



*International Civil Aviation Organization*

**The Thirteen Meeting of the Regional Airspace Safety Monitoring  
Advisory Group (RASMAG/13)**

Bangkok, Thailand, 02 – 05 August 2010

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**Agenda Item 5: Airspace safety monitoring activities/requirements in the Asia/Pacific Region**

**Summary of the Airspace Safety Review for the RVSM Operation in Asia Region**

(Presented by MAAR)

**Summary**

This paper provides the results of the airspace safety oversight for the RVSM operation in the Asia Region, including Bay of Bengal (BOB) and Western Pacific/South China Sea (WPAC/SCS) airspace.

**1. Introduction**

1.1. This paper provides the airspace safety oversight for the RVSM operation in the Asia Region, including Bay of Bengal (BOB) and Western Pacific/South China Sea (WPAC/SCS), as given in **Attachments 1** and **2**, respectively.

**2. Content of Safety Oversight Reports**

2.1. The content of the safety oversight reports includes:

- Introduction;
- Data submission,
- Summary of Large Height Deviation (LHD) occurrences, and
- Risk assessment and safety oversight

**3. Actions by the Meeting**

3.1. The meeting is invited to note the results of the airspace safety oversight presented in this working paper, and use the findings to consider the continuation of the RVSM operation in the Asia Region.

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**AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN  
BAY OF BENGAL AIRSPACE**

Presented by



**Monitoring Agency for Asia Region  
August 2010**

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**1. Introduction**

This report provides the summary of airspace safety oversight for the post RVSM implementation in the Asia Region, focusing on the **Bay of Bengal (BOB) airspace**. The RVSM safety oversight is conducted based on a one-month traffic sample data (TSD) collected in **December 2009** and monthly Large Height Deviation (LHD) reports between **June 2009 and May 2010** submitted by concerning States in the BOB region.

**2. Data Submission**

**2.1. Traffic Sample Data (TSD)**

Traffic Sample data for the month of December 2009 of aircraft operating in the BOB airspace was used to assess the safety of RVSM airspace. **Table 1** contains a summary of TSD received by MAAR.

<b>BOB States</b>	<b>FIR Name</b>	<b>Status</b>
Bangladesh	Dhaka	Not Received
India	Chennai	Received
	Delhi	Received
	Kolkata	Received
	Mumbai	Received
Malaysia	Kuala Lumpur	Received
Maldives	Male	Received
Myanmar	Yangon	Received
Nepal	Katmandu	Received
Pakistan	Karachi	Received
	Lahore	Received
Sri Lanka	Colombo	Received
Thailand	Bangkok	Received

**Table 1:** Summary of December TSD Submitted by States in the BOB Region

## 2.2. Large Height Deviation (LHD)

Series of cumulative 12-month of LHD reports were used in this safety assessment starting from June 2009 to May 2010. **Table 2** provides the summary of the LHD reports submitted by the concerned States in the BOB Region.

State	Bangladesh	India				Malaysia	Maldives	Myanmar	Nepal	Pakistan		Sri Lanka	Thailand
FIR	Dhaka	Chennai	Delhi	Kolkata	Mumbai	Kuala Lumpur	Male	Yangon	Katmandu	Karachi	Lahore	Colombo	Bangkok
Jun 09	X	X	X	X	X	X	X	X	X	X	X	X	X
Jul 09	X	X	X	X	X	X	X	X	X	X	X	X	X
Aug 09	X	X	X	X	X	X	X	X	X	X	X	X	X
Sep 09	X	X	X	X	X	X	X	X	X	X	X	X	X
Oct 10	X	X	X	X	X	X	X	X	X	X	X	X	X
Nov 10	X	X	X	X	X	X	X	X	X	X	X	X	X
Dec 10	X	X	X	X	X	X	X	X	-	X	X	X	X
Jan 10	X	X	X	X	X	X	X	X	-	X	-	X	X
Feb 10	X	X	X	X	X	X	-	X	-	-	-	X	X
Mar 10	X	X	X	X	X	X	-	X	X	-	-	X	X
Apr 10	X	X	X	X	X	X	-	X	X	-	-	X	X
May 10	X	X	X	X	X	X	-	X	-	-	-	X	X

**Table 2:** Summary of LHD Reports Submitted by BOB States

### 3. Summary of LHD Occurrences in BOB Airspace

Based on the received LHD reports shown in **Table 2**, the LHD occurrences in the BOB region are summarized as follows:

**Table 3** summarizes the number of LHD occurrences, associated LHD duration (in minutes), 12-month cumulative number of LHD occurrences, and 12-month cumulative LHD duration by month in the BOB RVSM airspace.

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)	12-month Cumulative Occurrences	12-month Cumulative Duration
June 2009	0	0	12	11
July 2009	0	0	11	10
August 2009	2	19	13	29
September 2009	1	1	13	30
October 2009	1	5	11	32
November 2009	0	0	10	32
December 2009	0	0	9	31
January 2010	2	0	10	30
February 2010	0	0	7	28
March 2010	1	3	7	28
April 2010	4	4	11	32
May 2010	0	0	11	32
<b>Total</b>	<b>11</b>	<b>32</b>	<b>11</b>	<b>32</b>

**Table 3:** Summary of LHD Occurrences and Duration in BOB RVSM Airspace

**Table 4** summarizes the number of LHD occurrences and associated LHD duration (in minutes) by cause of the deviation.

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	2	6
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters)	1	18
I	Turbulence or other weather related causes	1	3
M	Others	7	5
<b>Total</b>		<b>11</b>	<b>32</b>

**Table 4:** Summary of LHD Causes in the BOB RVSM Airspace

In light of the above, the LHD occurrences in the BOB RVSM airspace are summarized as follows:

- Compared to the previous Meeting, the number of LHD occurrences decreased from 13 to 11 occurrences while total LHD duration slightly increased from 30 to 32 minutes;
- Average duration of LHD occurrence is 2.9 minutes with maximum of 18 minutes;
- The overall LHD duration was driven by a significant event in August 2009, which accounted for 18 minutes or 60% of total duration; and
- Beside the event in August 2009, there are only a few non-nil LHD events reported from States in this region.

#### **4. Risk Assessment and Safety Oversight**

This section updates the results of the safety oversight for the RVSM implementation over BOB airspace, which was implemented on 27 November 2003. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of implementing the RVSM in the BOB airspace.

##### **4.1. Estimate of the CRM Parameters**

**Table 5** summarizes the value and source material for estimating values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM) to conduct the safety oversight for the RVSM implementation in the BOB airspace.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
T	Annual flight hours	1,566,154 flight-hr per yr	Based on the submitted Traffic Sample Data
$E_z(\text{same})$	Same-direction vertical occupancies	0.0480	
$E_z(\text{opposite})$	Opposite-direction vertical occupancies	0.0890	
$\lambda_x$	Average aircraft length	0.0267 nm	
$\lambda_y$	Average aircraft wingspan	0.0244 nm	
$\lambda_z$	Average aircraft height	0.0077 nm	
$\lambda_h$	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0267 nm	
$P_y(0)$	Probability of lateral overlap	0.0815	Based on average aircraft wingspan
$P_z(S_z)$	Probability of vertical overlap (with planned vertical separation $S_z$ )	$2.46 \times 10^{-8}$	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$P_z(0)$	Probability of vertical overlap (with planned vertical separation equal to zero)	0.5380	
$P_h(\theta)$	Probability of horizontal overlap	$6.88 \times 10^{-7}$	
$ \overline{\Delta V} $	Average relative along-track speed between aircraft on same direction routes	26.39 knots	Based on the submitted TSD
$ \overline{V} $	Average absolute aircraft ground speed	480 knots	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$ \overline{\dot{y}} $	Average absolute relative cross track speed for an aircraft pair nominally on the same track	4 knots	Conservatively estimated from processing GMU-collected GPS-derived positions of aircraft
$ \overline{h(\theta)} $	Average relative horizontal speed during overlap for aircraft pairs on routes with crossing angle $\theta$ ( $\theta=45^\circ$ )	367.4 knots	Corresponds to average aircraft speed of 480 knots
$ \overline{\dot{z}} $	Average absolute relative vertical speed of an aircraft pair that has lost all vertical separation	1.5 knots (all traffic flows)	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments

**Table 5:** Estimates of the Parameters in the CRM

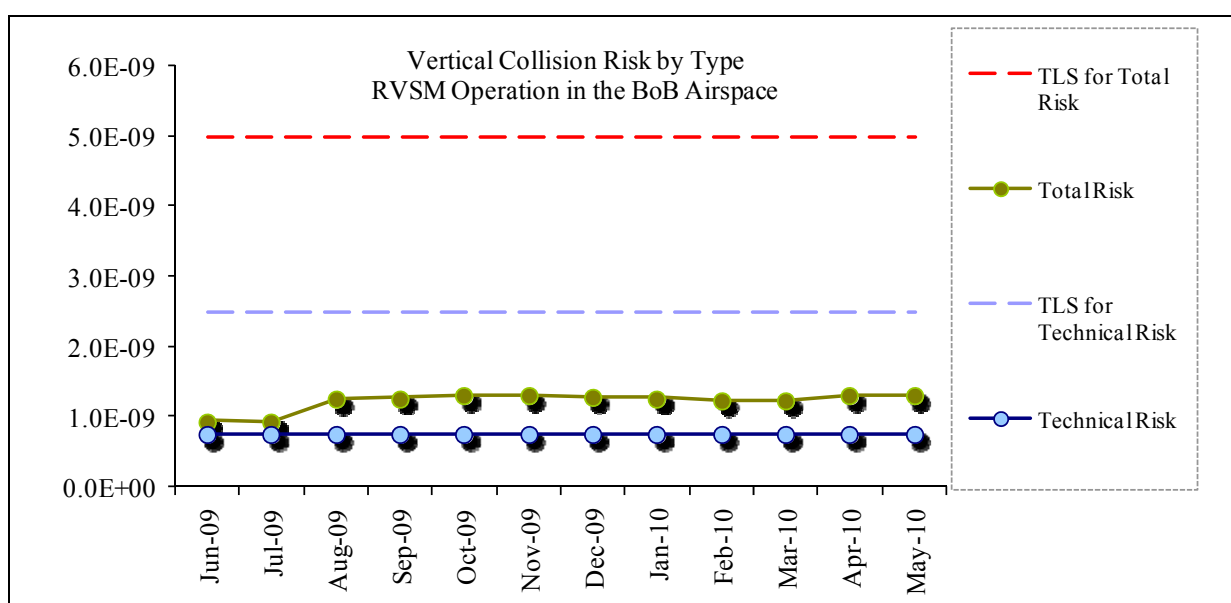
**4.2. Safety Oversight for the RVSM implementation in BOB Airspace**

**Table 6** summarizes the results of the airspace safety oversight, as of **August 2010**, in terms of the technical, operational, and total risks for the RVSM implementation in the BOB airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	$0.74 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$0.56 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>1.30 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Below Overall TLS</b>

**Table 6:** Risk Estimates for the RVSM Implementation in BOB Airspace

In addition, **Figure 3** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports since June 2009.



**Figure 3:** Trends of Risk Estimates for the RVSM Implementation in BOB Airspace

Based on these collision risk estimates, both technical and total risks from the **available TSD and LHD reports** satisfy the agreed TLS value of no more than  $2.5 \times 10^{-9}$  and  $5.0 \times 10^{-9}$  fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes, respectively.

It is important that relevant information be provided to MAAR in order to provide accurate and effective safety reports. It is strongly urged that States provide information to MAAR such that any adverse trends be identified in advance.

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**AIRSPACE SAFETY REVIEW FOR THE RVSM OPERATION IN  
WESTERN PACIFIC/SOUTH CHINA SEA AIRSPACE**

Presented by



**Monitoring Agency for Asia Region  
August 2010**

**1. Introduction**

This report provides the summary of airspace safety oversight for the post RVSM implementation in the Asia Region, focusing on the **Western Pacific/South China Sea (WPAC/SCS) airspace**. The RVSM safety oversight analysis is conducted based on a one-month traffic sample data (TSD) collected in **December 2009** and monthly Large Height Deviation (LHD) reports between **June 2009 and May 2010** submitted by concerning States in the WPAC/SCS region.

**2. Data Submission**

**2.1. Traffic Sample Data (TSD)**

Traffic Sample data for the month of December 2009 of aircraft operating in the WPAC/SCS airspace was used to assess the safety of RVSM airspace. **Table 1** contains a summary of TSD received by MAAR for the RVSM safety oversight in the WPAC/SCS airspace.

<b>States</b>	<b>FIR Name</b>	<b>Status</b>
Cambodia	Phnom Penh	Received
China	Sanya	Received
Hong Kong	Hong Kong	Received
Lao PDR	Vientiane	Received
Malaysia	Kuala Lumpur	Received
	Kota Kinabalu	Received
Philippines	Manila	Received
Singapore	Singapore	Received
Thailand	Bangkok	Received
Vietnam	Hanoi	Received
	Ho Chi Minh	Received

**Table 1:** Summary of TSD Submission by WPAC/SCS States

## 2.2. Large Height Deviation (LHD)

Series of cumulative 12-month of LHD Reports were used in this safety assessment starting from June 2009 to May 2010.

**Table 2** provides the summary of LHD reports submitted by the concerned States in the WPAC/SCS Region.

State	Cambodia	China		Loa PDR	Malaysia		Philippines	Singapore	Thailand	Vietnam	
FIR	Phnom Penh	Sanya	Hong Kong	Vientiane	Kota Kinabalu	Kuala Lumpur	Manila	Singapore	Bangkok	Hanoi	Ho Chi Minh
Jun 09	X	X	X	X	X	X	X	X	X	X	X
Jul 09	X	X	X	X	X	X	X	X	X	X	X
Aug 09	X	X	X	X	X	X	X	X	X	X	X
Sep 09	X	X	X	-	X	X	X	X	X	X	X
Oct 10	X	X	X	-	X	X	X	X	X	X	X
Nov 10	X	X	X	-	X	X	X	X	X	X	X
Dec 10	X	X	X	-	X	X	-	X	X	X	X
Jan 10	X	X	X	-	X	X	X	X	X	X	X
Feb 10	X	X	X	-	X	X	X	X	X	X	X
Mar 10	X	X	X	-	X	X	-	X	X	X	X
Apr 10	X	X	X	-	X	X	-	X	X	X	X
May 10	X	X	X	-	X	X	-	X	X	X	X

**Table 2:** Summary of LHD Reports Submission by WPAC/SCS States

**3. Summary of LHD Occurrences in WPAC/SCS Airspace**

Based on the received LHD reports shown in **Table 2**, the LHD occurrences between **June 2009 and May 2010** in the WPAC/SCS region are summarized as follows.

**Table 3** summarizes the number of LHD occurrences, associated LHD duration (in minutes), 12-month cumulative number of LHD occurrences, and 12-month cumulative LHD duration by month in the WPAC/SCS RVSM airspace.

<b>Month-Year</b>	<b>No. of LHD Occurrences</b>	<b>LHD Duration (Minutes)</b>	<b>12-month Cumulative Occurrences</b>	<b>12-month Cumulative Duration</b>
June 2009	7	14	73	117
July 2009	2	0	67	103
August 2009	5	16	63	108
September 2009	7	6	68	110
October 2009	6	15	70	120
November 2009	6	14	73	130
December 2009	6	5	73	125
January 2010	5	1	71	114
February 2010	3	2	67	108
March 2010	7	7	67	94
April 2010	12	11	71	98
May 2010	8	7	74	98
<b>Total</b>	<b>8</b>	<b>7</b>	<b>74</b>	<b>98</b>

**Table 3:** Summary of LHD Occurrences and Duration in WPAC/SCS RVSM Airspace

**Table 4** summarizes the number of LHD occurrences and associated LHD duration (in minutes) by cause of the deviation.

<b>LHD Category Code</b>	<b>LHD Category Description</b>	<b>No. of LHD Occurrences</b>	<b>LHD Duration (Min)</b>
A	Flight crew failing to climb/descend the aircraft as cleared	1	10
B	Flight crew climbing/descending without ATC clearance	2	2
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	4	8
E	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters)	57	68
F	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues	1	1
I	Turbulence or other weather related causes	1	3
M	Other	8	6
<b>Total</b>		<b>74</b>	<b>98</b>

**Table 4:** Summary of LHD Causes in the WPAC/SCS RVSM Airspace

In light of the above, the LHD occurrences in the WPAC/SCS RVSM airspace are summarized as follows:

- Compared to the previous Meeting, the total LHD duration improved from 110 minutes to 98 minutes while the number of LHD occurrences increased from 68 to 74 occurrences;
- Average duration of LHD occurrence improved from 1.62 minutes to 1.32 minutes; and
- Significant portion of LHD occurrences (57 of 74 occurrences) as well as duration (68 of 98 minutes) is contributable to coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues (Category E).

#### **4. Risk Assessment and Safety Oversight**

This section updates the results of safety oversight for the RVSM implementation over WPAC/SCS airspace. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of implementing the RVSM in the WPAC/SCS airspace.

**4.1. Estimate of the CRM Parameters**

**Table 5** provides the value and source material for estimating values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM) to conduct the safety oversight for the RVSM implementation in the WPAC/SCS airspace.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
T	Annual flight hours	905,147 flight-hours per year	Based on the submitted Traffic Sample Data
$E_z(\text{same})$	Same-direction vertical occupancies	0.1424	
$E_z(\text{opposite})$	Opposite-direction vertical occupancies	0.1081	
$\lambda_x$	Average aircraft length	0.0274 nm	
$\lambda_y$	Average aircraft wingspan	0.0249 nm	
$\lambda_z$	Average aircraft height	0.0078 nm	
$\lambda_h$	Diameter of the disk representing the shape of an aircraft in the horizontal plane	0.0274 nm	
$P_y(0)$	Probability of lateral overlap	0.0816	Based on average aircraft wingspan
$P_z(S_z)$	Probability of vertical overlap (with planned vertical separation equal to $S_z$ )	$2.46 \times 10^{-8}$	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$P_z(0)$	Probability of vertical overlap (with planned vertical separation equal to zero)	0.5380	
$P_h(\theta)$	Probability of horizontal overlap	$6.88 \times 10^{-7}$	
$ \overline{\Delta V} $	Average relative along-track speed between aircraft on same direction routes	25.52 knots	Based on the submitted TSD
$ \overline{V} $	Average absolute aircraft ground speed	480 knots	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$ \overline{y} $	Average absolute relative cross track speed for an aircraft pair nominally on the same track	4 knots	Conservatively estimated from processing GMU-collected GPS-derived positions of aircraft
$ \overline{h(\theta)} $	Average relative horizontal speed during overlap for aircraft pairs on routes with crossing angle $\theta$ (let $\theta=45^\circ$ )	367.4 knots	Corresponds to average aircraft speed of 480 knots
$ \overline{z} $	Average absolute relative vertical speed of an aircraft pair that has lost all vertical separation	1.5 knots (all traffic flows)	Conservative value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments

**Table 5:** Estimates of the Parameters in the CRM

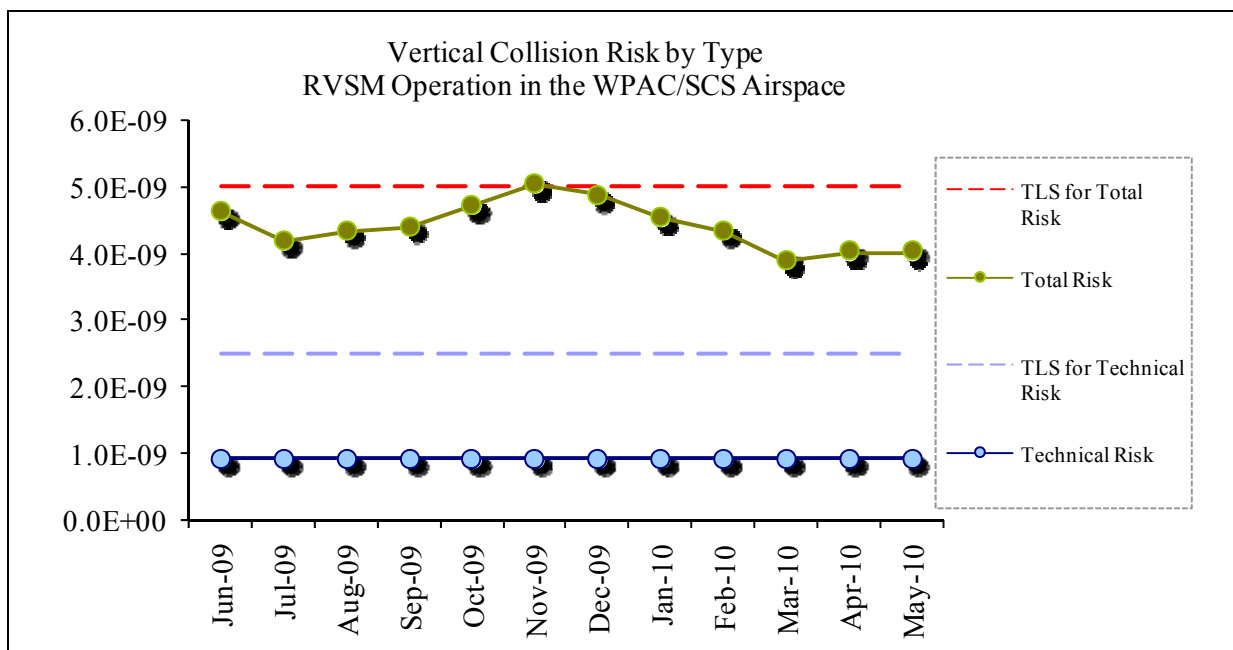
**4.2. Safety Oversight for the RVSM implementation in WPAC/SCS Airspace**

**Table 6** summarizes the results of the airspace safety oversight, as of **August 2010**, in terms of the technical, operational, and total risks for the RVSM operation in the WPAC/SCS airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	$0.92 \times 10^{-9}$	$2.5 \times 10^{-9}$	Below Technical TLS
Operational Risk	$2.79 \times 10^{-9}$	-	-
<b>Total Risk</b>	<b><math>3.71 \times 10^{-9}</math></b>	<b><math>5.0 \times 10^{-9}</math></b>	<b>Below Overall TLS</b>

**Table 6:** Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

In addition, **Figure 3** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports.



**Figure 3:** Trends of Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

Based on the collision risk estimate, both technical and total risks satisfy the agreed TLS value of no more than  $2.5 \times 10^{-9}$  and  $5.0 \times 10^{-9}$  fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes, respectively. The overall improvement is contributable to reduction in LHD occurrences and its duration.

Nonetheless, the number of LHD occurrences and duration is significant to the risk estimate. As a result, it is strongly recommended that States continue to take any remedial and preventive actions necessary to persistently maintain the number of LHD occurrence as well as duration to a minimum.

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