International Civil Aviation Organization

The Sixteenth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/16)

Bangkok, Thailand, 20 – 24 February 2012

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

VERTICAL SAFETY MONITORING REPORT FROM THE PACIFIC APPROVALS REGISTRY AND MONITORING ORGANIZATION DECEMBER 2010 – NOVEMBER 2011

(Presented by the United States/Pacific Approvals Registry and Monitoring Organization (PARMO))

SUMMARY

This working paper presents the vertical safety monitoring report from the Pacific Approvals Registry and Monitoring Organization (PARMO) for the time period 1 December 2010 to 30 November 2011. This report contains a summary of large height deviation reports received by the PARMO for that time period and an update of the vertical collision risk for Pacific and North East Asia airspace is presented.

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

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 fulfils the ICAO emphasis on safety management systems; such reporting for international airspace is a component of safety management systems.

2. DISCUSSION

2.1 This working paper contains the PARMO safety monitoring report for the time period 1 December 2010 to 30 November 2011. It contains a summary of large height deviation reports, and estimates of vertical risk for Pacific and North East Asia airspace.

3. ACTION BY THE MEETING

3.1 The meeting is invited to

a) note the results of the airspace safety oversight presented in this working paper, and

b) discuss any relevant matters as appropriate.

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Pacific and North East Asia Airspace
RVSM Safety Monitoring Report
December 2010 to November 2011

Prepared by:
Pacific Approvals Registry and Monitoring Organization (PARMO)

Summary

The purpose of this report is to compare actual performance to safety goals related to 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 PARMO for the most recent reporting period of 1 December 2010 to 30 November 2011. There are a total of 28 reported large height deviations that occurred during this period in Pacific and a portion of North East Asia RVSM airspace. This report also contains an update of the vertical collision risk. The vertical collision risk estimate for Pacific airspace meets the target level of safety (TLS) value of 5.0 x 10^{-9} fatal accidents per flight hour. The vertical collision risk estimate for a portion North East Asia airspace also meets the TLS value of 5.0 x 10^{-9} fatal accidents per flight hour.

1. Introduction

1.1. The Pacific Approvals Registry and Monitoring Organization (PARMO), a service provided by the U.S. Federal Aviation Administration's Technical Center, serves as the regional monitoring agency (RMA) for Pacific and for a portion of North East Asia airspace.

1.2. This report covers the current reporting period 1 December 2010 to 30 November 2011 in the PARMO's ongoing process of providing periodic updates of information relevant to the continued safe use of the RVSM in Pacific and North East Asia airspace. The PARMO produces two reports each calendar year following the standardize reporting period and format guidelines set forth by the International Civil Aviation Organization's (ICAO's) Asia and Pacific Region Regional Airspace Safety Monitoring Advisory Group (RASMAG). These guidelines are stated in reference 1, paragraph 5.34. This report includes information relevant to continued safe use of the RVSM in a portion of North East Asia airspace as well as the Pacific airspace.

1.3. Within this report, the reader will find the large height deviation reports received by the PARMO during the reporting period and the corresponding update to the vertical collision risk estimate. There were a total of 28 such reports submitted to the PARMO during the reporting period. A full description of the data sources used in this report is provided in reference 3.

2. Data Submission

2.1. The most recent annual one-month traffic movement samples for December 2010 were received from the Flight Information Regions (FIRs) listed in Table 1. These traffic movement samples are used to update the vertical risk estimates contained in this safety monitoring report.

Table 1: Summary of December 2010 Traffic Sample Data

State	FIR Name	Status
Fiji	Nadi	Received
New Zealand	Auckland	Received
Republic of Korea	Incheon	Received
Tahiti	Tahiti	Received
United States	Oakland	Received
	Anchorage	Received

Table 1: Summary of December 2010 Traffic Sample Data

2.2. Large Height Deviation (LHD) Data

2.2.1. The table in Appendix A presents the fidelity with which Pacific and North East Asia Flight Information Regions (FIRs) provided large height deviation reports (including 'NIL reports') to the PARMO each month during the reporting period. Since December 2010 the PARMO has received LHD reports for each month from all of the FIR's. The PARMO continues to request that ATS providers forward reports of large height deviations (300-ft magnitude or more) on a monthly basis. The email address for the PARMO is: aparmo@faa.gov. The website address for the PARMO is http://www.faa.gov/air_traffic/separation_standards/parmo/.

3. Large Height Deviations Report Summary

3.1. An increase in the total LHD duration (minutes), from 145 minutes to 207 minutes was observed from the reported risk-bearing events in Pacific airspace. There was one risk-bearing event reported for the portion of North East Asia airspace during the current twelve-month reporting period. Tables 2 and 3 summarize the number of risk-bearing LHD occurrences and durations during the time period 1 December 2010 to 30 November 2011 in the Pacific Airspace and a portion of North East Asia airspace, respectively. The details of these events can be found in Appendix C of this report.

Table 2. Summary of LHD Occurrences and Durations in Pacific Airspace

Month-Year	No. of LHD Occurrences	LHD Duration (Minutes)
Dec-10	0	0
Jan-11	1	5
Feb-11	1	5
Mar-11	5	19
Apr-11	1	15
May-11	3	97
Jun-11	2	25
Jul-11	0	0

Aug-11	2	15
Sep-11	3	26
Oct-11	0	0
Nov-11	0	0
Total	**18**	**207**

Table 3. Summary of LHD Occurrences and Durations in a Portion of North East Asia Airspace

Month-Year	**No. of LHD Occurrences**	**LHD Duration (Minutes)**
Dec-10	0	0
Jan-11	0	0
Feb-11	0	0
Mar-11	0	0
Apr-11	1	0.33
May-11	0	0
Jun-11	0	0
Jul-11	0	0
Aug-11	0	0
Sep-11	0	0
Oct-11	0	0
Nov-11	0	0
Total	**1**	**0.33**

3.2. The large height deviation reports are separated by categories based on the details provided for each deviation. There are three such categories: large deviations contributing to technical risk, large height deviations contributing to operational risk and large height deviations occurring outside of RVSM airspace or airspace for which the PARMO is the responsible RMA. There were no reported events related to technical risk, Appendix B contains no reported events contributing to technical risk.

3.3. Details of nineteen large height deviations contributing to operational risk provided to the PARMO during the reporting period are contained in Appendix C. Eighteen of these events were reported for Pacific airspace. The following sections contain summaries of some of the LHD data; the events are separated into those which involve errors related to air traffic control and those related to flight procedures.

Errors Related to Air Traffic Control

3.4. Ten of the nineteen events that contribute to operational risk were related to air traffic control. It is noted that the cause of three of these ten events related to air traffic control involved errors in coordination of control between ATC facilities. All three of the events related to coordination errors were due to human factor issues.

3.5. Four events related to air traffic control were ATC loop errors. One of these errors occurred in the western portion of the Oakland FIR, between Oakland the Manila FIR boundary. This event accounted for 21 minutes of unprotected operation due to confusion and misunderstanding between ATC and the pilot. The remaining 3 events under this

category took place in the Central Pacific (CENPAC), Japan-Guam, and South Pacific (SOPAC) traffic flows, were all estimated to be 5 minutes in duration.

3.6. Two events related to air traffic control did not fit into an existing LHD event category, and were tagged as 'Other'. One of these events took place in the North Pacific (NOPAC) traffic flow and was caused by the misdirection of an HF voice message acknowledging a climb clearance to the Oakland ARTCC instead of the Anchorage ARTCC. The FAA uses a third-party provider for HF voice communications. The duration of this event was estimated to be 15 minutes. The other event under the Other category took place within the SOPAC traffic flow. In this event, the aircraft had been cleared to operate with block altitudes, but the automation system was protecting the upper flight level in the block altitude. The duration estimated for this event was 60 minutes.

Errors Related to Flight Procedures

3.7. Seven events listed in Appendix C were caused by the flight crew climbing/descending without clearance, and not following the clearance properly. All of these events occurred in Pacific airspace. These events accounted for 79 minutes of operation at incorrect flight level.

3.8. Two events listed in Appendix C involved an aircraft contingency event leading to sudden inability to maintain the assigned flight level. In one of these events, the aircraft ascended from FL260 to FL450. Because the final flight level was above RVSM airspace, the duration at incorrect flight level was minimized and only the time to transition through RVSM flight levels was accounted for in the risk estimate.

3.9. To identify trends in risk-bearing large height deviations, the causes of each of the nineteen risk-bearing reports contained in Appendix C are summarized in Figures 1 and 2. The large height deviation error codes are defined in Table 4.

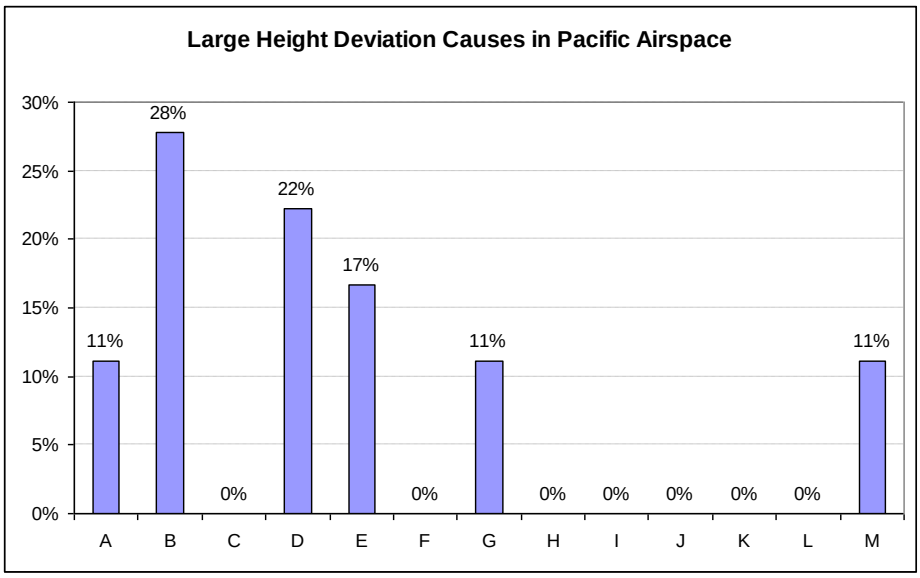

Figure 1. Percent of Large Height Deviations by Category in Pacific Airspace

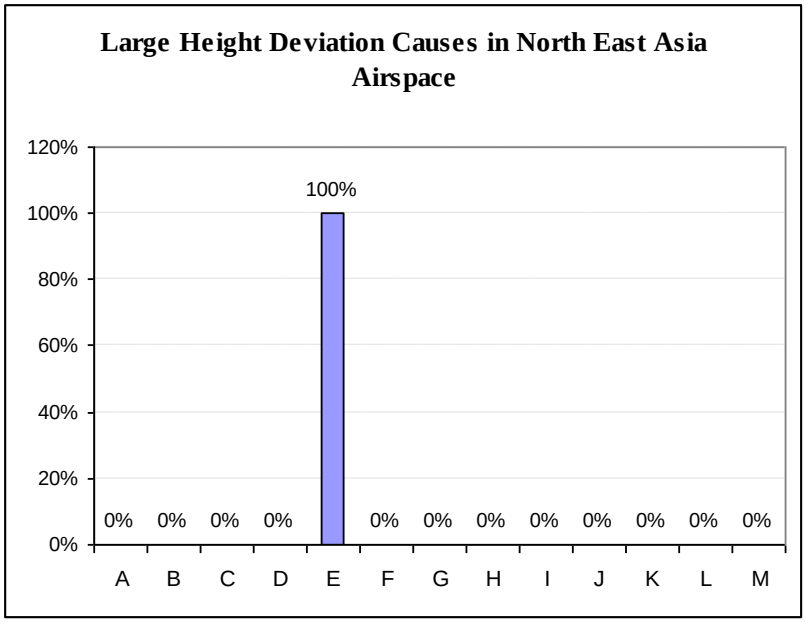

Figure 2. Percent of Large Height Deviations by Category in a Portion of North East Asia Airspace

Table 4. Large Height Deviation Code Definitions for Figure 1

Deviation Code	Cause of Deviation
Operational Errors	
A	Flight crew failing to climb/descend the aircraft as cleared;
B	Flight crew climbing /descending without ATC clearance;
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.);
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);
E	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);
F	Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues;
Aircraft Contingency Events	
G	Aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure);
H	Airborne equipment failure leading to unintentional or undetected change of flight level (e.g. altimetry errors);
Deviation due to Meteorological Condition	
I	Turbulence or other weather related causes;

Deviation Code	Cause of Deviation
Deviation due to TCAS RA	
J	TCAS resolution advisory; flight crew correctly following the resolution advisory;
K	TCAS resolution advisory; flight crew incorrectly following the resolution advisory
Others	
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);
M	Other

3.10. In addition, Table 5 presents a summary of the reported errors by deviation code for Pacific airspace.

Table 5. Summary Large Height Deviations by Category – Pacific Airspace

LHD Category Code	LHD Category Description	No of LHD Occurrences	LHD Duration (Min)	No. of Flight Levels Transitioned Without Clearance
A	Flight crew failing to climb/descend the aircraft as cleared;	2	37	2
B	Flight crew climbing /descending without ATC clearance;	5	42	7
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);	4	36	0
E	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);	3	12	0
G	Aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure);	2	5	13
M	Other	2	75	3

3.11. As shown in Figure 1, the largest contributor to risk-bearing large height deviations in Pacific airspace is flight crew climbing/descending without ATC clearance. There were five reported events attributed to the flight crew changing flight level without ATC clearance, accounting for 42 minutes of operation at incorrect flight levels.

3.12. Appendix D contains the details of all reported large height deviations occurring outside of RVSM airspace and airspace for which the PARMO is not the responsible RMA. These large height deviations do not affect the risk estimate for Pacific or North East Asia airspace but are presented in this report for completeness. There are nine such large height

deviations. All but one of the events listed in Appendix D were related to ATC coordination errors.

4. Estimate of Vertical Collision Risk for Pacific Airspace

4.1. The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) continued to be met in Pacific airspace, thus supporting the ongoing safe application of RVSM.

4.2. The estimate of vertical collision risk has been updated in the same manner used in reference 4. Figure 3 provides the vertical collision risk estimates by type (e.g. technical, operational, and total) for each month during the current reporting period. Each monthly risk estimate was 'weighted' by the estimated number of flight hours in each Pacific airspace flow. Table 8 provides the definitions used for each Pacific airspace flow. Table 8 also provides the estimated flying hours and the proportion of flying hours for each traffic flow. The proportion of flying hours is used to weight the collision risk estimates from each traffic flow to calculate the overall vertical collision risk in Pacific airspace.

4.3. Figure 3 provides the PARMO's updated risk estimates for Pacific RVSM airspace based on recent reports of large height deviations. The estimated flying hours in the portion of Pacific RVSM airspace for which the PARMO is the responsible RMA is 1,019,436 flying hours per year.

4.4. Figure 3 shows that the estimate of vertical collision risk was greater than the TLS in June 2011. The calculation maintains the event reports for 12-calendar months in the estimate of collision risk. At the start of June 2011, the risk estimation for the NOPAC traffic flow accounted for 73 minutes of operation at incorrect flight level. Two events were reported for June 2011 with an additional 25 minutes of operation at incorrect flight level in the NOPAC traffic flow. Because the NOPAC traffic flow accounts for a larger proportion of flying hours in Pacific airspace and has relatively high passing frequencies, the time spent at incorrect flight levels within the NOPAC traffic flow has a larger effect on the estimate of risk than in other traffic flows. Figure 3 shows that the overall risk estimate returns to a lower level in August 2011, when two events, reported in August 2010 for the NOPAC traffic flow, accounting for 44 minutes of operation at incorrect flight levels were dropped from the estimate of risk.

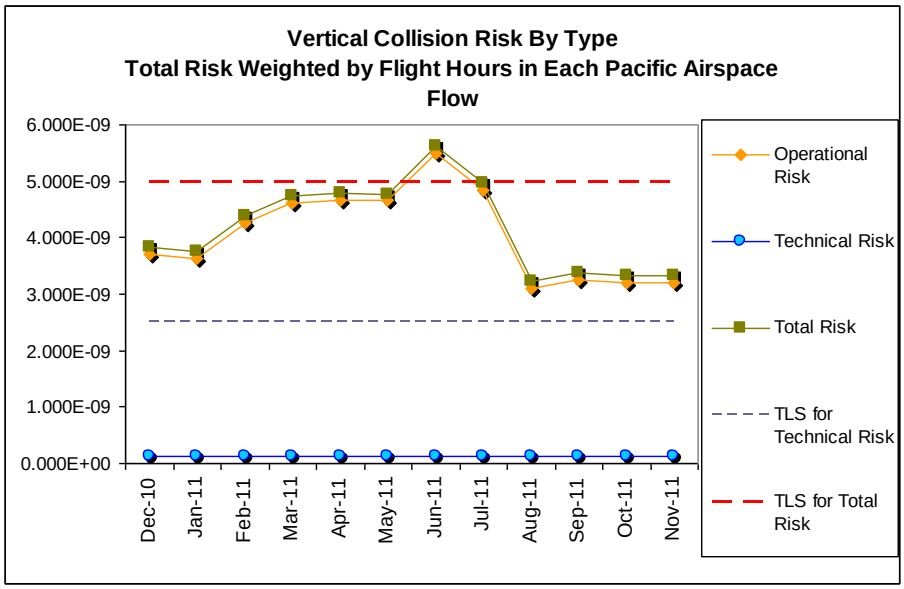

Figure 3. Vertical Collision Risk for Pacific RVSM Airspace

Table 8. Traffic Flows Used in Pacific Vertical Collision Risk Estimate

Sub-Region of Pacific	Flow	Description of Flow	Estimated Annual Flying Hours	Proportion of Flying Hours in Airspace
North Pacific	NOPAC	North America west to Japan/Korea/beyond plus Japan/Korea to and from Alaska and beyond	123,058	12.07%
	Central Pacific (CENPAC)	Japan/Korea/other Asian origins east to North America	202,622	19.88%
	Central East Pacific (CEP)	North American mainland to and from Hawaii	206,400	20.25%
	Hawaii/Japan	Japan/Korea to and from Hawaii	64,343	6.31%
	Japan/Guam	Japan/Korea to and from Guam/Saipan/other proximate destinations	3,480	0.34%
	Other	All other North Pacific flights not covered above	41,904	4.11%
South Pacific and Pacific trans-equatorial	Australia/New Zealand/South Pacific States	Australia to and from New Zealand; Australia to and from South Pacific island states; New Zealand to and from South Pacific states	18,000	1.77%
	Nadi	Fiji to and from all airports except those in Australia or New Zealand	96,516	9.47%

Sub-Region of Pacific	Flow	Description of Flow	Estimated Annual Flying Hours	Proportion of Flying Hours in Airspace
	Australia-New Zealand/Japan	Australia to and from Japan/Korea; New Zealand to and from Japan/Korea	52,632	5.16%
	SOPAC	Australia to and from airports in northern hemisphere; New Zealand to and from airports in northern hemisphere	210,480	20.65%

4.5. Table 9 presents the estimates of vertical collision risk for Pacific airspace. The technical risk is estimated to be 0.123×10^{-9} fatal accidents per flight hour (fapfh). The operational risk estimate is 3.193×10^{-9} fapfh. The estimate of the overall vertical collision risk is 3.316×10^{-9} fapfh. This estimate meets the regionally agreed TLS value of 5.0×10^{-9} fapfh. This new estimate is based on the most recent 12 months of large height deviation reporting and collision risk parameters based on the December 2010 traffic samples collected.

Table 9. Vertical Collision Risk Estimates for Pacific Airspace

Portions of Pacific RVSM Airspace *– estimated annual flying hours = 1,019,436 hours (note: estimated hours based on the December 2010 traffic sample data)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.123×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	3.193×10^{-9}	-	
Total Risk	3.316×10^{-9}	5.0×10^{-9}	Below Overall TLS

5. Estimate of Vertical Collision Risk for North East Asia Airspace

5.1. The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) is met in a portion of North East Asia airspace. Table 10 presents the estimates of vertical collision risk for a portion of North East Asia airspace. The technical risk is estimated to be 1.268×10^{-9} fapfh. The LHD reports received during the most recent 12 calendar months are included in the estimate of vertical operational risk. The current operational risk value is 0.3602×10^{-9} fapfh. The estimate of the overall vertical collision risk is 1.628×10^{-9} fapfh. This estimate meets the regionally agreed TLS value of 5.0×10^{-9} fapfh. This new estimate was based on the most recent 12 months of large height deviation reporting and the traffic sample received in December 2010. The estimated annual flying hours for this portion of North East Asia airspace is 175,248 flying hours per year. Table 11 presents the current collision risk model (CRM) parameters used in the vertical safety assessment for the Incheon FIR.

Table 10. Vertical Collision Risk Estimates for North East Asia Airspace

Portions of NE Asia RVSM Airspace – *estimated annual flying hours = 175,248 hours (note: estimated hours based on the December 2010 traffic sample data)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	1.286×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	0.360×10^{-9}	-	
Total Risk	1.628×10^{-9}	5.0×10^{-9}	Below Overall TLS

Table 11. CRM Parameters used in the vertical risk estimate for the Incheon FIR

Parameter Symbol	**Parameter Definition**	**Parameter Value**	**Source for Value**
$\overline{\lvert\Delta V\rvert}$	Average relative along-track speed between aircraft on same direction routes	38.3 knots	Estimated from TSD in 2005
$\overline{\lvert V\rvert}$	Average absolute aircraft ground speed	480 knots	Conservative value used in NAT and Pacific vertical safety assessments
$\lvert\bar{\dot{y}}\rvert$	Average absolute relative cross track speed for an aircraft pair nominally on the same track	5 knots	Estimated from processing GMU-collected GPS-derived positions of aircraft monitored in connection with Pacific RVSM
$\lvert\bar{\dot{z}}\rvert$	Average absolute relative vertical speed of an aircraft pair that have lost all vertical separation	1.5 knots	Conservative value used in NAT vertical safety assessment
$\dot{h}(\theta)$	Average relative horizontal speed during horizontal overlap for aircraft pairs on routes with crossing angle θ (θ=45°)	367.4 knots	Value used in Western Pacific/South China Sea safety assessment (corresponds to an average aircraft speed of 480 knots)
λ_x	Average aircraft length	0.0308 NM	Estimated from TSD
λ_y	Average aircraft wingspan	0.0274 NM	Estimated from TSD
λ_z	Average aircraft height	0.0085 NM	Estimated from TSD
E_z*(same)*	Same direction vertical occupancy value	0.4749	Estimated from TSD
E_z*(opposite)*	Opposite direction vertical occupancy value	0.1328	Estimated from TSD

5.2. Figure 4 provides the PARMO's updated risk estimates for a portion of North East Asia RVSM airspace based on recent reports of large height deviations.

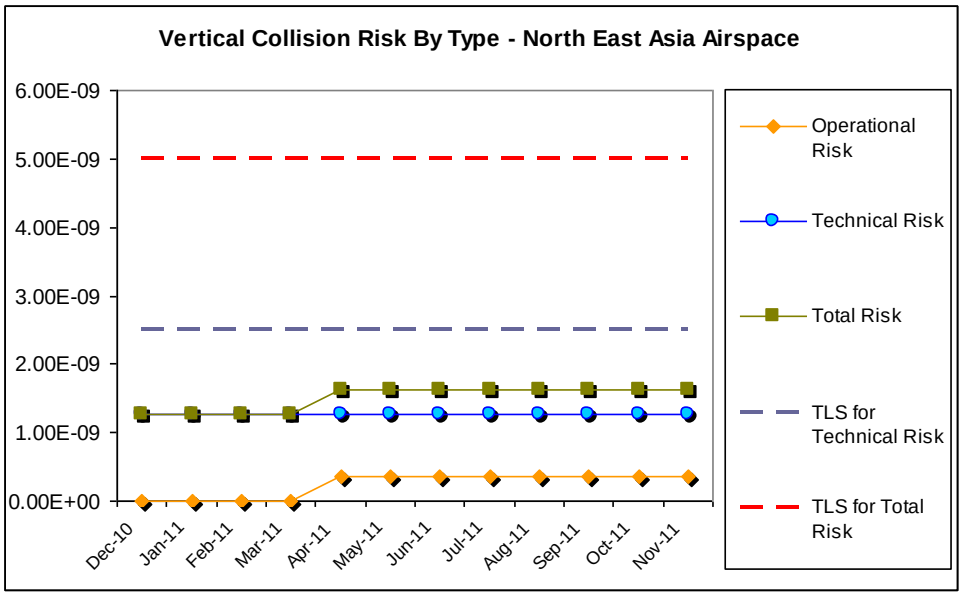

Figure 4. Vertical Collision Risk for North East Asia RVSM Airspace

6. Summary and Conclusions

6.1. This report has presented an update of the vertical collision risk for Pacific and a portion of North East Asia airspace, and a summary of large height deviation reports received by the PARMO for the current reporting period, 1 December 2010 to 30 November 2011.

6.2. The update of the vertical collision risk was performed to determine whether the TLS continued to be met in support of the ongoing safe use of RVSM in Pacific airspace. The estimate of the overall vertical collision risk, 3.316 x 10^{-9} fapfh, is below the TLS value of 5.0 x 10^{-9} fapfh. This new estimate reflects the most-recent reports of large height deviations.

6.3. The update of the vertical collision risk was performed to determine whether the TLS is met in support of the ongoing safe use of RVSM in a portion of North East Asia airspace. The estimate of the overall vertical collision risk, 1.628 x 10^{-9} fapfh meets the TLS value of 5.0 x 10^{-9} fapfh. This estimate reflects the most-recent reports of large height deviations.

6.4. There were twenty-eight reported large height deviations occurring within Pacific and North East Asia RVSM airspace during the reporting period. Nineteen risk-bearing events contributed to the operational risk in Pacific RVSM airspace. A large contributor to risk-bearing large height deviations errors was flight crews climbing/descending without ATS clearance. Details of all deviations were provided in this report and its appendices.

6.5. ATS providers should continue to forward reports of height deviations of 300 ft or more in magnitude to the PARMO on a monthly basis. A ‘NIL report’ (where applicable) is as valuable as a report containing actual incidents. Therefore, if zero large-height-deviation events occur during a calendar month, the PARMO requests that a ‘NIL report’ be submitted. The email address for the PARMO is: aparmo@faa.gov. The website address for the PARMO is http://www.faa.gov/air_traffic/separation_standards/parmo/.

References

1. "Report of the Seventh Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/7)," International Civil Aviation Organization, Bangkok, Thailand, June 2007.
2. *Handbook for a Regional Monitoring Agency Supporting Implementation and Continued Safe Use of the Reduced Vertical Separation Minimum: RMA Handbook*, International Civil Aviation Organization, August 2003 Edition.
3. "Pacific Airspace RVSM Safety Monitoring Report October – December 2004," Draft Version 1.0, Prepared by the PARMO, February 2004.
4. "Update of Pacific Reduced Vertical Separation Minimum (RVSM) Safety Assessment," WP/3, Tenth Meeting of the ICAO Reduced Vertical Separation Minimum (RVSM) Implementation Task Force (RVSM TF/10), Honolulu 29-30 January 2001.

Appendix A
Monthly Large Height Deviations Reports Received by the PARMO

STATE	FIJI	NEW ZEALAND	REPUBLIC OF KOREA	TAHITI	UNITED STATES	
FIR	*Nadi*	*Auckland*	*Incheon*	*Tahiti*	*Anchorage*	*Oakland*
Dec-10	X	X	X	X	X	X
Jan-11	X	X	X	X	X	X
Feb-11	X	X	X	X	X	X
Mar-11	X	X	X	X	X	X
Apr-11	X	X	X	X	X	X
May-11	X	X	X	X	X	X
Jun-11	X	X	X	X	X	X
Jul-11	X	X	X	X	X	X
Aug-11	X	X	X	X	X	X
Sep-11	X	X	X	X	X	X
Oct-11	X	X	X	X	X	X
Nov-11	X	X	X	X	X	X

X = Large Height Deviation Report was received for the specified month (including reports indicating "NIL" events)

Appendix B

Height Deviations Contributing to Technical Risk in the Pacific and a Portion of North East Asia Airspace Reported to the PARMO during the Reporting Period

No events to list

Appendix C
Height Deviations Contributing to Operational Risk in the Pacific and a Portion of North East Asia Airspace Reported to the PARMO during the Reporting Period

Event date	Source	Assigned FL	Observed / Reported FL	Duration at incorrect FL	Cause
12-Jan-11	ATS 4	FL390	FL360	Unknown	Coordination errors in the ATC-ATC transfer of control – human factors
1-Feb-11	ATS 8	FL310	FL350	Unknowm	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)
2-Mar-11	ATS 7	FL410	FL430	Unknown	Flight crew climbing /descending without ATC clearance;
17-Mar-11	ATS 4	FL380	FL360	Unknown	Coordination errors in the ATC-ATC transfer of control – human factors
18-Mar-11	ATS 8	Unknown	FL390	5 minutes	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);
21-Mar-11	ATS 3	FL320	FL335	2 minutes	Flight crew climbing /descending without ATC clearance;
28-Mar-11	ATS 7	FL340	FL340	2 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)
16-Apr-11	ATS 5	FL410	FL410	20 seconds	Coordination errors in the ATC-ATC transfer of control – human factors
23-Apr-11	ATS 4	FL370	FL380	15 minutes	Flight crew climbing /descending without ATC clearance;
4-May-11	ATS 4	FL360	FL380	Unknown	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message)

Event date	Source	Assigned FL	Observed / Reported FL	Duration at incorrect FL	Cause
19-May-11	ATS 4	360B390	FL350	32 minutes	Flight crew failing to climb/descend the aircraft as cleared
23-May-11	ATS 4	FL320	FL310	60 minutes	Other - Aircraft cleared for block altitude 300B320, ATC system was proctecting only FL320. ATC alerted by the system when the aircraft reported FL310.
14-Jun-11	ATS 7	None	FL320	10 minutes	Flight crew climbing /descending without ATC clearance;
18-Jun-11	ATS 7	FL360	FL380	15 minutes	Other - ARINC sent HF radio response to clearance to Oakland instead of Anchorage - Anchorage never received WILCO response from aircraft for the climb clearance
11-Aug-11	ATS 4	FL410	Descending	10 minutes	Flight crew climbing /descending without ATC clearance
24-Aug-11	ATS 3	FL380	FL365	Unknown	Aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)
2-Sep-11	ATS 7	260B280	FL450	levels crossed only	Aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)
2-Sep-11	ATS 8	Unknown	FL350	21 minutes	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);
14-Sep-11	ATS 7	11600 meters	FL360	5 minutes	Flight crew failing to climb/descend the aircraft as cleared;

Appendix D
Height Deviation Incidents Occurring Outside of Exclusionary RVSM Airspace and/or Airspace for which the PARMO is the Responsible RMA

Event date	Source	Assigned FL	Observed / Reported FL	Duration at incorrect FL	Cause
27-Jan-11	ATS 7	Unknown	FL080	Unknown	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
11-Mar-11	ATS 7	Unknown	FL330	FL320	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
2-May-11	ATS 8	Unknown	FL 350	Unknown	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
18-Jun-11	ATS 7	FL 360	FL 380	Unknown	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
20-Jun-11	ATS 7	FL 280	FL 220	Unknown	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message);
15-Aug-11	ATS 8	FL360	FL340	Unknown	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
2-Sep-11	ATS 8	Unknown	FL350	5 minutes	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
26-Oct-11	ATS 8	FL320	FL320	18 minutes	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues
26-Nov-11	ATS 7	Unknown	FL290	Unknown	Coordination errors in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues