International Civil Aviation Organization

The Second Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/2)

Bangkok, Thailand, 4-8 October 2004

Agenda Item 4: Review the airspace safety monitoring arrangements in the Asia/Pacific Region and the activities of regional airspace safety monitoring agencies

SUMMARY OF THE AIRSPACE SAFETY REVIEW FOR THE RVSM IMPLEMENTATION IN ASIA REGION – BAY OF BENGAL AIRSPACE

(Presented by Monitoring Agency for Asia Region – MAAR)

Summary

This paper provides the report of airspace safety review of the RVSM implementation in Asia Region, focusing on Bay of Bengal Airspace.

1. Introduction

1.1 This paper provides the annual report of airspace safety review of the RVSM implementation in Asia Region, focusing on Bay of Bengal Airspace, as given in the **Attachment**.

2. Action by the Meeting

2.1 The Meeting is invited to note the results of the safety oversight presented and use the findings to support the continuation of the RVSM implementation in the BOB airspace.

2.2 The Meeting is invited to note the need of support from all States concerned to provide MAAR with:

- RVSM approval records for all registered aircraft in Asia Region
- Specified Traffic sample data for July 2004
- Month LHD reports

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AIRSPACE SAFETY REVIEW FOR RVSM IMPLEMENTATION IN ASIA REGION

Bay of Bengal Airspace

October 2004

(DRAFT)

Monitoring Agency for Asia Region
(MAAR)

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TABLES OF CONTENT

1. INTRODUCTION

The report provides the summary of airspace safety review for the post Reduced Vertical Separation Minimum (RVSM) implementation in the Asia Region, focusing on the **Bay of Bengal (BOB) airspace.** The review conducted based on a one-month traffic sample data collected in July 2004 from concerned States in the BOB region.

The reviewed issues in the airspace review include:

- Summary of traffic data,
- RVSM approval registry,
- Summary of RVSM non-compliant aircraft operating in RVSM airspace
- Summary of large height deviation (LHD), and
- Risk assessment and safety oversight of the RVSM airspace in the BOB.

2. BACKGROUND

Monitoring Agency for Asia Region (MAAR) was established by Aeronautical Radio of Thailand, Ltd. (AEROTHAI) under the approval of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to officially assume the duties and responsibilities of the Regional Monitoring Agency (RMA) for the Asia Region from 2 September 2003.

The principal role of the MAAR is to assist the International Civil Aviation Organization (ICAO) in the continuation of the safety assessment program for the implementation of Reduced Vertical Separation Minimum (RVSM).

2.1 FIRs under MAAR Responsibility

The geographical area under MAAR responsibility is the Asia Region, which includes the ICAO Western Pacific/South China Sea (WPAC/SCS) and Bay of Bengal (BOB) areas. The Flight Information Regions (FIR)/Areas of Responsibility (AOR) in the WPAC/SCS and BOB areas are summarized in **Table 1**.

States	FIRs/AOR
WPAC/SCS	
Cambodia	Phnom Penh
China	Sanya AOR
Hong Kong	Hong Kong
Indonesia	Bali
	Jakarta
	Ujung Pandang
Lao PDR	Vientiane
Malaysia	Kuala Lumpur
	Kota Kinabalu
Philippines	Manila
Singapore	Singapore
Taiwan	Taiwan
Thailand	Bangkok
Vietnam	Hanoi

States	FIRs/AOR
	Ho Chi Minh
BOB	
Bangladesh	Dhaka
India	Chennai
	Delhi
	Kolkata
	Mumbai
Indonesia	Jakarta
Malaysia	Kuala Lumpur
Maldives	Male
Myanmar	Yangon
Nepal	Katmandu
Pakistan	Karachi
	Lahore
Singapore	Singapore
Sri Lanka	Colombo
Thailand	Bangkok

Table 2-1: FIRs/ AOR in the WPAC/SCS and BOB under MAAR Responsibility

2.2 Data Inquiry for RVSM Airspace Safety Review

At the RVSM/TF/21 (Bangkok, 8-12 March 2004), the meeting agreed that one month of TSD of aircraft operating on the EMARSSH routes would be collected by all States involved in **July 2004,** and submitted to MAAR by the end of August**.** In addition, the LHD reports should be sent to the MAAR by the first week of every month.

3. SUMMARY OF TRAFFIC SAMPLE DATA

3.1 Traffic Sampling

Table 3-1 presents the information requested for an individual traffic movement, or flight, in the sample.

Item	Example	Mandatory or Optional
Date (either month/day/year or day/month/year format)	5/01/00 or 01/05/00 for 1 May 2000	Mandatory
Aircraft call sign	MAS704	Mandatory
Aircraft Type	B734	Mandatory
Origin Aerodrome	WMKK	Mandatory
Destination Aerodrome	RPLL	Mandatory
Entry Fix into RVSM Airspace	MESOK	Mandatory
Time at Entry Fix	2:25 (or 0225)	Mandatory
Flight Level at Entry Fix	330	Mandatory
Exit Fix from RVSM Airspace	NISOR	Mandatory
Time at Exit Fix	4:01 (or 0401)	Mandatory
Flight Level at Exit Fix	330	Mandatory
First Fix Within RVSM Airspace OR First Airway Within RVSM Airspace	MESOK OR G582	Mandatory
Time at First Fix	02:25 OR 0225	Mandatory
Flight Level at First Fix	330	Mandatory
Second Fix Within RVSM Airspace OR Second Airway Within RVSM Airspace	MEVAS OR G577	
Time at Second Fix	02:50 OR 0250	Mandatory
Flight Level at Second Fix	330	Mandatory
(Continue with as many Fix/Time/Flight-Level entries as are required to describe the flight's movement within RVSM airspace)		Optional

Table 3-1: Information Required for a Flight in Traffic Sample

3.2 Received Traffic Data

As shown in **Table 3-1**, there is a total of 15 FIRs in the BOB airspace, where RVSM were implemented. **Table 3-2** contains a summary of the traffic data collected between 1 and 31 July 2004 for use in the analysis.

States	FIR Name	Status	Remarks
Bangladesh	Dhaka	No data received	-
India	Chennai	Received	Data completed
	Delhi	Received	Data completed
	Kolkata	Received	Data completed
	Mumbai	Received	Data completed
Indonesia	Jakarta	No data received	-
Malaysia	Kuala Lumpur	Received	Data completed
Maldives	Male	Received	Data completed
Myanmar	Yangon	No data received	-
Nepal	Katmandu	No data received	-
Pakistan	Karachi	Received	Data completed
	Lahore	Received	Missing data on 5 July 2004
Singapore	Singapore	Received	Data completed
Sri Lanka	Colombo	No data received	-
Thailand	Bangkok	Received	Data completed

Table 3-2: Summary of Traffic Data of July 2004 Received by MAAR for the BOB Region

3.3 Traffic Data Analyses

Based on this information received, the TSD is summarized as follows:

3.3.1 Flight Information

3.3.1.1 Flights per States

The number of flights in the traffic data of each State is summarized in **Figure 3-1**.

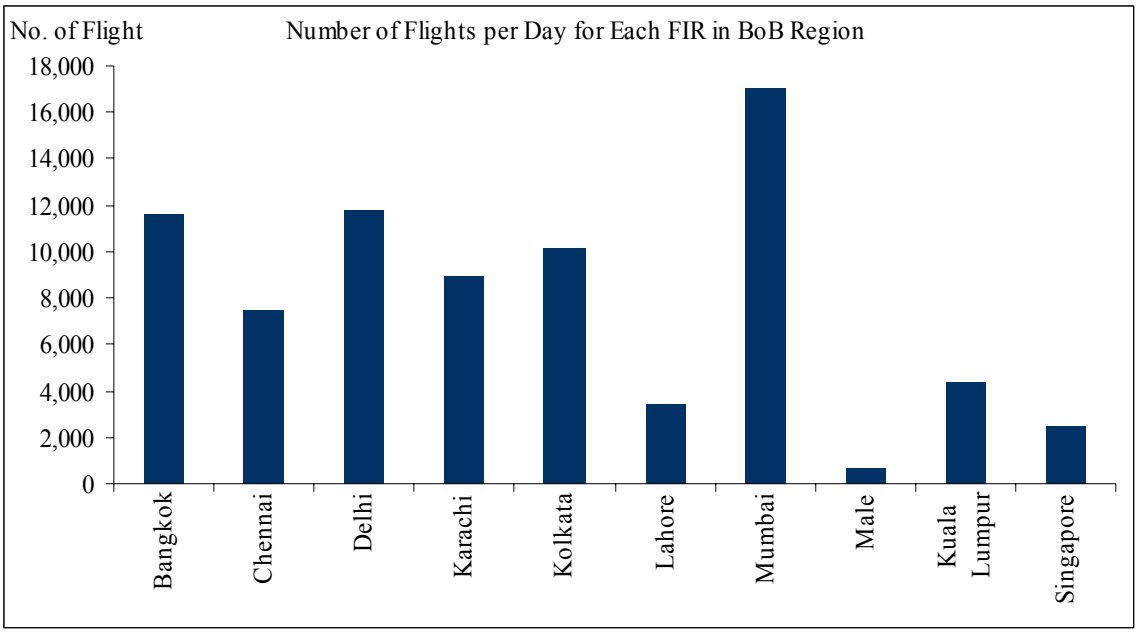

Figure 3-1: Number of Flights per States in BOB Region

3.3.1.2 Flight per State per day

Daily sizes of the submitted TSD are shown in **Figures 3-2** through **3-11**. It is noted that scale of the vertical axis (number of flights) depends on the size of the sample.

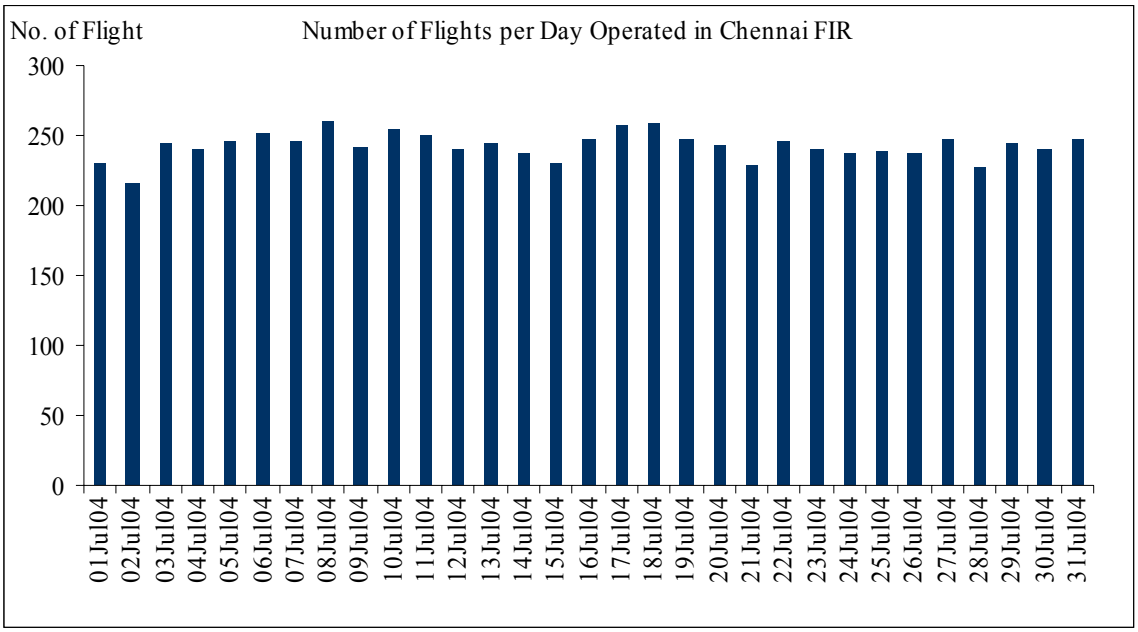

Figure 3-2: Traffic Data from India (Chennai FIR)

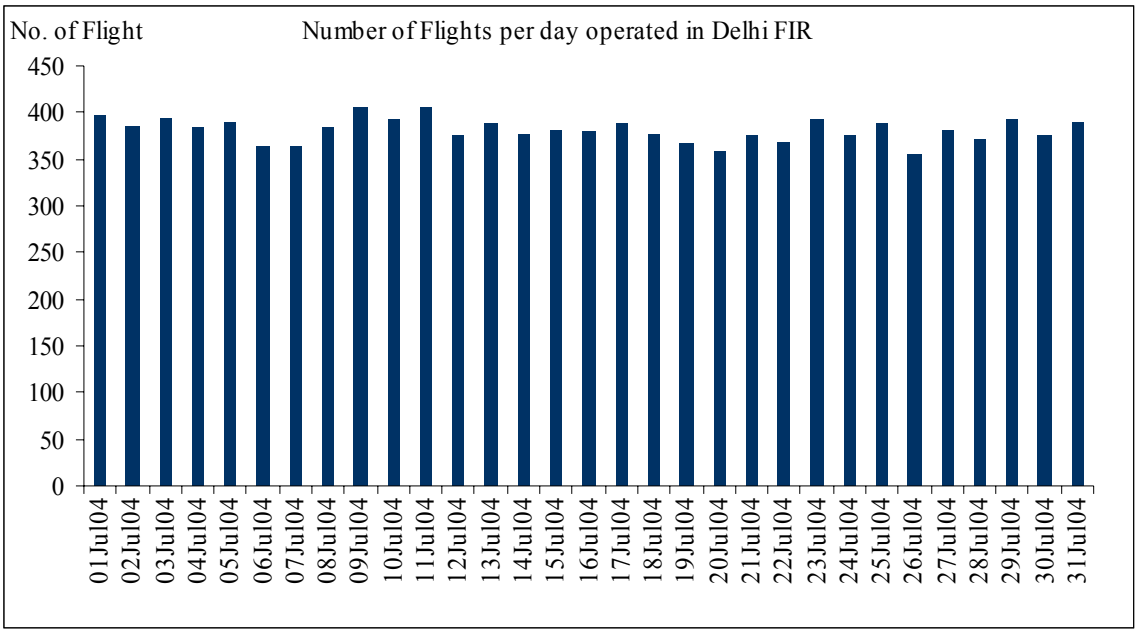

Figure 3-3: Traffic Data from India (Delhi FIR)

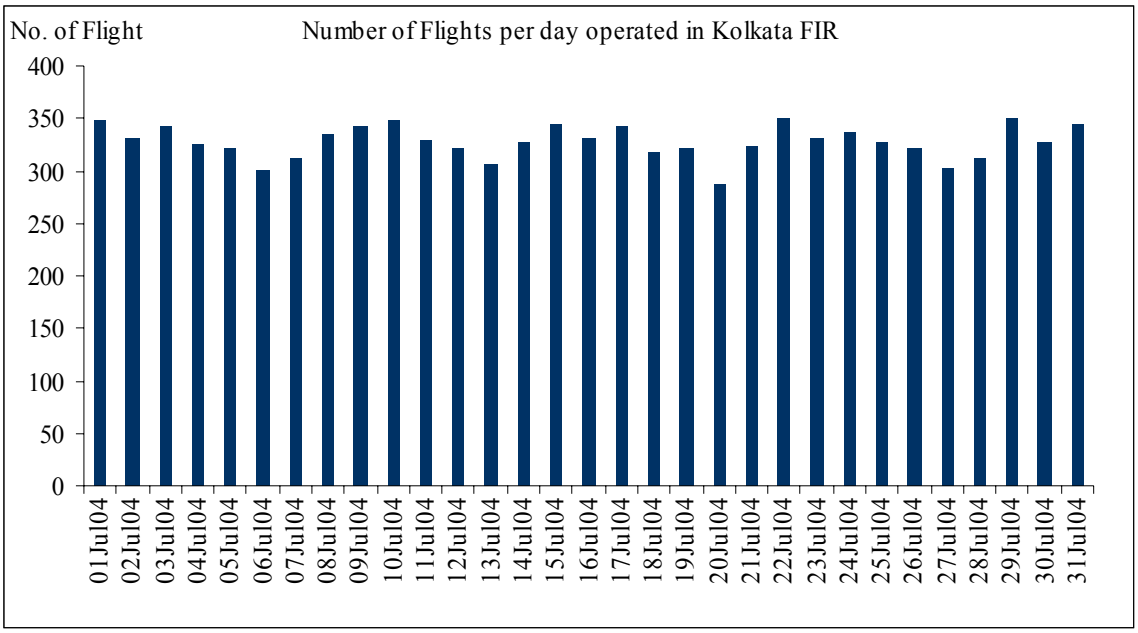

Figure 3-4: Traffic Data from India (Kolkata FIR)

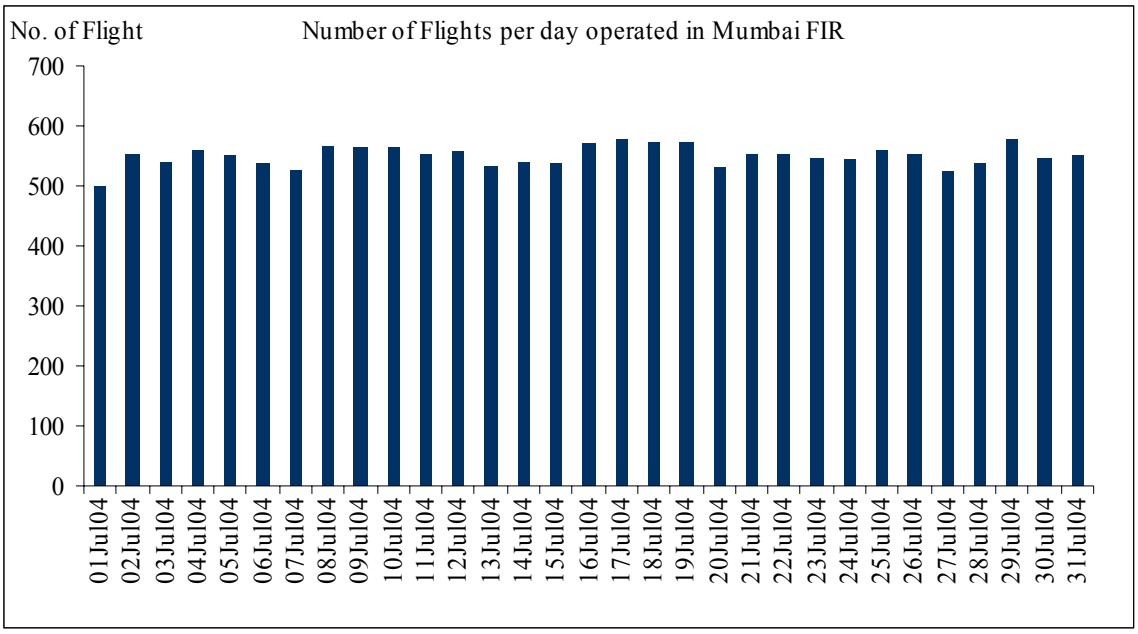

Figure 3-5: Traffic Data from India (Mumbai FIR)

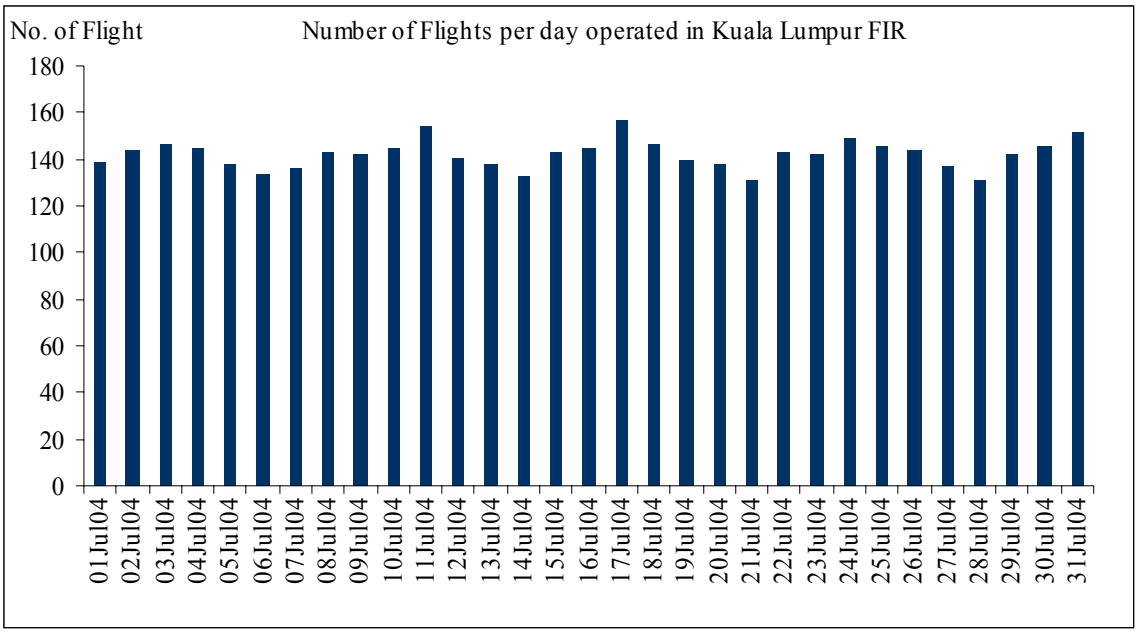

Figure 3-6: Traffic Data from Malaysia (Kuala Lumpur FIR)

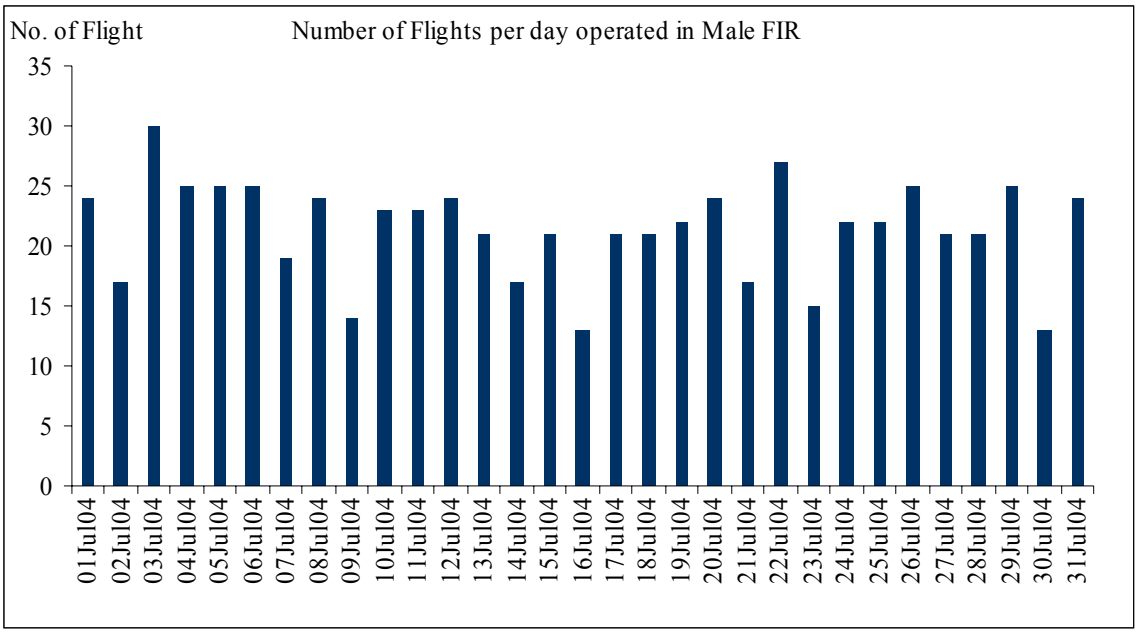

Figure 3-7: Traffic Data from Maldives (Male FIR)

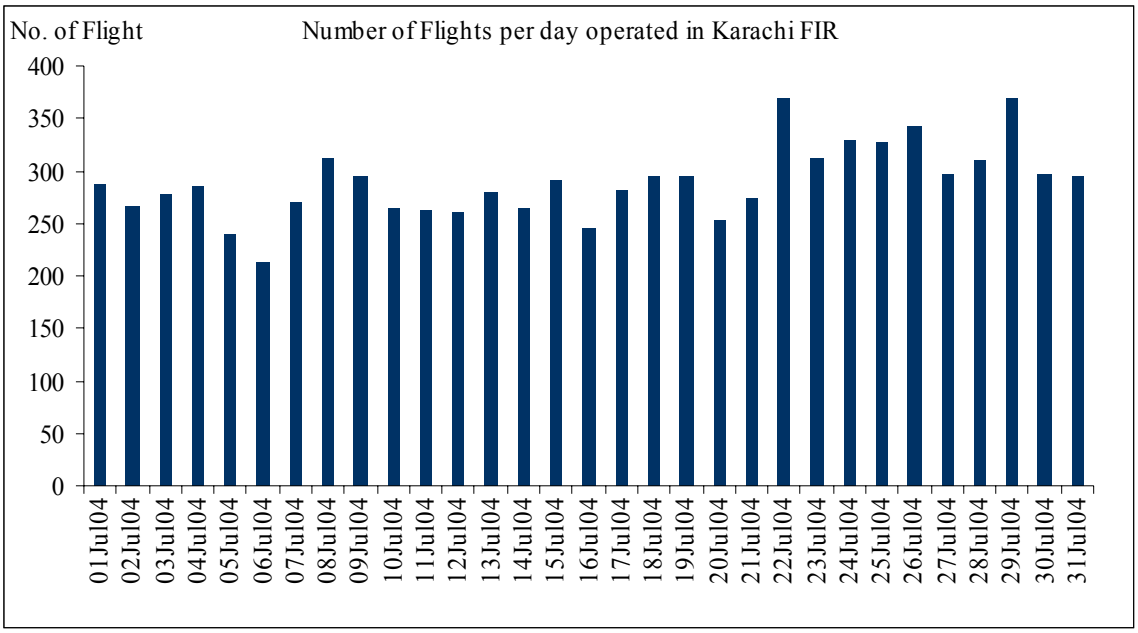

Figure 3-8: Traffic Data from Pakistan (Karachi FIR)

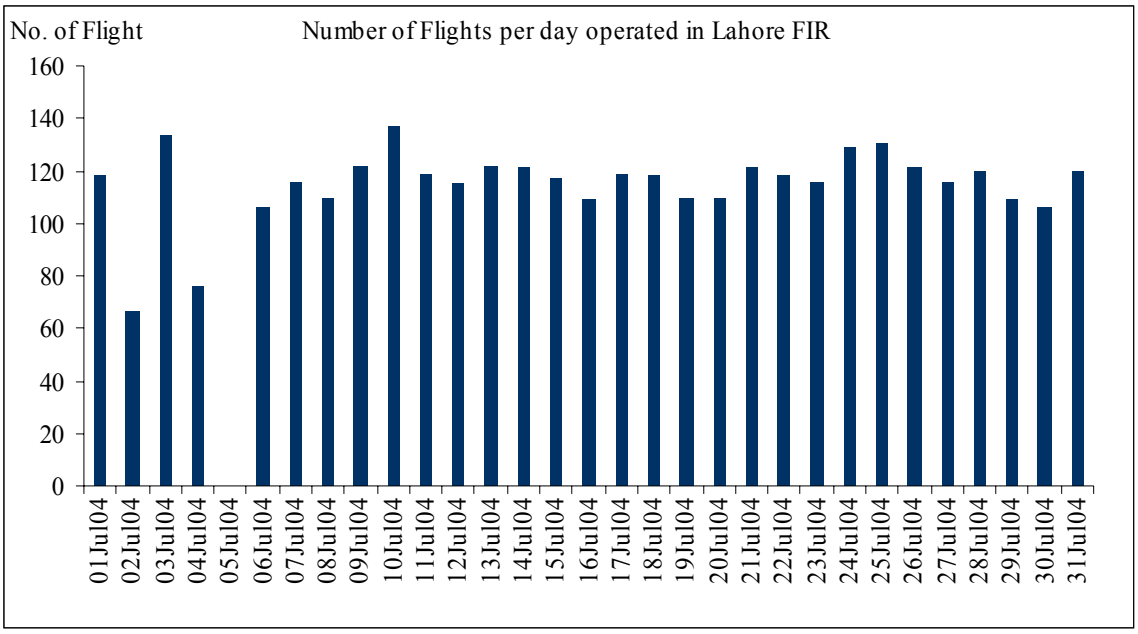

Figure 3-9: Traffic Data from Pakistan (Lahore FIR)

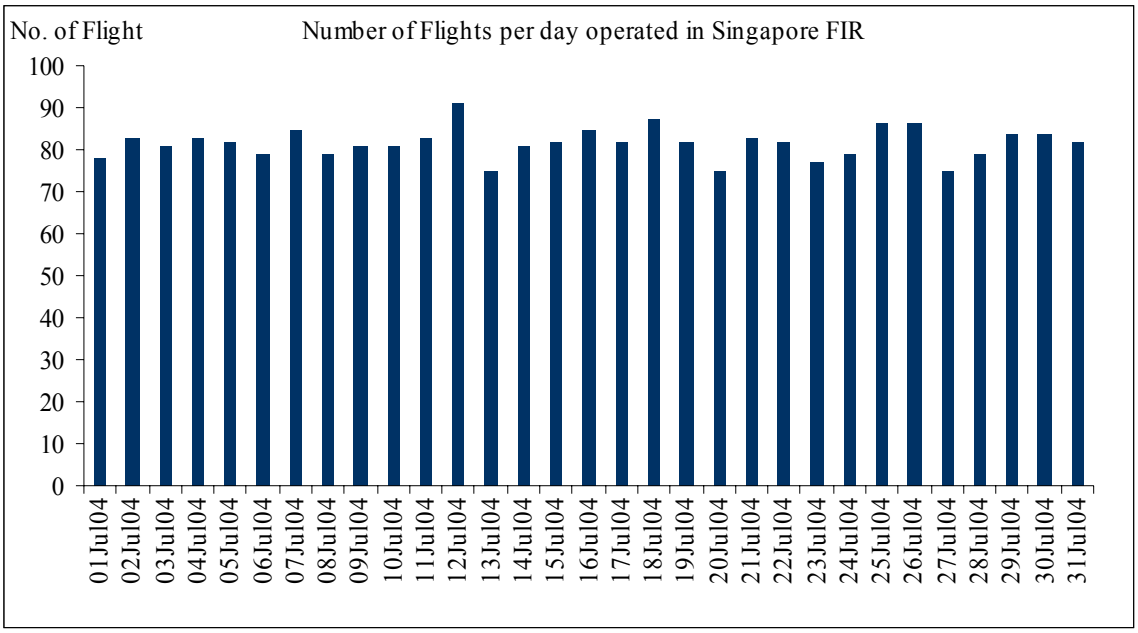

Figure 3-10: Traffic Data from Singapore (Singapore FIR)

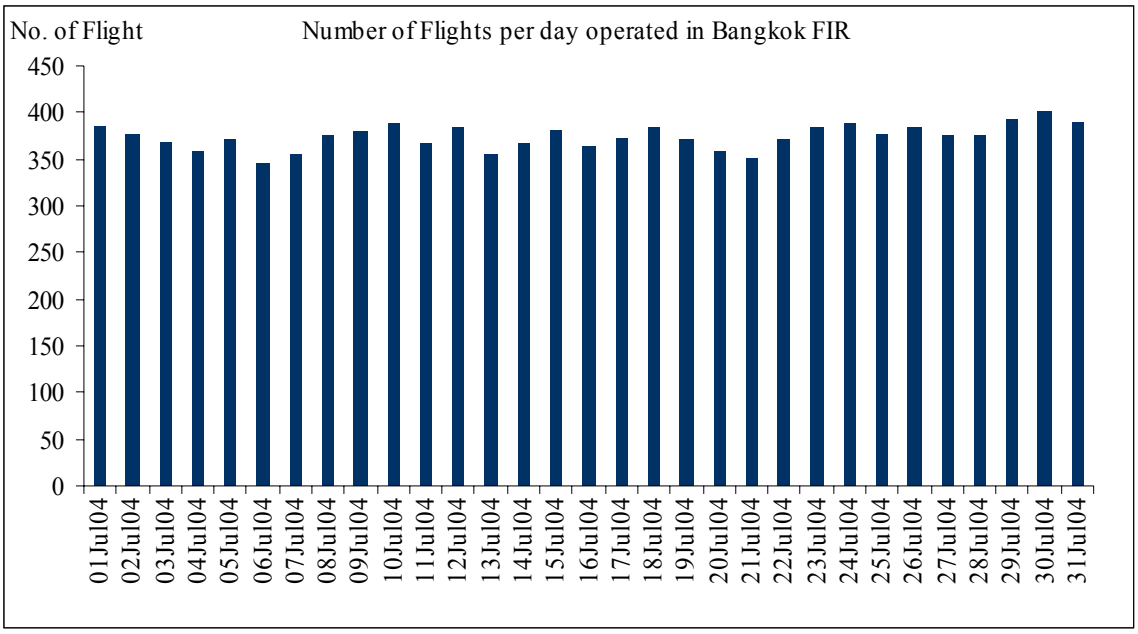

Figure 3-11: Traffic Data from Thailand (Bangkok FIR)

3.3.2 Traffic Flows

The main traffic flows within and through the BOB region are the traffic within Indian FIRs and traffic from East Asia to Europe, and vice versa.

3.3.2.1 Top-50 State Pairs

Figure 3-12 shows the top-50 State pairs, based on FIR-flights. The chart shows, for each State pair, traffic in both directions. The State name of the 2-letter State code is provided in **Appendix A**.

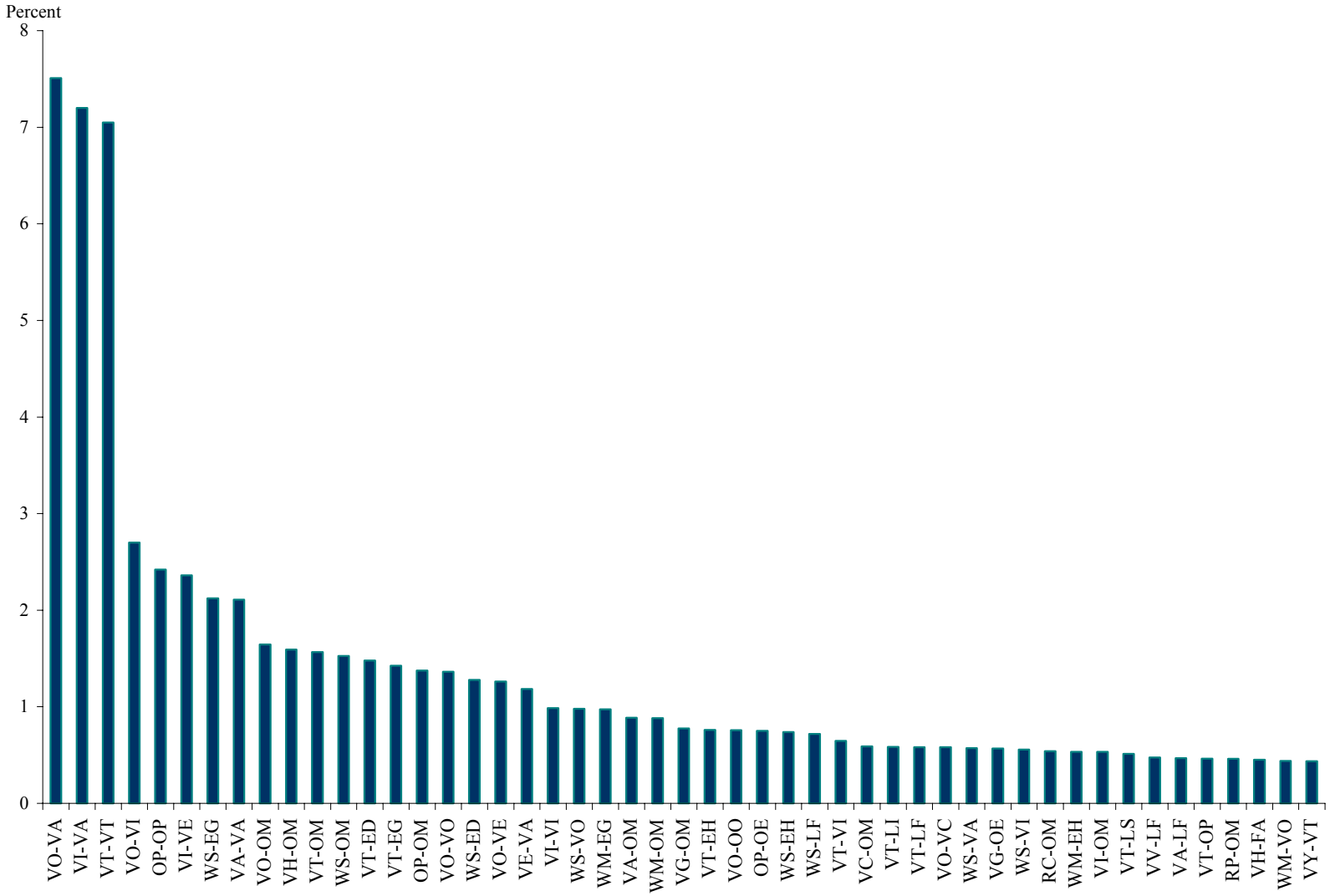

Figure 3-12: Top-50 State Pairs

3.3.2.2 Top-50 City Pairs

Figure 3-13 shows the top-50 city pairs, based on FIR-flights. The chart shows, for each city, traffic in both directions. The city name of the 4-letter city code is provided in **Appendix B**.

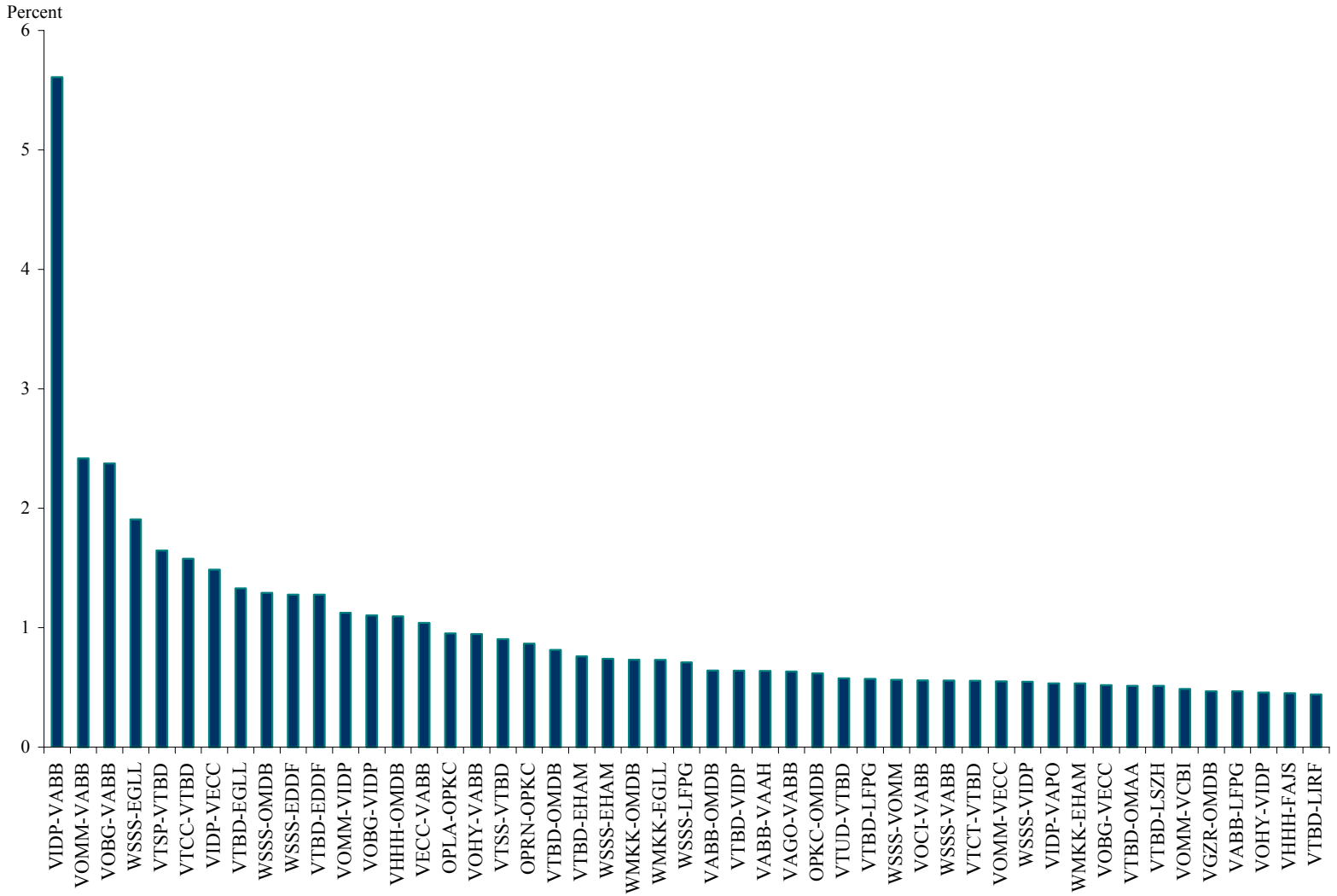

Figure 3-13: Top-50 City Pairs

3.3.3. Operator Profiles

The survey provides comprehensive and detailed information about the airspace users of the RVSM airspace in BOB region. **Figure 3-14** show the top 50 commercial operators, in terms of total FIR-flights between FL290-410, as observed in the traffic sample. These operators represent over 90 percent of the operations observed in the sample. The top five, representing approximately 40 percent of the total operations in the data sample, are Indian Airlines (IAC), Jet Airways (JAI), Thai Airways International (THA), Singapore Airlines (SIA), and Air Sahara (SAQ).

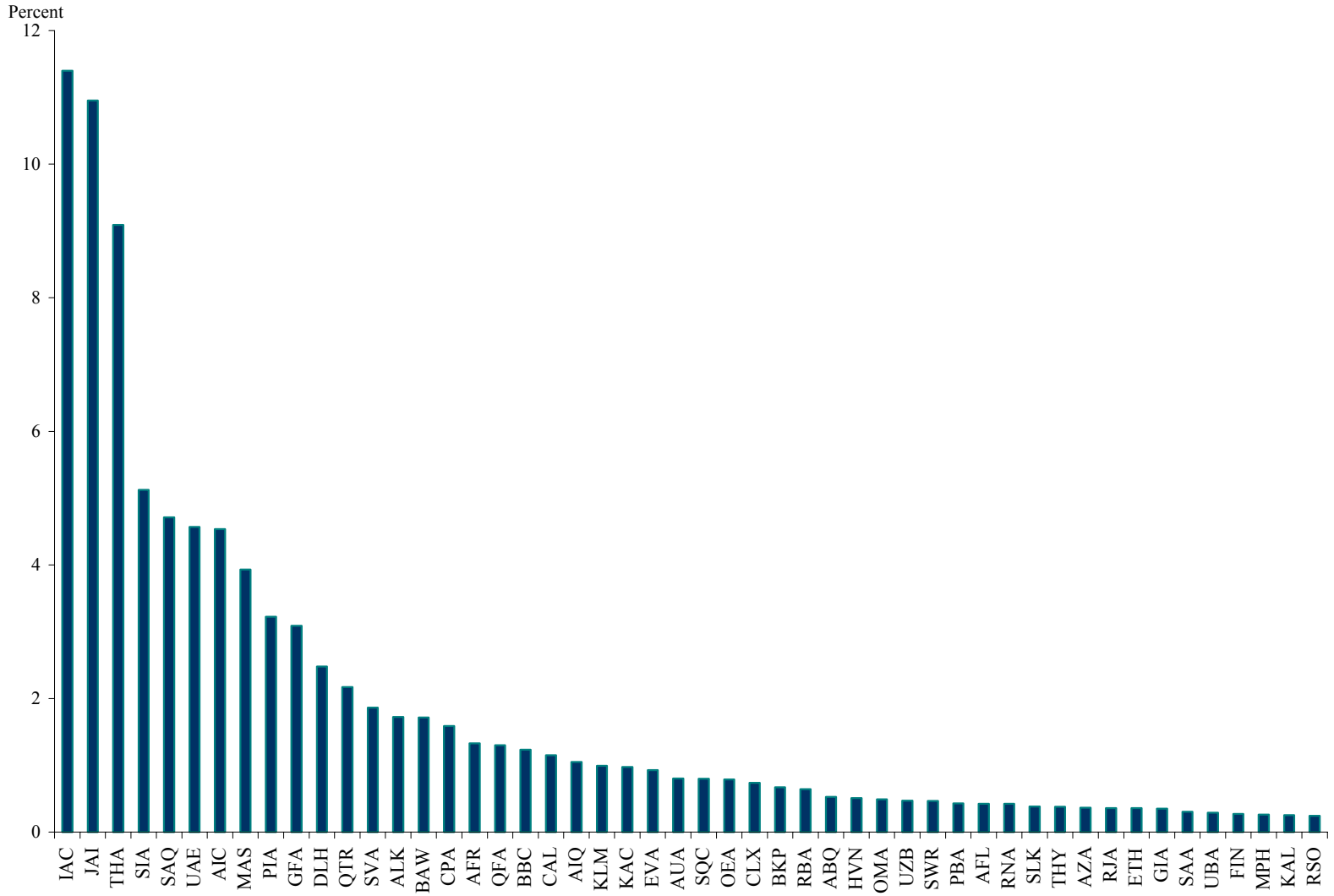

Figure 3-14: Top 50 Operators Operated in RVSM Airspace of BOB Region

3.3.4 Aircraft Type Profiles

In order to standardize the presentation of the results, the aircraft types observed in the various FIR samples were combined into aircraft groups. Hence, **Figure 3-15** shows the number of FIR-flights of the top 50 aircraft group, based on the submitted traffic sample data.

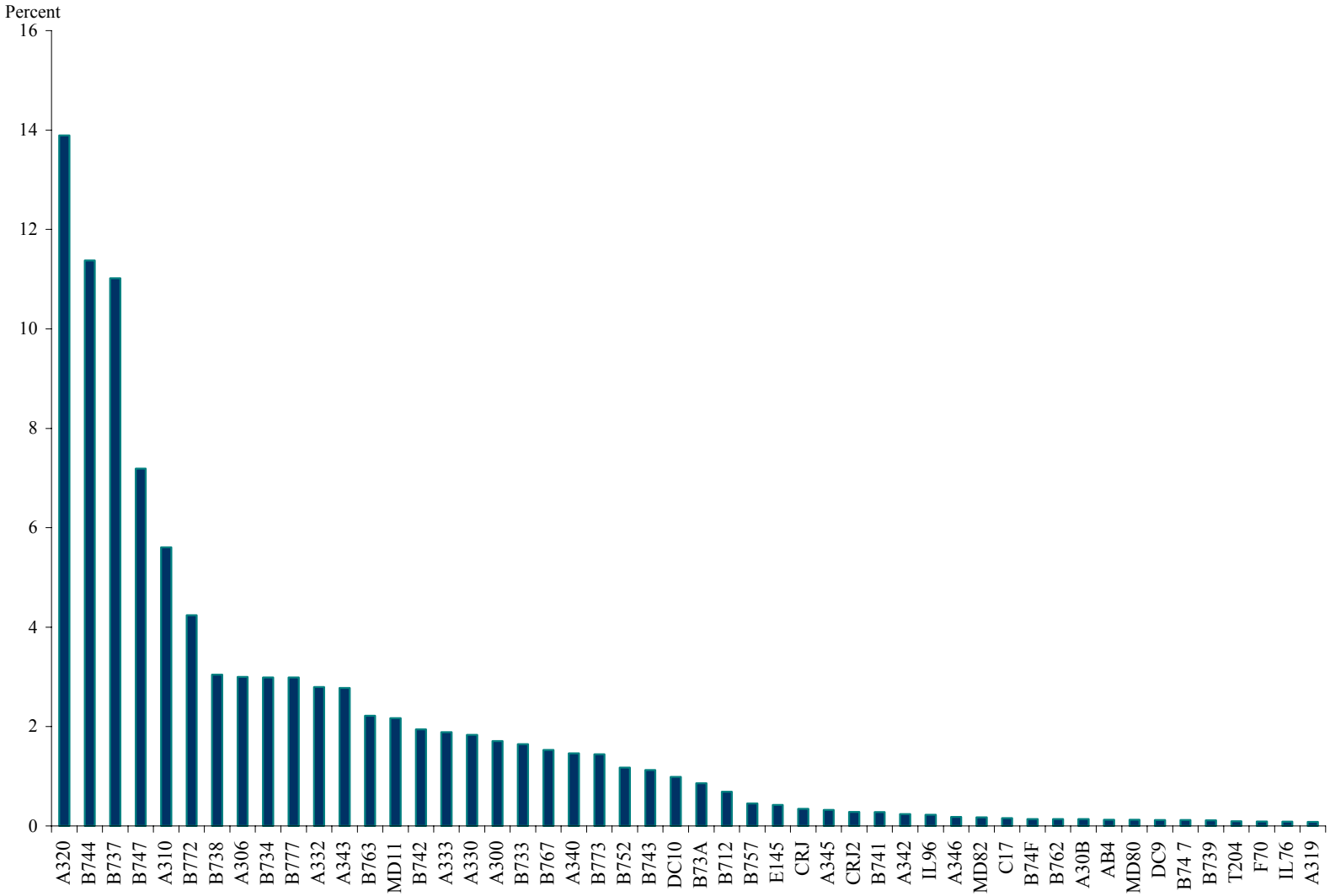

Figure 3-15: Top 50 Aircraft Type Classification Operated in RVSM Airspace of BOB Region

3.3.5 Flight Level Utilization

For the RVSM implementation in BOB region, the Single Alternate Flight Level Orientation Scheme (FLOS) is applied full band between FL290 and 410. Accordingly, odd and even flight levels are assigned to the traffic in the Eastbound and Westbound directions, respectively. From the received traffic sample, **Figure 3-16** shows the flight level utilization in the RVSM airspace between FL 290 and 410 in the RVSM airspace of BOB Region.

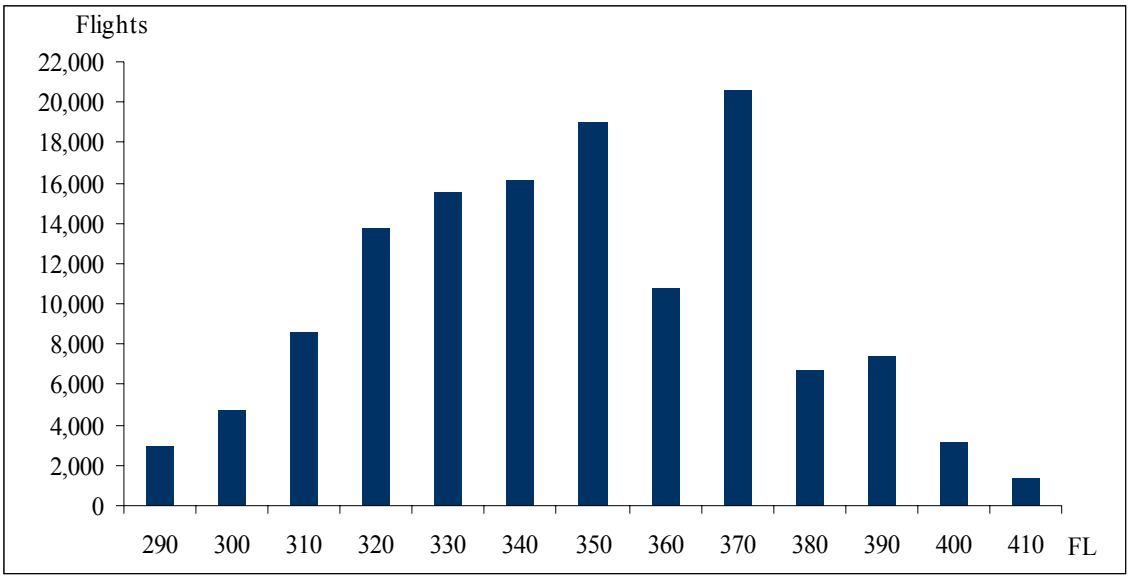

Figure 3-16: Flight Level Utilization in BOB

4. RVSM APPROVAL REGISTRY

One of the principle responsibilities of MAAR is to establish and maintain a central registry of State RVSM approvals of operators and aircraft using the RVSM airspace. Since the 27 September 2003, the collected data of RVSM approval registry contained in MAAR database is summarized in **Table 4-1**. The 3-letter operator codes are provided in **Appendix C**.

States	Operators	Registered Aircraft	Remarks
WPAC/SCS			
Cambodia	-	-	No data received
China	14 + 1 Military	284 + 1Military	CAL, CCA, CDG, CES, CHH, CSH, CSN, CSZ, CXA, CXN, CYH, MDA, TNA, YZR, and MIL
Hong Kong	6 + GA	136 + 3 GA	AHK, AMU, CPA, HAD, MTJ, PJS, and GA
Indonesia	10	99	BTV, GIA, HDI, LNI, MDL, MNA, PAS, PRZ, STQ, and TRV
Lao PDR	-	-	No data received
Malaysia	2 + GA	60 + 1 GA	AXM, MAS, and GA
Philippines	2 + GA	28 + 3GA	GAP, PAL, and GA
Singapore	4	138	SIA, SLK, TGW, and VLU
Taiwan	5	73	EVA, FEA, MDA, TNA, and UIA
Thailand	8 + GA	134 + 130 GA	BKP, OEA, PBA, SCR, TFT, THA, THJ, VAP, and GA
Vietnam	1	20	HVN
BOB			
India	5 + GA	129 + 2 GA	AIC, IAC, JAI, REL, SAQ, and GA
Indonesia	Same as above		
Malaysia	2 + GA	60 + 1 GA	AXM, MAS, and GA
Maldives	-	-	No data received
Myanmar	-	-	No data received
Nepal	-	-	No data received
Pakistan	1	40	PIA
Singapore	Same as above		
Sri Lanka	1	13	ALK
Thailand	Same as above		
Others			
Brunei	1	10	RBA

Table 4-1: RVSM Approval Registry Records in MAAR Database (Last update: August 2004)

Note that the complete details of RVSM approval registry records are available in the MAAR website (www.aerothai.co.th/maar).

In view of the number of aircraft operating in the RVSM airspace, the database containing RVSM approved data should be more extensive. Thus, it is very likely that there are more aircraft and operators not listed in the database. **MAAR would like to request the concerned States to provide RVSM approval records of all registered aircraft.**

5. SUMMARY OF RVSM NON-COMPLIANT AIRCRAFT OPERATING IN RVSM AIRSPACE

MAAR has received the following reports regarding the non-RVSM compliant aircraft operating in the RVSM airspace. Upon the receipt of this notification from MECMA, MAAR informed all States under MAAR responsibility, as summarized in **Table 5-1**.

Report No.	Reported Agency	Date Reported	Operator	Remarks	Actions by MAAR
1	MECMA	17 May 2004	Aero Asia (RSO)	Number of flights operated by RSO were carried out on flight plans with W in Item 10, although the database indicate that no RVSM approval has be granted	Informed all States under MAAR responsibilities.

Table 5-1: Reports of Non-RVSM-Compliant Aircraft

6. SUMMARY OF LARGE HEIGHT DEVIATION

Based on the requirement of safety monitoring for the RVSM implementation in Asia Region, all concerned States are requested to submit the LHD reports to MAAR on a monthly basis. The LHD reports are used to estimate risks from technical and operational errors, which would facilitate the completion of the safety oversight for the Asian airspace where RVSM was implemented.

The summary of LHD reports submitted by the concerned States in the BOB Region, are provided in **Table 6-1**.

States	FIR Name	Received		Remarks/ Missing Report
		From	To	
Bangladesh	Dhaka	Jan 03	Jul 04	
India	Chennai	Jan 03	Jul 04	
	Delhi	Jan 03	Jul 04	
	Kolkata	Jan 03	Jul 04	
	Mumbai	Jan 03	Jul 04	
Indonesia	Jakarta	Jan 03	Jan 04	Missing reports: Feb 04 to present
Malaysia	Kuala Lumpur	Jan 03	Aug 04	
Maldives	Male	Jan 03	Aug 04	
Myanmar	Yangon	Jan 03	May 04	Missing reports: Jun 04 to present
Nepal	Katmandu	Jan 03	Jul 04	
Pakistan	Karachi	Jan 03	Aug 04	
	Lahore	Jan 03	Aug 04	
Singapore	Singapore	Jan 03	Jul 04	
Sri Lanka	Colombo	Jan 03	Jun 04	Missing reports: Jul 04 to present
Thailand	Bangkok	Jan 03	Jul 04	

Table 6-1: Summary of LHD Reports Received by MAAR since January 2003 for BOB

6.1 LHD Occurrences

Based on the received LHD reports, **Figure 6-1** shows the number of LHD occurrences and the associated LHD duration (in minutes) in WPAC/SCS and BOB, respectively, for each month between January 2003 and July 2004. In summary, there were 9 LHD occurrences in BOB, accounted for 35 minutes of operational errors since January 2003. The total number of LHD occurrences and erroneous duration are considered to be relatively small.

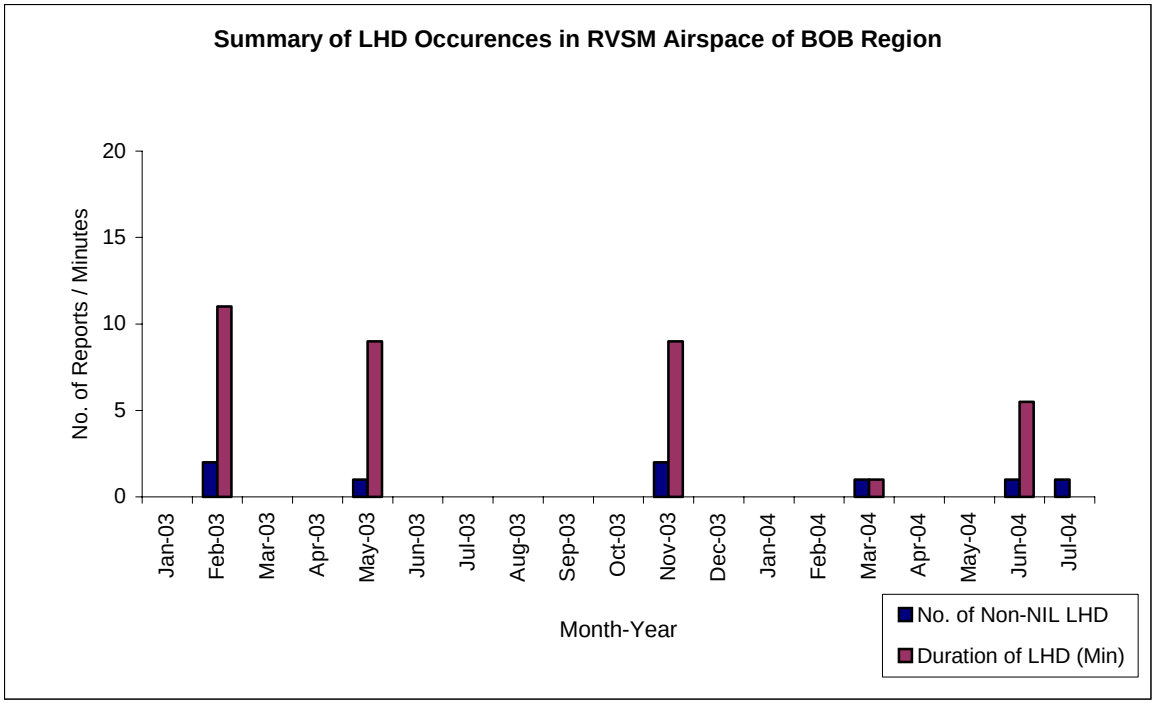

Figure 6-1: Summary of LHD Occurrences in RVSM Airspace of BOB

6.2 Causes of LHD

Based on the LHD occurrences, **Figure 6-2** summarizes of the number of LHD occurrences by the causes of deviation, using the letter-coding scheme of **Table 6-2**.

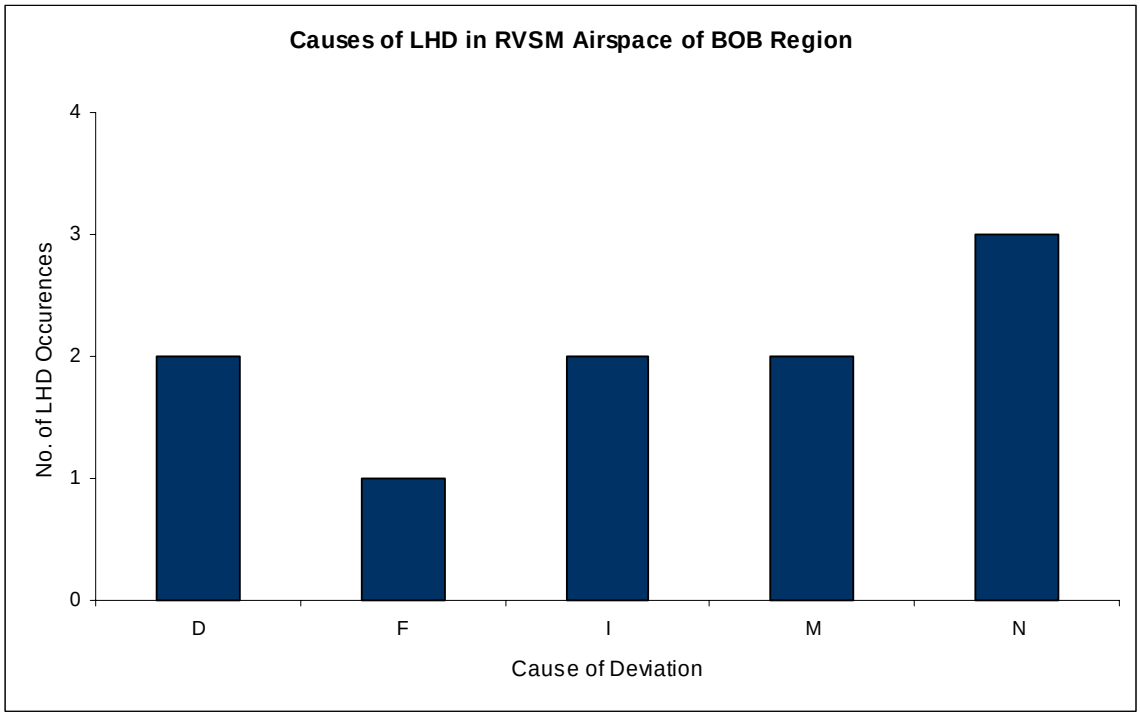

Figure 6-2: Causes of LHD Occurrences in RVSM Airspace of BOB

Code	Cause of Large Height Deviation
A	Failure to climb/descend as cleared
B	Climb/descend without ATC Clearance
C	Entry into airspace at an incorrect flight level
D	Deviation due to turbulence or other weather related cause
E	Deviation due to equipment failure
F	Deviation due to collision avoidance system (TCAS) advisory
G	Deviation due to contingency event
H	Aircraft not approved for operation in RVSM restricted airspace
I	ATC system loop error; (e.g. pilot misunderstands clearance message or ATC issues incorrect clearance)
J	Equipment control error encompassing incorrect operation of fully functional FMS or navigation system (e.g. by mistake the pilot incorrectly operates INS equipment)
K	Incorrect transcription of ATC clearance or re-clearance into the FMS
L	Wrong information faithfully transcribed into the FMS (e.g. flight plan followed rather than ATC clearance or original clearance followed instead of re-clearances)
M	Error in ATC-unit-to ATC-unit transferred message
N	Negative transfer received from transferring ATC-unit
O	Other

Table 6-2: Codes Defining Causes of LHD Reports

7. RISK ASSESSMENT AND SAFETY OVERSIGHT

The purpose of this section is to update the results of 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 [Reference 1, 2, and 3].

As envisioned by the Review of the ICAO General Concept of Separation Panel (RGCSP), introduction of RVSM would be safe if:

- Collision risk due to all causes does not exceed 5 fatal accidents per 10^9 flying hours,
- Collision risk due to aircraft height-keeping systems does not exceed 2.5 fatal accidents per 10^9 flying hours.

The traffic sample data (TSD) of July 2004 and the continuous LHD reports associated with the BOB airspace (since January 2003) are used to produce the risk estimates presented in this report

7.1 Estimate of the CRM Parameters

This section provides the value and source material for estimating values for each of the parameters of the internationally accepted Collision Risk Model (CRM), which is used to conduct the safety oversight for the RVSM implementation in BOB.

7.1.1 Annual Flight Hours

Table 7-1 summarizes the estimated flight hour per annum between FL 290 and FL 410 of BOB airspace reported in the submitted TSD. The estimate of the annual flying hours in the BOB airspace where the RVSM is to be implemented is **701,487** flight-hours per year.

States	FIRs	Estimated Number of Annual Flights in FIR	Estimated Average Duration of Flight in FIR (Hrs)	Estimated Annual Number of Flying Hours in FIR (Hrs)
Bangladesh	Dhaka	-	-	-
India	Chennai	78,200	1.10	38,767
	Delhi	44,067	0.94	41,697
	Kolkata	105,399	1.00	72,051
	Mumbai	210,871	1.04	113,342
Indonesia	Jakarta	-	-	-
Malaysia	Kuala Lumpur	41,594	0.79	12,132
Maldives	Male	15,463	2.21	4,176
Myanmar	Yangon	-	-	-
Nepal	Katmandu	-	-	-
Pakistan	Karachi	95,955	0.90	29,745
	Lahore	19,788	0.48	16,180
Singapore	Singapore	15,192	0.50	10,017
Sri Lanka	Colombo	-	-	-
Thailand	Bangkok	90,151	0.67	67,341
Sum		**729,702**	**0.96**	**701,487**

Table 7-1: Annual Flight Hours for the Safety Oversight of the RVSM implementation in BOB

7.1.2 Vertical Occupancies

Table 7-2 provides the estimates of the same and opposite-direction vertical occupancies for all FIRs in the BOB airspace where RVSM is planned to implement.

Occupancy Parameter	Estimated Value
E_z(same)	0.006844
E_z(opposite)	0.066381

Table 7-2: Estimated Vertical Occupancies Values used in the Safety Oversight for the RVSM implementation in BOB

7.1.3 Aircraft Size

Based on the received TSD from the 11 FIRs, the average aircraft height, length, and wingspan of the aircraft operating in the BOB airspace are given in **Table 7-3**. Note that the majority of aircraft types operated in the BOB airspace are A320, B744, and B733 (see Chapter 3: **Figure 3-15**).

Aircraft	λ_z = Height (nm)	λ_x = Length (nm)	λ_y = Wingspan (nm)
Average Aircraft	0.0083	0.0290	0.0265

Table 7-3: Aircraft Size used in the Safety Oversight for the RVSM implementation in BOB

Estimation of the risk for proximate aircraft pairs at adjacent flight levels on crossing routes requires the diameter of the disk representing the shape of an aircraft in the horizontal plane, λ_h. This value has been taken as 0.0327 nm for the average aircraft in the BOB airspace.

7.1.4 Other CRM Parameters

For the other parameters in the CRM f, the same values used in the safety assessment for the RVSM implementation in the BOB region are used. These values are applicable for this assessment since these estimates are considered to be conservative for assessing the safety of the RVSM airspace where the Single Alternate FLOS is applied. **Table 7-4** provides the estimates for the rest of the parameters in the CRM.

Parameter Symbol	Parameter Definition	Parameter Value	Source for Value
$P_y(0)$	Probability of Lateral Overlap	0.0835	Value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$P_h(0)$	Probability of Horizontal Overlap	6.88×10^{-7}	Value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$\overline{\lvert \Delta V \rvert}$	Average relative along-track speed between aircraft on same direction routes	13 knots	Estimated from 1995 NAT sample of 11 429 proximate same-direction aircraft pairs; used in NAT and Pacific RVSM safety assessments
$\overline{\lvert V \rvert}$	Average absolute aircraft ground speed	480 knots	Value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments
$\lvert \overline{\dot{y}} \rvert$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	4 knots	Estimated from processing GMU-collected GPS-derived positions of aircraft, assuming that 41.63 percent of operations are conducted by aircraft with GPS as primary means of navigation
$\left\lvert \overline{h(\theta)} \right\rvert$	Average relative horizontal speed during overlap for aircraft pairs on routes with crossing angle θ (let θ=45°)	367.4 knots	Corresponds to average aircraft speed of 480 knots
$\lvert \overline{\dot{z}} \rvert$	Average absolute relative vertical speed of an aircraft pair that has lost all vertical separation	1.5 knots (all traffic flows)	Value used in NAT, Pacific, Western Pacific/South China Sea RVSM safety assessments

Table 7-4: Conservative Estimates of the Parameters in the CRM

7.2 Safety Oversight for the RVSM implementation in BOB Airspace

This section summarizes the results of the safety assessment for the BOB RVSM implementation. **Table 7-5** provides the estimates of technical, operational, and total risks for the RVSM implementation in the BOB airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	5.59×10^{-10}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.43×10^{-9}	-	-
Total Risk	1.99×10^{-9}	5.0×10^{-9}	Below Technical TLS

Table 7-5: Risk Estimates for the RVSM Implementation in BOB

Figure 7-1 presents the trends of collision risk estimates for each month using the appropriate 12-month interval of LHD reports since January 2003.

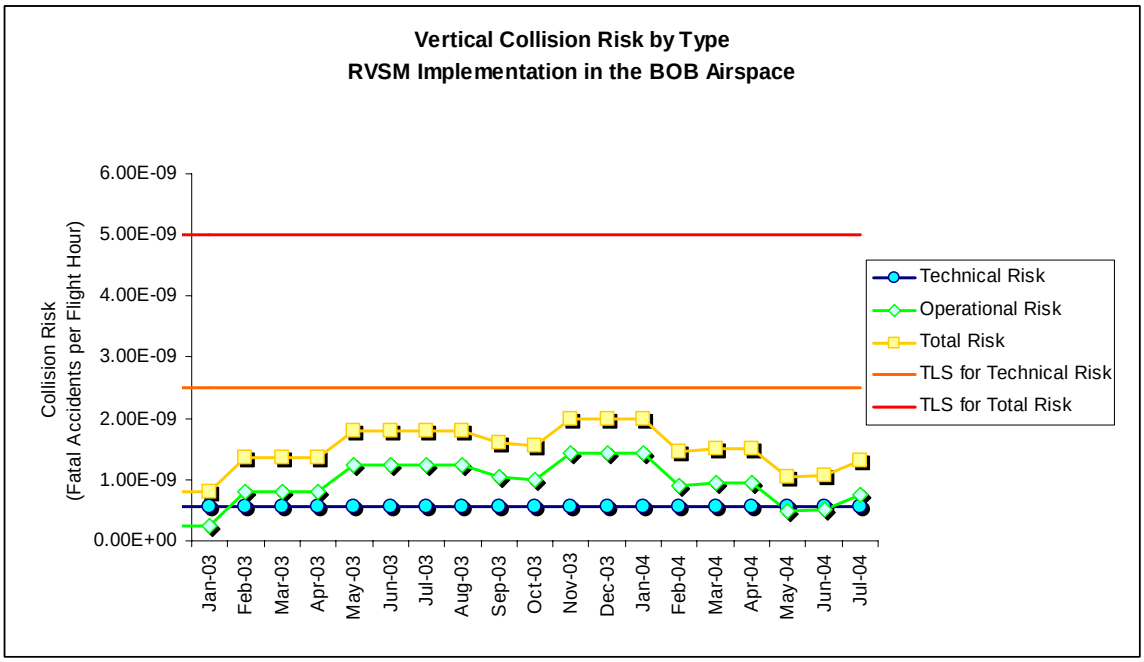

Figure 7-1: Trends of Risk Estimates for the RVSM Implementation in BOB

Based on the collision risk estimates, the technical risk for the RVSM implementation in BOB is 5.59×10^{-10} fatal accidents per flight hour. The total risk attributed to all causes is 1.99×10^{-9}. Therefore, **the estimates of both technical and total risks satisfy the agreed TLS value of no more than 2.5×10^{-9} and 5.0×10^{-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.**

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REFERENCES

1. *Manual on Implementation of a 300 m (1,000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*, International Civil Aviation Organization, Doc 9574, Montreal, March 1992.

2. Review of the General Concept of Separation Panel, Sixth Meeting, Montreal, 28 November – 15 December 1988, ICAO Doc 9536, RGCSP/6, Volumes 1 and 2.

3. Review of the General Concept of Separation Panel, Seventh Meeting, Montreal, 30 October – 20 November 1990, ICAO Doc 9572, RGCSP/7.

APPENDIX A
ICAO 2-Letter State Code

State Code	State
ED	Germany
EG	United Kingdom
EH	Netherlands
FA	South Africa
LF	France
LI	Italy
LS	Switzerland
OE	Saudi Arabia
OM	United Arab Emirates
OO	Oman
OP	Pakistan
RC	China
RP	Philippines
VA	India
VC	Sri Lanka
VE	India
VG	Bangladesh
VH	Hong Kong (China)
VI	India
VO	India
VT	Thailand
VV	Viet Nam
VY	Myanmar
WM	Malaysia (Peninsular)
WS	Singapore

APPENDIX B

ICAO 4-letter City (Airport) Code

Location Code	Location
EDDF	Frankfurt/Main
EGLL	London Heathrow
EHAM	Amsterdam/Schiphol
FAJS	Johannesburg (Johannesgurg International Airport)
LFPG	Paris-Charles De Gaulle
LIRF	Roma/Fiumicino
LSZH	Zurich
OMAA	Abu Dhabi International
OMDB	Dubai International
OPKC	Karachi/Quaid-E-Azam Intl
OPLA	Lahore
OPRN	Islamabad/Chaklala
VAAH	Ahmedabad
VABB	Bombay/Mumbai
VAGO	Goa (Navy)
VAPO	Pune (Iaf)
VCBI	Bandaranaike International Airport Colombo
VECC	Calcutta
VGZR	Zia Intl.Airport,Dhaka
VHHH	Hong Kong/International
VIDP	Delhi/Indira Gandhi Intl
VOBG	Bangalore
VOCI	N/A
VOHY	Hyderabad
VOMM	Madras/Chennai
VTBD	Bangkok/Bangkok Intl Airport (Bkk)
VTCC	Chiang Mai
VTCT	Chiang Rai
VTSP	Phuket
VTSS	Songkhla/Hat Yai
VTUD	Udon Thani
VYYY	Yangon/Intl
WMKK	Kuala Lumpur International Airport
WSSS	Singapore/Changi

APPENDIX C

ICAO 3-letter Operator Code

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Operator Code	Operator Name
Brunei	
RBA	Royal Brunei Airlines
China	
CAL	China Airlines
CCA	Air China
CDG	Shandong Airlines
CES	China Eastern Airlines
CHH	Hainan Airlines
CSH	Shanghai Airlines
CSN	China Southern Airlines
CSZ	Shenzhen Airlines
CXA	Xiamen Airlines
CXN	China Southwest Airlines
CYH	China Yunnan Airlines
MDA	Mandarin Airlines
MIL	Military Aircrafts
TNA	Tanavco Airways Ltd.
YZR	Yangze River Express Airlines
Hong Kong	
AHK	Air Hong Kong Ltd.
CPA	Cathey Pacific Airways Limited
HAD	Hong Kong Dragon Airlines
MTJ	Metrojet Ltd.
PJS	Jet Aviation (Asia Pacific) PTE Ltd.
India	
AIC	Air India
IAC	Indian Airlines
JAI	Jet Airways
REL	Reliance Air
SAQ	Air Sahara
Indonesia	
BTV	Batavia Air
GIA	Garuda Indonesia, P.T.
HDI	ADAM
LNI	Lion Mentari Airlines
MDL	Mandala Airlines
MNA	PT. Merpati Nusantara Airlines
PAS	P.T. Pelita Air Service
PRZ	Air Paradise International
STQ	Star Air
TRV	TRAV
Malaysia	
AXM	Air Asia SDN. BHD.
MAS	Malaysian Airlines System

Operator Code	Operator Name
Pakistan	
PIA	Pakistan Airlines
Philippines	
GAP	Air Philippines
PAL	Philippine Airlines Inc.
Singapore	
SIA	Singapore Airlines Ltd.
SLK	Silkair (Singapore) PTE Ltd.
TGW	Tiger Airways
VLU	Valuair
Sri Lanka	
ALK	Air Lanka
Taiwan	
EVA	Eva Airways Corporation
FEA	Far Eastern Air Transport Corporation
MDA	Mandarin Airlines
TNA	Tanavco Airways Ltd.
UIA	Uni Airways Corporation
Thailand	
BKP	Bangkok Airline
OEA	Orient Thai Airline
PBA	PB Air
SCR	Si-Chang Flying Service
TFT	Thai Flying Service
THA	Thai Airways International Ltd.
THJ	Thai Jet
VAP	Phuket Air
Vietnam	
HVN	Hang Khong Vietnam