



International Civil Aviation Organization

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

Pattaya, Thailand, 27-30 May 2014

Agenda Item 3: Reports from Asia/Pacific RMAs and EMAs

PARMO VERTICAL SAFETY REPORT

(Presented by United States/PARMO)

SUMMARY

This paper compares actual performance to safety goals that support the continued use of reduced vertical separation minimum (RVSM) in Pacific and North East Asia airspace. This report contains a summary of large height deviation reports received by the Pacific Approvals Registry and Monitoring Organization (PARMO) for the most recent reporting period of 1 January to 31 December 2013. There are a total of 19 reported large height deviations (LHDs) accounting for 239.1 minutes of operation at incorrect flight level in Pacific RVSM airspace. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Pacific airspace does not meet target level of safety (TLS) value of 5.0×10^{-9} fatal accidents per flight hour. The vertical collision risk estimate for a portion of North East Asia airspace meets the TLS value of 5.0×10^{-9} fatal accidents per flight hour.

This paper relates to –

Strategic Objectives:

A: *Safety – Enhance global civil aviation safety*

Global Plan Initiatives:

GPI-2 Reduced vertical separation minima
GPI-8 Collaborative airspace design and management
GPI-9 Situational awareness
GPI-16 Decision support systems and alerting systems
GPI-21 Navigation systems

1. INTRODUCTION

1.1 The Pacific Approvals Registry and Monitoring Organization (PARMO) produces a periodic report which is distributed twice annually to Pacific and North East Asia air traffic service (ATS) providers and airspace users. The report presented in this paper fulfills the ICAO emphasis on safety management systems; such reporting for international airspace is a component of safety management systems.

1.2 This working paper contains the PARMO safety monitoring report for the time period 1 January to 31 December 2013. It contains a summary of large height deviation reports, and estimates of vertical risk for Pacific and North East Asia airspace

2. DISCUSSION

2.1 **Attachment A** contains the PARMO Vertical Safety Monitoring Report for January to December 2013.

Executive Summary

2.2 **Table 1** summarizes Pacific airspace RVSM technical, operational, and total risks. **Figure 1** presents collision risk estimate trends during the period from 1 January 2013 to 31 December 2013.

Pacific RVSM Airspace -estimated annual flying hours = 1,250,084 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 18 Total Risk (Previous RASMAG)	4.46×10^{-9}	5.0×10^{-9}	Below the TLS
Technical Risk	0.16×10^{-9}	2.5×10^{-9}	Below the Technical TLS
Operational Risk	7.90×10^{-9}		
Total Risk	8.05×10^{-9}	5.0×10^{-9}	Above the TLS

Table 1: Pacific Airspace RVSM Risk Estimates

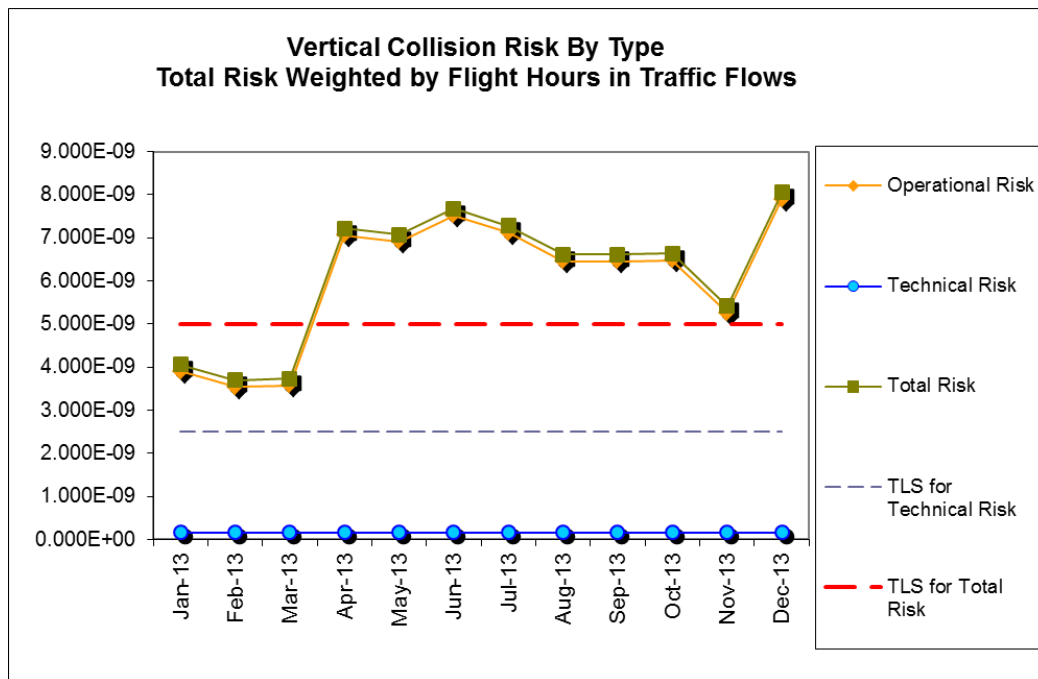


Figure 1: Pacific Airspace RVSM Risk Estimate Trends

2.3 **Table 2** presents a summary of the 12-month cumulative operational risk and LHD causes within Pacific airspace from 1 January 2013 until 31 December 2013.

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
A	Flight crew fails to climb or descend the aircraft as cleared	4	17	2	0.55
B	Flight crew climbing or descending without ATC clearance	4	66	6	3.00
C	Incorrect operation or interpretation of airborne equipment	0	0	0	0
D	ATC system loop error	4	121	1	3.19
E	ATC transfer of control coordination errors due to human factors	4	35	0	1.15
F	ATC transfer of control coordination errors due to technical issues	0	0	0	0
G	Aircraft contingency leading to sudden inability to maintain level	0	0	0	0
H	Airborne equipment failure and unintentional or undetected level change	0	0	0	0
I	Turbulence or other weather related cause	0	0	0	0
J	TCAS resolution advisory and flight crew correctly responds	0	0	0	0
K	TCAS resolution advisory and flight crew incorrectly responds	0	0	0	0
L	An aircraft being provided with RVSM separation is not RVSM Approved	0	0	0	0
M	Other	0	0	0	0
Total		16	239	9	7.90

Table 2. 12-month cumulative operational risk associated with LHD reports by LHD category within Pacific RVSM airspace

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

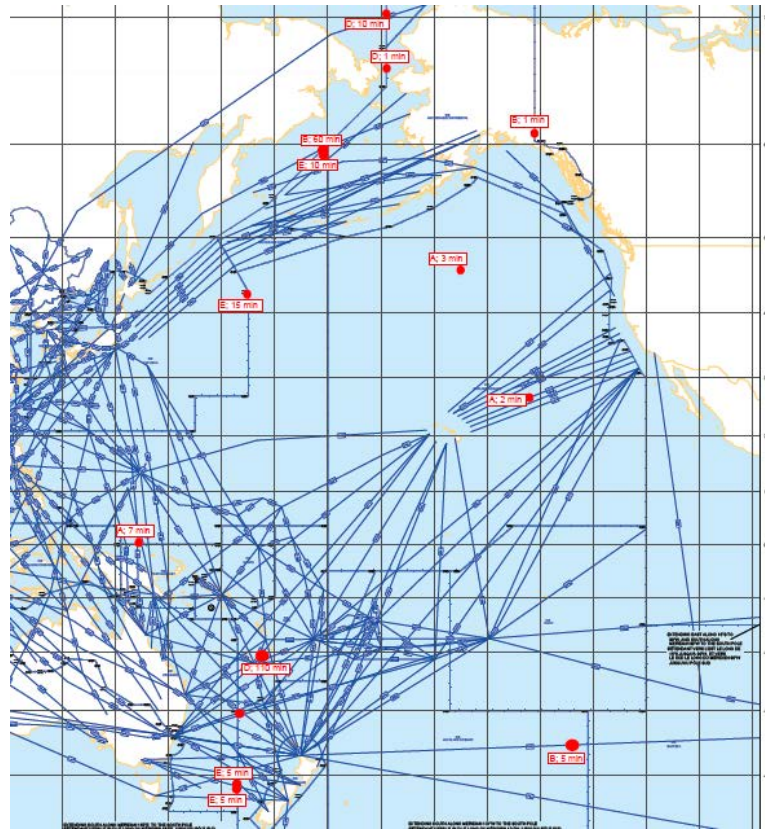


Figure 2. Pacific Airspace – Risk Bearing LHD

- 2.5 The vertical collision risk estimate in Pacific airspace did not meet the TLS primarily due to the occurrence of two long duration events. One event with a duration of 110 minutes was caused by an ATC loop error. In this case, the updated clearance information was not received by the aircraft, but was manually updated in the ATC automation system. The aircraft operated within the airspace at the incorrect flight level until it was transferred to the adjacent facility when the event was discovered.
- 2.6 Another event had a duration of 55 minutes. In this case, communication between ATC and the aircraft was lost. The pilot did not adhere to the published lost communication procedures.
- 2.7 **Table 3** summarizes portions of North East (NE) Asia airspace RVSM technical, operational, and total risks. **Figure 3** presents collision risk estimate trends during the period from 1 January 2013 to 31 December 2013.

North East Asia RVSM Airspace -estimated annual flying hours = 97,752 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 18 Total Risk (Previous RASMAG)	0.11×10^{-9}	5.0×10^{-9}	Below the TLS
Technical Risk	0.41×10^{-9}	2.5×10^{-9}	Below the Technical TLS
Operational Risk	0.19×10^{-9}		
Total Risk	0.60×10^{-9}	5.0×10^{-9}	Below the TLS

Table 3: Portions of NE Asia Airspace RVSM Risk Estimates

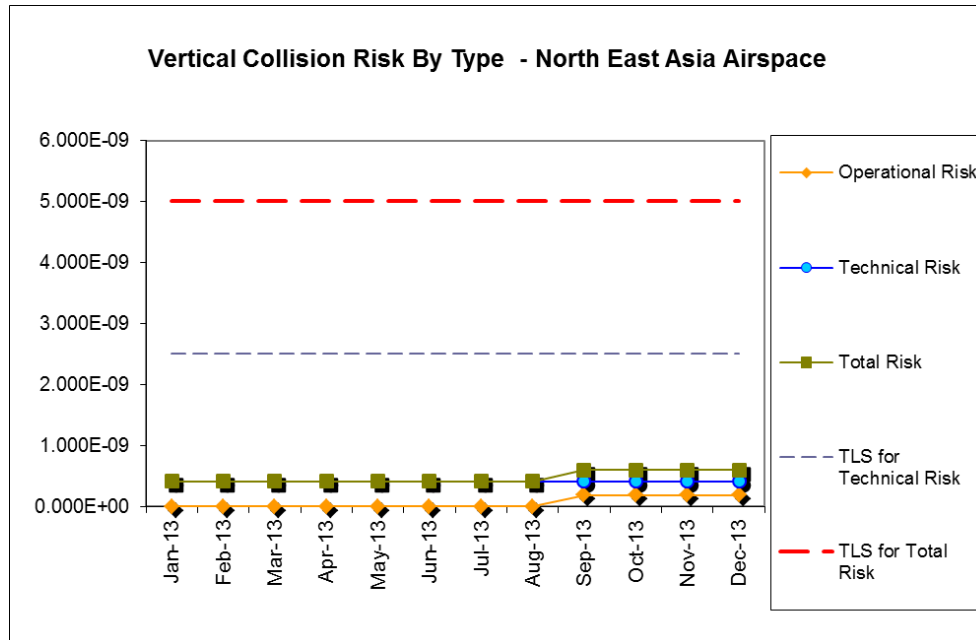


Figure 3: Portion of NE Asia Airspace RVSM Risk Estimate Trends

2.8 **Table 4** presents a summary of the 12-month cumulative operational risk and LHD causes within Pacific airspace from 1 January 2013 until 31 December 2013.

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
A	Flight crew fails to climb or descend the aircraft as cleared	0	0	0	0.55
B	Flight crew climbing or descending without ATC clearance	0	0	0	3.00
C	Incorrect operation or interpretation of airborne equipment	0	0	0	0
D	ATC system loop error	0	0	0	3.19
E	ATC transfer of control coordination errors due to human factors	4	0.1	0	1.15
F	ATC transfer of control coordination errors due to technical issues	0	0	0	0
G	Aircraft contingency leading to sudden inability to maintain level	0	0	0	0
H	Airborne equipment failure and unintentional or undetected level change	0	0	0	0
I	Turbulence or other weather related cause	0	0	0	0
J	TCAS resolution advisory and flight crew correctly responds	0	0	0	0
K	TCAS resolution advisory and flight crew incorrectly responds	0	0	0	0
L	An aircraft being provided with	0	0	0	0

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
	RVSM separation is not RVSM Approved				
M	Other	0	0	0	0
Total		3	0.1	0	7.90

Table 4: Summary of LHD Causes within a portion of NE Asia Airspace

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

- a) note the information contained in this paper; and
- b) discuss any relevant matters as appropriate.

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**Pacific Approvals and Registry Monitoring Organization
(PARMO)**

**Airspace Safety Review of RVSM in
Pacific and North East Asia Airspace
January to December 2013**

Role	Name and Position	Signature and Date
Prepared By	Christine Falk Operations Research Analyst	

Executive Summary

For the period 1 January 2013 to 31 December 2013 inclusive, the total risk estimated for Pacific RVSM airspace does not meet the agreed Target Level of Safety (TLS) value of 5.0×10^{-9} fapfh. **Table A** summarizes RVSM technical, operational and total risks. **Figure A** presents collision risk estimate trends.

Pacific RVSM Airspace -estimated annual flying hours = 1,250,084 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 18 Total Risk (Previous RASMAG)	4.46×10^{-9}	5.0×10^{-9}	Below the TLS
Technical Risk	0.16×10^{-9}	2.5×10^{-9}	Below the Technical TLS
Operational Risk	7.90×10^{-9}		
Total Risk	8.05×10^{-9}	5.0×10^{-9}	Above the TLS

Table A: Pacific Airspace RVSM Risk Estimates

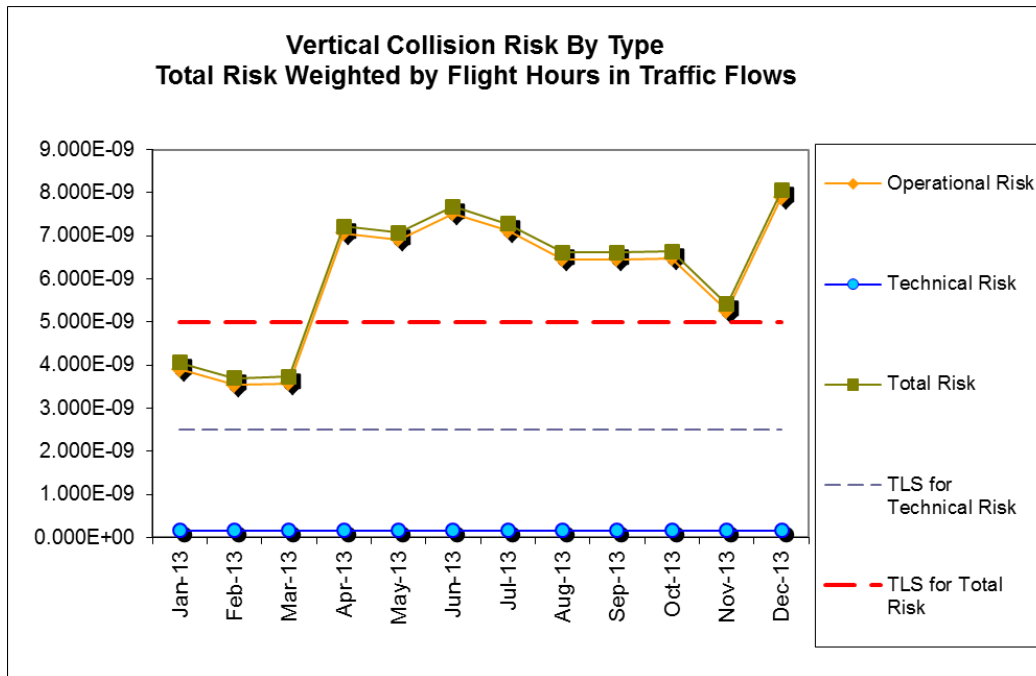


Figure A: RVSM Risk Estimate Trends

Table B presents a summary of 12-month cumulative operational risk associated with Large Height Deviation (LHD) reports by LHD category within Pacific RVSM airspace for the reporting period.

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
A	Flight crew fails to climb or descend the aircraft as cleared	4	17	2	0.55
B	Flight crew climbing or descending without ATC clearance	4	66	6	3.00
C	Incorrect operation or interpretation of airborne equipment	0	0	0	0
D	ATC system loop error	4	121	1	3.19
E	ATC transfer of control coordination errors due to human factors	4	35	0	1.15
F	ATC transfer of control coordination errors due to technical issues	0	0	0	0

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
G	Aircraft contingency leading to sudden inability to maintain level	0	0	0	0
H	Airborne equipment failure and unintentional or undetected level change	0	0	0	0
I	Turbulence or other weather related cause	0	0	0	0
J	TCAS resolution advisory and flight crew correctly responds	0	0	0	0
K	TCAS resolution advisory and flight crew incorrectly responds	0	0	0	0
L	An aircraft being provided with RVSM separation is not RVSM Approved	0	0	0	0
M	Other	0	0	0	0
Total		16	239	9	7.90

Table B: 12-month cumulative operational risk associated with LHD reports by LHD category within Pacific RVSM airspace

Figure B provides the 12-Month cumulative operational risk by LHD category cause within Pacific airspace during the assessment period.

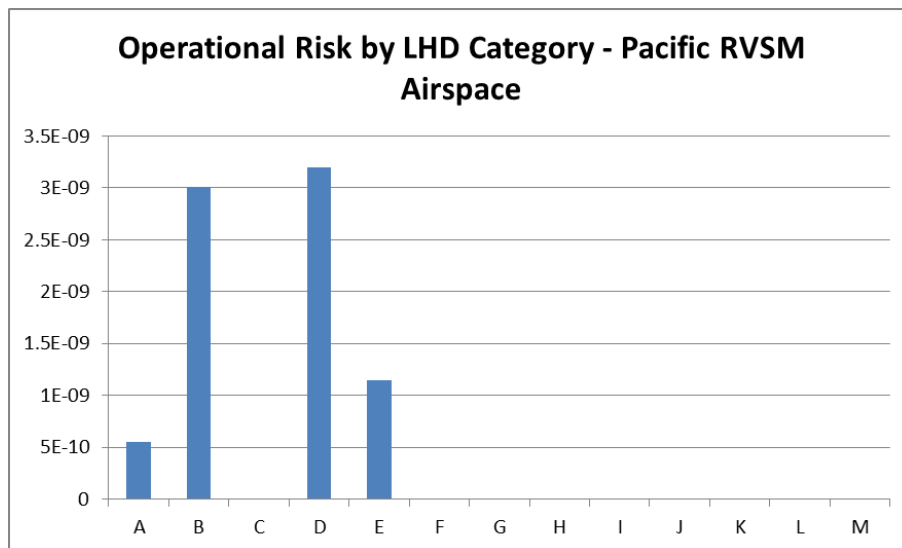


Figure B: Operational risk composition and trend

For the period 1 January 2013 to 31 December 2013 inclusive, the total risk estimated for a portion of North East Asia RVSM airspace meets the agreed Target Level of Safety (TLS) value of 5.0×10^{-9} . **Table C** summarizes RVSM technical, operational and total risks. **Figure C** presents collision risk estimate trends.

North East Asia RVSM Airspace -estimated annual flying hours = 97,752 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 18 Total Risk (Previous RASMAG)	0.11×10^{-9}	5.0×10^{-9}	Below the TLS
Technical Risk	0.41×10^{-9}	2.5×10^{-9}	Below the Technical TLS
Operational Risk	0.19×10^{-9}		
Total Risk	0.60×10^{-9}	5.0×10^{-9}	Below the TLS

Table C: North East Asia Airspace RVSM Risk Estimates

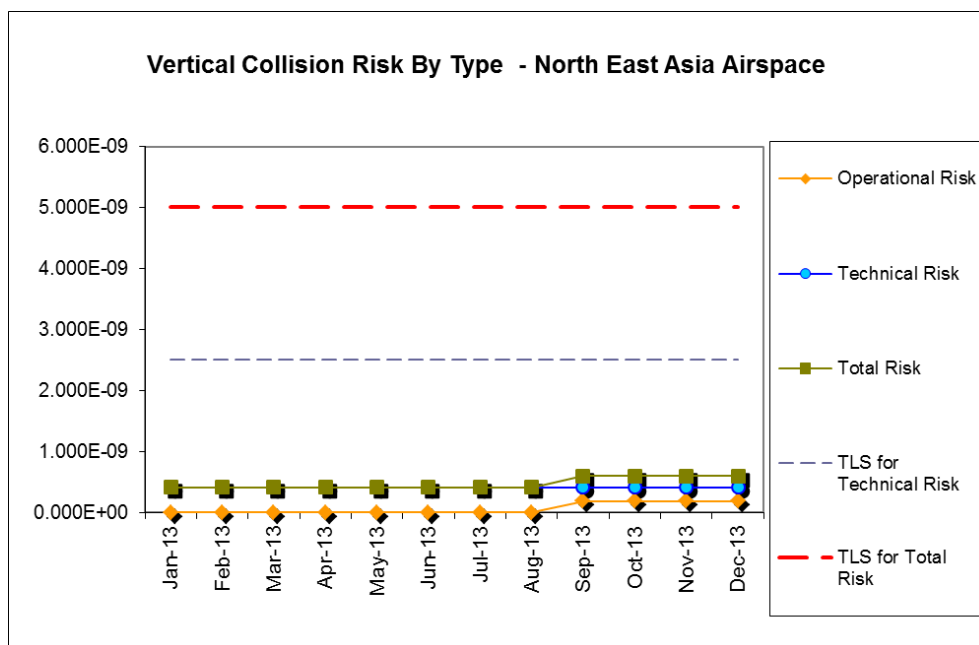


Figure C: RVSM Risk Estimate Trends in North East Asia RVSM Airspace

Table D presents a summary of 12-month cumulative operational risk associated with Large Height Deviation (LHD) reports by LHD category within North East Asia RVSM airspace for the reporting period.

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
A	Flight crew fails to climb or descend the aircraft as cleared	0	0	0	0.55
B	Flight crew climbing or descending without ATC clearance	0	0	0	3.00
C	Incorrect operation or interpretation of airborne equipment	0	0	0	0
D	ATC system loop error	0	0	0	3.19
E	ATC transfer of control coordination errors due to human factors	4	0.1	0	1.15
F	ATC transfer of control coordination errors due to technical issues	0	0	0	0
G	Aircraft contingency leading to sudden inability to maintain level	0	0	0	0
H	Airborne equipment failure and unintentional or undetected level change	0	0	0	0
I	Turbulence or other weather related cause	0	0	0	0
J	TCAS resolution advisory and flight crew correctly responds	0	0	0	0
K	TCAS resolution advisory and flight crew incorrectly responds	0	0	0	0
L	An aircraft being provided with RVSM separation is not RVSM Approved	0	0	0	0
M	Other	0	0	0	0
Total		3	0.1	0	7.90

Table D: 12-month cumulative operational risk associated with LHD reports by LHD category within North East Asia RVSM airspace

AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN Pacific and North East Asia AIRSPACE January 2013 TO December 2013

Prepared by
Pacific Approvals and Registry Monitoring Organization (PARMO) – May 2013
(An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

1.1 This report provides an airspace safety review of RVSM airspace risk in the Anchorage, Auckland, Incheon, Nadi, Oakland and Tahiti Flight Information Regions (FIRs). The review is undertaken monthly using a twelve month data sample period.

2. Data Sources

2.1 **Traffic Sample Data (TSD).** A TSD covering four weeks of the month of December 2013 of aircraft operating in the Anchorage, Auckland, Incheon, Nadi, Oakland, and Tahiti FIRs was used as required by ICAO Regional agreement. **Table 1** indicates those FIRs which submitted a TSD in time for preparation of this report. The Nadi FIR indicated the December 2013 TSD would be submitted by early June, which is too late for inclusion in this report.

FIR	December 2013 TSD Submitted to PARMO
Anchorage	X
Auckland	X
Incheon	X
Nadi	
Oakland	X
Tahiti	X

Table 1: December 2013 TSD Submitted to PARMO

2.2 **Large Height Deviation (LHD).** A cumulative 12-month data set of LHD reports was used, covering January 2013 to December 2013. **Table 2** indicates those FIRs which submitted LHD reports including nil returns. **Appendix A** provides details of LHD reports.

Name of FIR	Anchorage	Auckland	Incheon	Nadi	Oakland	Tahiti
Jan-13	X	X	X	X	X	X
Feb-13	X	X	X	X	X	X
Mar-13	X	X	X	X	X	X
Apr-13	X	X	X	X	X	X
May-13	X	X	X	X	X	X
Jun-13	X	X	X	X	X	X
Jul-13	X	X	X	X	X	X

Aug-13	X	X	X	X	X	X
Sep-13	X	X	X	X	X	X
Oct-13	X	X	X	X	X	X
Nov-13	X	X	X	X	X	X
Dec-13	X	X	X	X	X	X

Table 2: Summary of LHD Reports submitted by FIRs

3. Summary of LHD Occurrences

3.1 Pacific RVSM Airspace

3.2 **Table 3** and **Figure 1** summarize the number of LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed by month from 1 January 2013 to 31 December 2013 inclusive for Pacific airspace.

Month-Year	No. of Non-NIL LHD	LHD Duration (min)	No. Levels Crossed
2013			
January	1	7	0
February	0	0	0
March	2	10	0
April	4	120	2
May	1	1	0
June	3	16	4
July	1	10	1
August	1	15	0
September	1	0	0
October	1	5	1
November	0	0	0
December	1	55	1
Total	16	239	9

Table 3: Summary of non-NIL LHD occurrences and duration for Pacific RVSM airspace

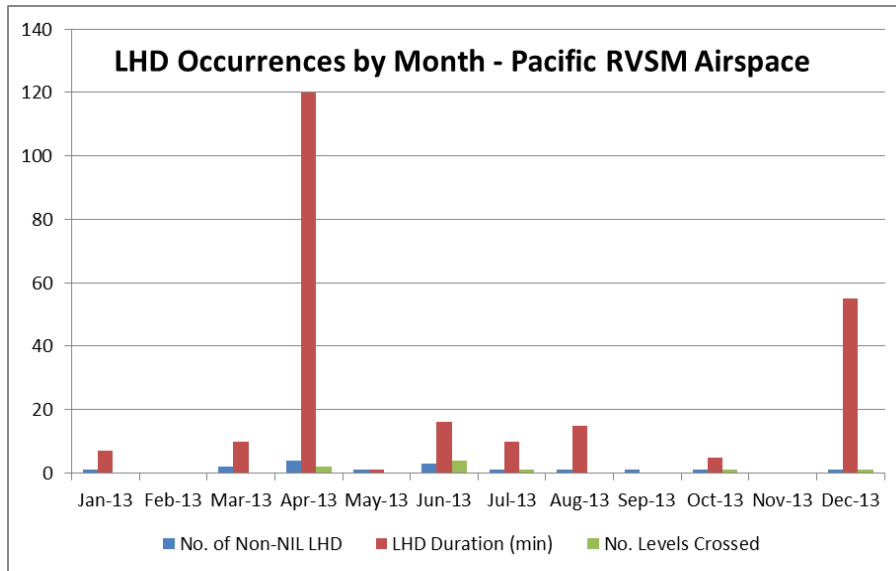


Figure 1: Summary of LHD occurrences (by month) for Pacific RVSM airspace

3.3 There were two long duration LHD events during the current reporting period. One event with a duration of 110 minutes was caused by an ATC loop error. In this case, the updated clearance information was not received by the aircraft, but was manually updated in the ATC automation system. The aircraft operated within the airspace at the incorrect flight level until it was transferred to the adjacent facility when the event was discovered.

3.4 Another event was reported with a duration of 55 minutes. In this case, communication between ATC and the aircraft was lost. The pilot did not follow the published lost communication procedures. The pilot correctly continued to follow the flight path contained in the filed flight plan. However, the pilot incorrectly followed the indicated flight level changes in the flight plan.

3.5 **Table 4** 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 1 January 2013 to 31 December 2013 inclusive for Pacific RVSM airspace.

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance
A	Flight crew failing to climb/descend the aircraft as cleared	4	17	2
B	Flight crew climbing/descending without ATC Clearance	4	66	6
C	Incorrect operation or interpretation of airborne equipment (e.g. incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed	0	0	0

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance
	instead of re-clearance etc)			
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	4	121	1
E	Coordination errors in the ATC to ATC transfer or control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters)	4	35	0
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues	0	0	0
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	0	0	0
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0	0
I	Deviation due to turbulence or other weather related cause	0	0	0
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	0	0	0
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0	0
L	An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)	0	0	0
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.	0	0	0
Total		16	239	9

Table 4: Summary of LHD occurrences and duration by LHD category for Pacific RVSM airspace

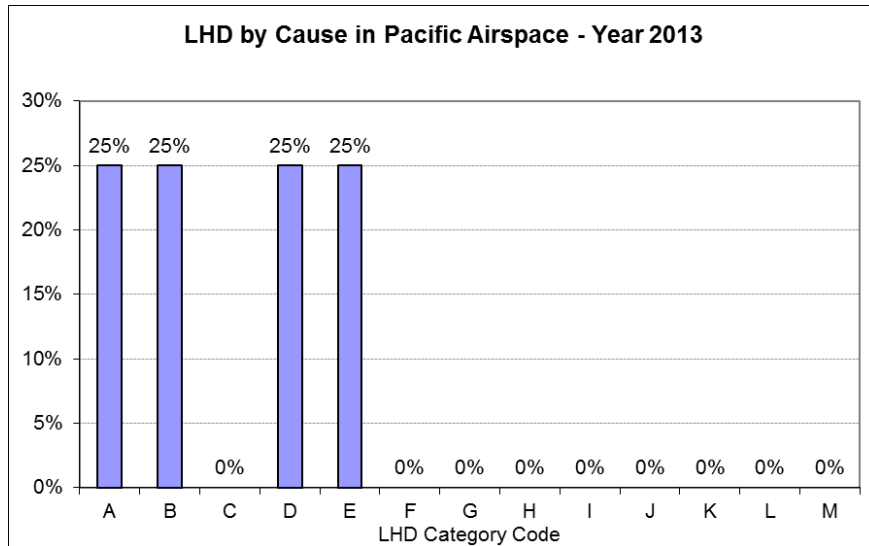


Figure 2: Summary of LHD causes for Pacific RVSM airspace

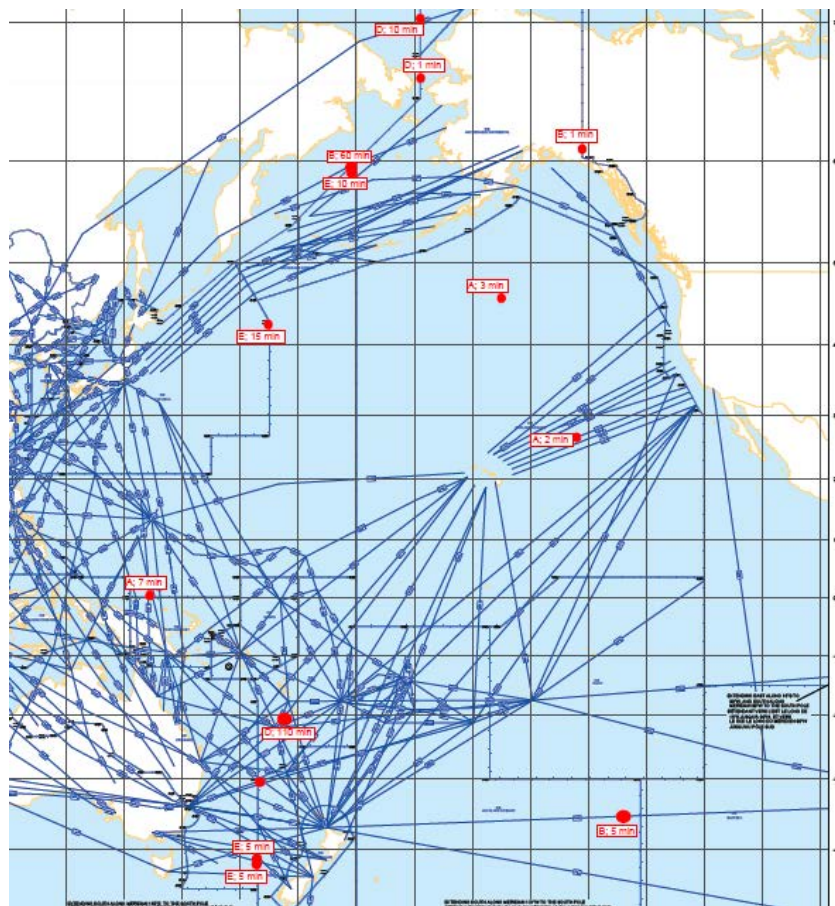


Figure 3: Pacific RVSM airspace LHD locations

3.6 **Table 5** and **Figure 4** presents a summary of 12-month cumulative operational risk associated with Large Height Deviation (LHD) reports by LHD category within Pacific airspace for the reporting period.

Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance	Operational Risk (x 10 ⁻⁹)
A	Flight crew fails to climb or descend the aircraft as cleared	0	0	0	0.55
B	Flight crew climbing or descending without ATC clearance	0	0	0	3.00
C	Incorrect operation or interpretation of airborne equipment	0	0	0	0
D	ATC system loop error	0	0	0	3.19
E	ATC transfer of control coordination errors due to human factors	4	0.1	0	1.15
F	ATC transfer of control coordination errors due to technical issues	0	0	0	0
G	Aircraft contingency leading to sudden inability to maintain level	0	0	0	0
H	Airborne equipment failure and unintentional or undetected level change	0	0	0	0
I	Turbulence or other weather related cause	0	0	0	0
J	TCAS resolution advisory and flight crew correctly responds	0	0	0	0
K	TCAS resolution advisory and flight crew incorrectly responds	0	0	0	0
L	An aircraft being provided with RVSM separation is not RVSM Approved	0	0	0	0
M	Other	0	0	0	0
Total		3	0.1	0	7.90

Table 5: 12-month cumulative operational risk associated with LHD reports by LHD category for Pacific RVSM airspace

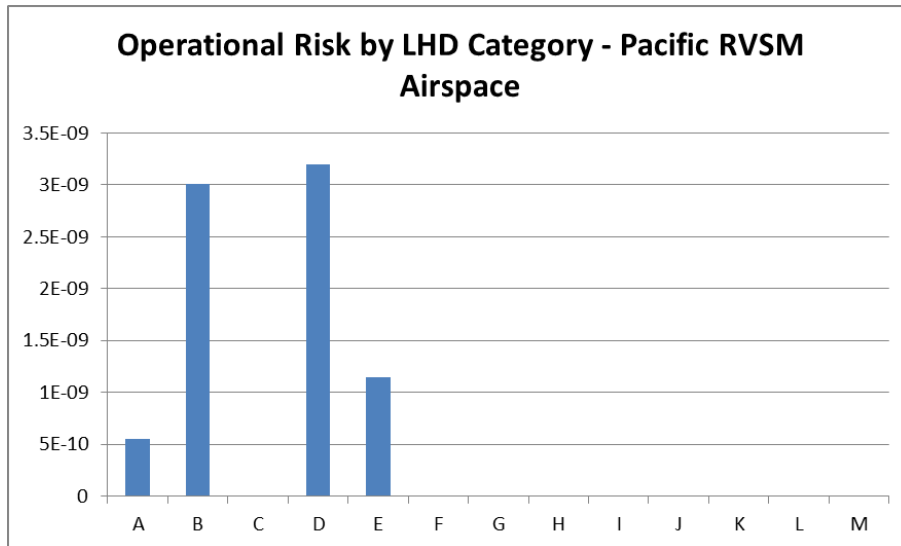


Figure 4: Operational risk composition and trend for Pacific RVSM airspace

3.7 North East Asia RVSM Airspace

3.8 **Table 6** and **Figure 5** summarize the number of LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed by month from 1 January 2013 to 31 December 2013 inclusive for North East Asia airspace.

Month-Year	No. of Non-NIL LHD	LHD Duration (min)	No. Levels Crossed
2013			
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	2	0	0
July	1	0	0
August	0	0	0
September	1	0.1	0
October	0	0	0
November	0	0	0
December	0	0	0
Total	3	0.1	0

Table 6: Summary of non-NIL LHD occurrences and duration for North East Asia RVSM airspace

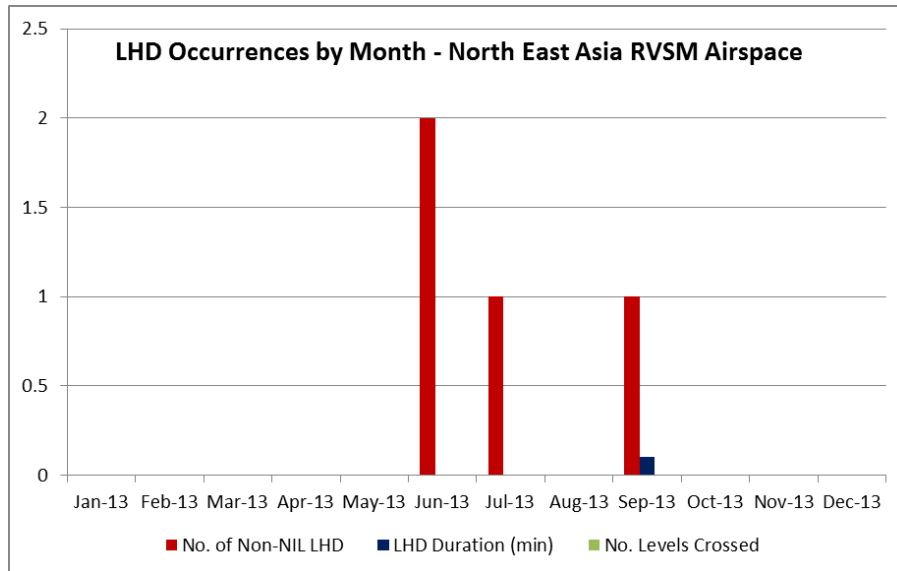


Figure 5: Summary of LHD occurrences (by month) for North East Asia RVSM airspace

3.9 **Table 7** and **Figure 6** summarize the number of LHD occurrences, the associated LHD duration (in minutes) and number of flight levels crossed without clearance, by LHD category from 1 January 2013 to 31 December 2013 inclusive for North East Asia RVSM airspace.

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance
A	Flight crew failing to climb/descend the aircraft as cleared	0	0	0
B	Flight crew climbing/descending without ATC Clearance	0	0	0
C	Incorrect operation or interpretation of airborne equipment (e.g. incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed instead of re-clearance etc)	0	0	0
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	0	0	0
E	Coordination errors in the ATC to ATC transfer or control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters)	4	0.1	0
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues	0	0	0

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	No. Levels Crossed Without Clearance
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)	0	0	0
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	0	0	0
I	Deviation due to turbulence or other weather related cause	0	0	0
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	0	0	0
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory	0	0	0
L	An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)	0	0	0
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.	0	0	0
Total		3	0.1	0

Table 7: Summary of LHD occurrences and duration by LHD category for North East Asia RVSM airspace

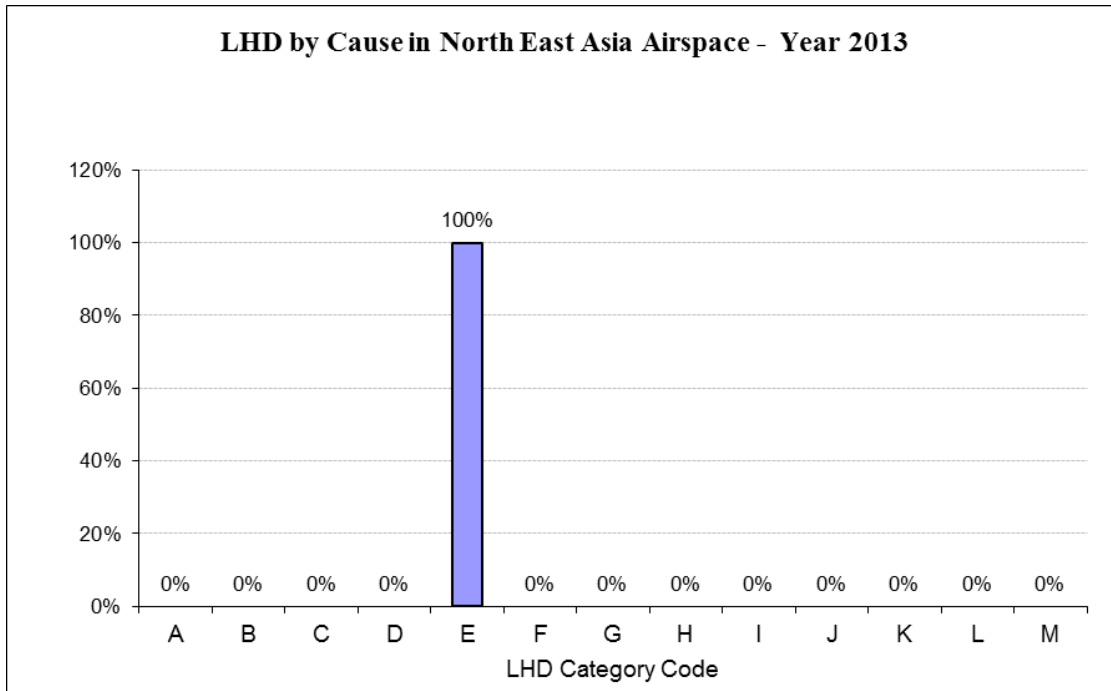


Figure 6: Summary of LHD causes for North East Asia RVSM airspace

3.10 **Table 8** presents a summary of 12-month cumulative operational risk associated with Large Height Deviation (LHD) reports by LHD category within North East Asia airspace for the reporting period.

Code	LHD Category Description	Operational Risk (x 10 ⁻⁹)
A	Flight crew fails to climb or descend the aircraft as cleared	0
B	Flight crew climbing or descending without ATC clearance	0
C	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	0
E	ATC transfer of control coordination errors due to human factors	0.19
F	ATC transfer of control coordination errors due to technical issues	0
G	Aircraft contingency leading to sudden inability to maintain level	0
H	Airborne equipment failure and unintentional or undetected level change	0
I	Turbulence or other weather related cause	0
J	TCAS resolution advisory and flight crew correctly responds	0
K	TCAS resolution advisory and flight crew incorrectly responds	0
L	An aircraft being provided with RVSM separation is not RVSM approved	0

M	Other	0
Total		0.19

Table 8: 12-month cumulative operational risk associated with LHD reports by LHD category for North East Asia RVSM airspace

4. Risk Assessment and Safety Oversight

4.1 Pacific RVSM airspace

4.2 Collision Risk Model (CRM) Parameters

4.3 The value of the parameters in the CRM used to estimate risk in Pacific RVSM airspace, are summarized in Table 9.

Parameter	Description	Value
$ \Delta V $	Average relative same-direction speed	13 Knots
$ V $	Average aircraft speed	480 knots
$ y $	Average relative cross-track speed	5 knots
$ z $	Average relative vertical speed during loss of vertical separation	1.5 knots
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.538

Table 9: Estimates of the parameters in the CRM for Pacific RVSM airspace

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

Pacific RVSM Airspace -estimated annual flying hours = 1,250,084 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 18 Total Risk (Previous RASMAG)	4.46×10^{-9}	5.0×10^{-9}	Below the TLS
Technical Risk	0.16×10^{-9}	2.5×10^{-9}	Below the Technical TLS
Operational Risk	7.90×10^{-9}		
Total Risk	8.05×10^{-9}	5.0×10^{-9}	Above the TLS

Table 10: Pacific Airspace Risk Estimates

4.5 **Figure 7** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.

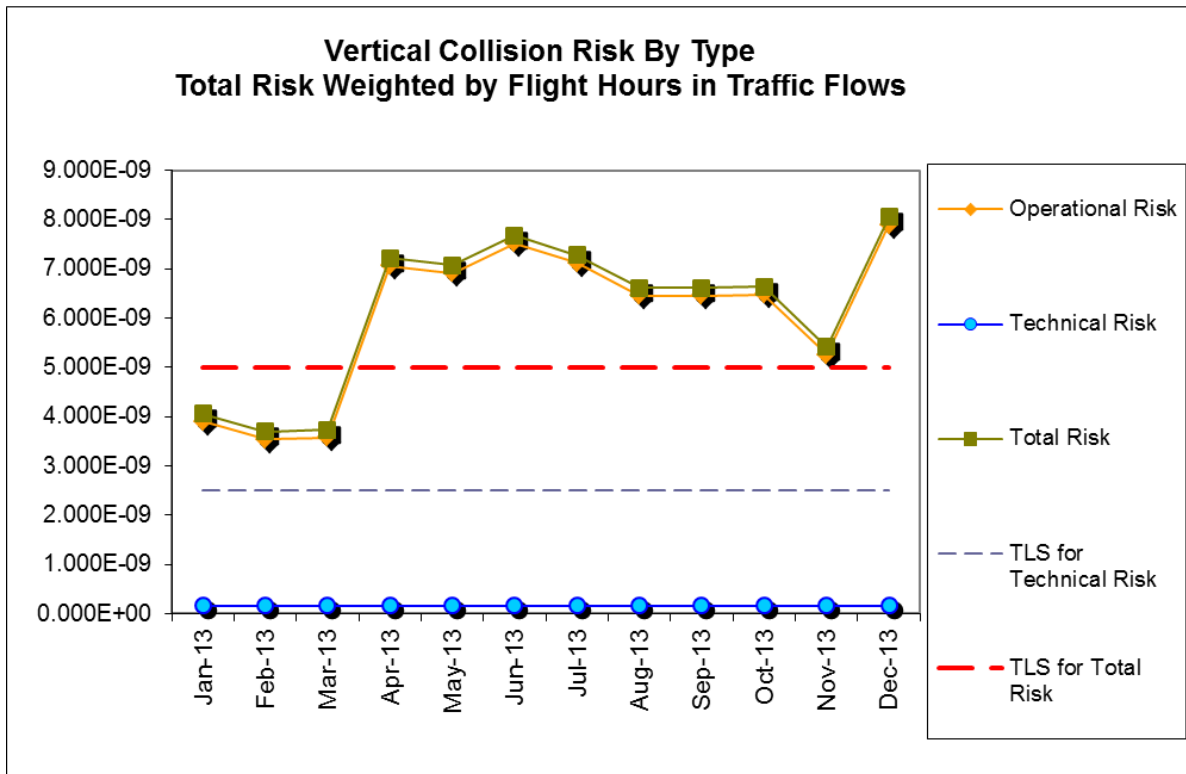


Figure 7: Trends of Risk Estimates for Pacific RVSM Airspace

4.6 North East Asia RVSM airspace

4.7 Collision Risk Model (CRM) Parameters

4.8 The value of the parameters in the CRM used to estimate risk in North East Asia RVSM airspace, are summarized in Table 11.

Parameter	Description	Value
λ_x	Average aircraft length	0.028 NM
λ_y	Average aircraft wingspan	0.025 NM
λ_z	Average aircraft height	0.008 NM
$ \Delta V $	Average relative same-direction speed	38.3 Knots
$ V $	Average aircraft speed	480 knots
$ \dot{y} $	Average relative cross-track speed	5 knots
$ \dot{z} $	Average relative vertical speed during loss of vertical separation	1.5 knots
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.538

Table 11: Estimates of the parameters in the CRM for North East Asia RVSM airspace

4.9 **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 12**. The technical risk meets the agreed TLS value of no more than 2.5×10^{-9} fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes. **The operational and weighted total risk meets the specified TLS value** for these components of 5.0×10^{-9} .

North East Asia RVSM Airspace -estimated annual flying hours = 97,752 hours (note: estimated hours based on December 2013 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
RASMAG 18 Total Risk (Previous RASMAG)	0.11×10^{-9}	5.0×10^{-9}	Below the TLS
Technical Risk	0.41×10^{-9}	2.5×10^{-9}	Below the Technical TLS
Operational Risk	0.19×10^{-9}		
Total Risk	0.60×10^{-9}	5.0×10^{-9}	Below the TLS

Table 12: North East Asia RVSM Airspace Risk Estimates

4.10 **Figure 8** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.

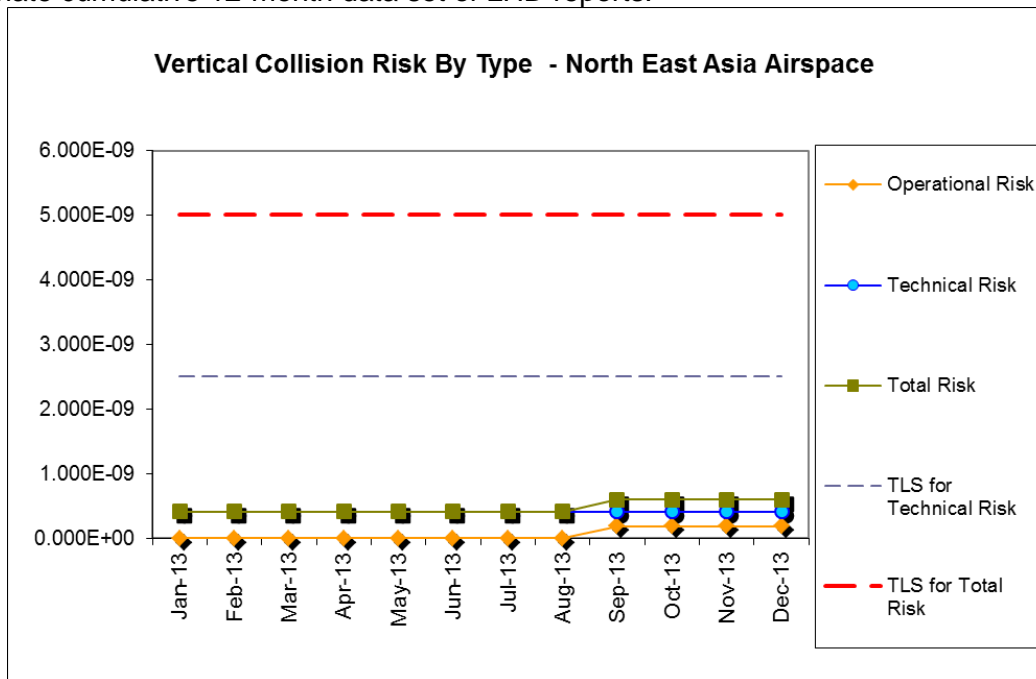


Figure 8: Trends of Risk Estimates for North East Asia RVSM Airspace

Appendix A to AIRSPACE SAFETY REVIEW

Details of the Reported LHD Events

Event date	Assigned FL	Observed / Reported FL	Duration at incorrect FL	Cause	Category
7-Jan-13	FL350	Block F330F350	7 minutes	Flight crew failing to climb/descend the aircraft as cleared;	A
14-Mar-13	FL 380	Block F370F380	Unknown	Flight crew failing to climb/descend the aircraft as cleared;	A
15-Mar-13	Block F320F340	Block F320F360	Unknown	Coordination errors in the ATC-unit-to-ATC-unit 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)	E
2-Apr-13	FL350	FL370	3 minutes	Flight crew failing to climb/descend the aircraft as cleared /CC	A / CC
8-Apr-13	FL340	FL360	2 minutes	Flight crew failing to climb/descend the aircraft as cleared /CC	A / CC
19-Apr-13	FL400	Block F380F400	1 hour 50 minutes	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	D
20-Apr-13	FL 340	FL 360	Unknown	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination)	E
30-May-13	FL340	FL350	1 minute	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	D
4-Jun-13	FL320	Unknown	1 minute	Flight crew climbing /descending without ATC clearance	B
21-Jun-13	FL 350	FL 370	Unknown	Flight crew climbing /descending without ATC clearance	B
21-Jun-13	FL350	FL370	10 minutes	Coordination errors in the ATC-unit-to-ATC-unit 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)	E
23-Jun-13	None	FL320	0	Coordination errors in the ATC-unit-to-ATC-unit 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)	E
23-Jun-13	None	FL340	0	Coordination errors in the ATC-unit-to-ATC-unit 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)	E
4-Jul-13	FL 370	FL 350	10 minutes	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	D

Event date	Assigned FL	Observed / Reported FL	Duration at incorrect FL	Cause	Category
5-Jul-13	None	FL340	0	Coordination errors in the ATC-unit-to-ATC-unit 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)	E
1-Aug-13	FL 400	Block F390F400	15 minutes	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination).	E
11-Sep-13	FL331	FL371	6 seconds	Coordination errors in the ATC-unit-to-ATC-unit 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)	E
23-Sep-13	FL 330	FL 330	0 minutes	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)	D
28-Oct-13	FL330	FL350	Unknown	Flight crew climbing /descending without ATC clearance	B
11-Dec-13	FL390	FL410	55 minutes	Flight crew climbing /descending without ATC clearance	B
