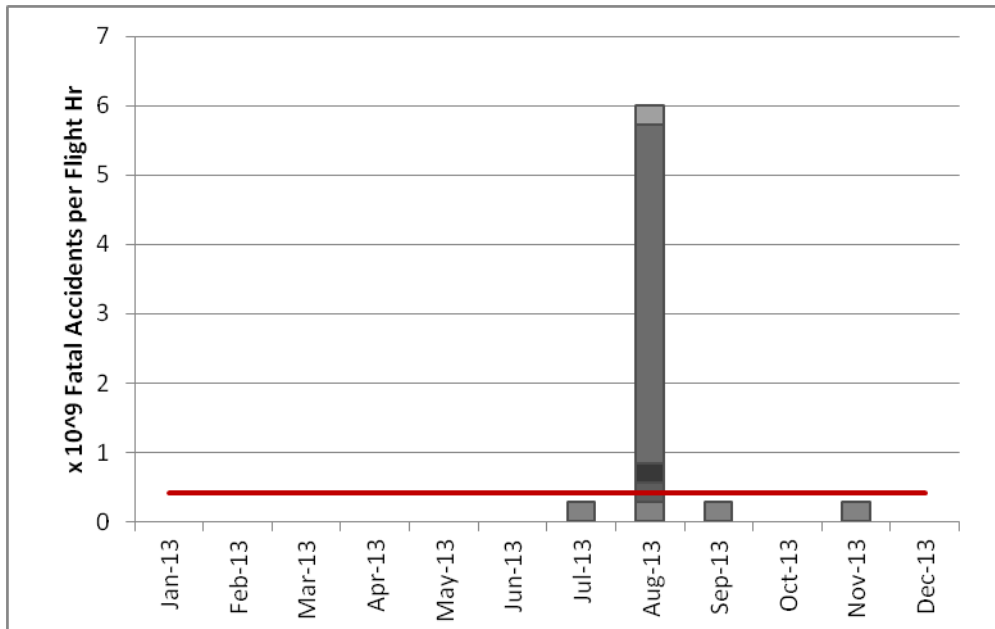
4.3 **Figure 5** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.



**Figure 5:** Trends of Risk Estimates for Mongolia 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 6** below shows the monthly risks for the month of **July 2013** are **above** the average monthly risk of the annual risk of  $5.0 \times 10^{-9}$  (red line in **Figure 6** below, which is approximately  $0.4167 \times 10^{-9}$  fatal accidents per flight hour).



**Figure 6: Monthly LHD Risk Estimates for Mongolia Airspace.**

Red line is the average monthly value for an annual risk of  $5.0 \times 10^{-9}$ . Risk is measured in Fatal Accidents per Flight Hour (FAPFH).

## 5. Analysis of Operational Errors

5.11 **Figure 7** depicts geographic location of risk bearing LHDs and hot spots in Mongolia airspace based on LHD reports from January to December 2013 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.



**Figure 7:** Geographical Location of LHDs in Mongolia Airspace

5.12 The main hot spot in Mongolia is the southwest boundary of Ulaanbaatar FIR next to Beijing FIR, NIXAL and INTIK, where the main risk-bearing event occurred.

**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.

<b>State</b>	<b>Total RVSM Approved Airframes</b>	<b>Resultant Monitoring Burden</b>	<b>Total Airframes Remaining to be Monitored</b>
Mongolia (ZM)	<b>6</b>	<b>6</b>	<b>1</b>

**Table 7:** LTHM Burden

**Appendix A: Details of the Reported LHD Events**

<b>Date</b>	<b>Assigned FL</b>	<b>Observed/ Reported FL</b>	<b>Duration at Incorrect FL</b>	<b>Category</b>	<b>Cause</b>
18/7/2013	8400 m	9200 m	< 1 min	E	No FL revision
31/7/2013	10400 m	10100 m	0 min	D	ATC-incorrect clearance
2/8/2013	9800 m	11100 m	< 1 min	E	No FL revision
2/8/2013	9800 m	10400 m	< 1 min	E	No FL revision
5/8/2013	10400 m	11600 m	< 1 min	E	No FL revision
19/8/2013	9200 m	10400 m	< 14 min	E	Late FL revision
21/8/2013	8400 m	9200 m	< 1 min	E	No FL revision
16/9/2013	FL350	FL390	< 1 min	E	No FL revision
25/11/2013	FL340	FL330	< 1 min	E	No FL revision