International Civil Aviation Organization

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

Bangkok, Thailand, 2 – 5 August 2010

Agenda Item 3: Reports from Asia/Pacific RMAs

SAFETY ASSESSMENT OF RVSM WITHIN THE FLIGHT INFORMATION REGIONS MONITORED BY THE AAMA

(Presented by Australia)

SUMMARY

This paper presents the results of three safety assessments undertaken by the Australian Airspace Monitoring Agency (AAMA) for the twelve month period ending 30 April 2010. The assessments cover the Brisbane, Honiara, Jakarta, Melbourne, Nauru, Port Moresby and Ujung Pandang FIRs.

1. Introduction

1.1. This paper provides details of the three airspace safety oversight assessments undertaken by the AAMA for the RVSM implementations in the Australian, Indonesian, Nauru, Papua New Guinea and Solomon Islands RVSM airspace. The reports are detailed in **Attachments 1 to 3**.

2. Discussion

2.1 Since the completion of the April 2010 assessments provided with this paper, the AAMA has completed further assessments for the months of May and June 2010 for both the Australian and Indonesian airspace. These assessments show that in the Australian airspace, the number of Category A and B type incidents has increased over the last few months and that the assessed risk currently approximates 6.06E-9. For the Indonesian airspace, the total risk has reduced significantly since April to be 3.94E-9. This has been primarily the result of high duration LHDs dropping out of the 12 month operational error sample.

2.2 Incident reports for the Honiara and Nauru FIRs are incorporated into the Australian assessment due to the low number of incidents and flight hours. Additionally the Australian air navigation service provider is the controlling authority for the upper airspace in these FIRs.

2.3 The AAMA has had significant problems in obtaining valid traffic sample data from Papua New Guinea and as a result has had to rely on December 2007 data to make the assessment detailed in Attachment 3. Additionally the AAMA has no confidence in the ability of the air navigation service provider to effectively report operational errors. Both these issues are an on-going focus for the AAMA to resolve in partnership with both the PNG CAA and the State air navigation service provider.

2.4 The AAMA is pleased to report that the assistance it now receives from the Indonesian authorities is enabling it to undertake the necessary assessments in a timely manner. The AAMA now provides monthly assessments of the Jakarta and Ujung Pandang FIRs and has a good working interface with the relevant authorities that enables a productive review of issues identified in the assessment. The AAMA is still working with these authorities to improve reporting of operational error and the accuracy of traffic sample data.

3. Actions by the Meeting

3.1 The meeting is invited to note and discuss the results of the airspace safety oversight presented in this working paper.

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AIRSERVICES AUSTRALIA

AUSTRALIAN AIRSPACE MONITORING AGENCY (AAMA)

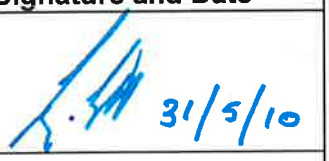
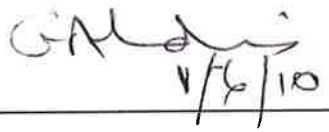
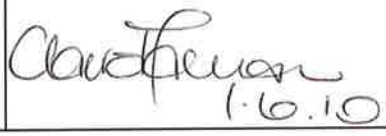
SAFETY & ENVIRONMENT GROUP

SAFETY SYSTEMS, RISK & ANALYSIS

Operational Analysis Unit

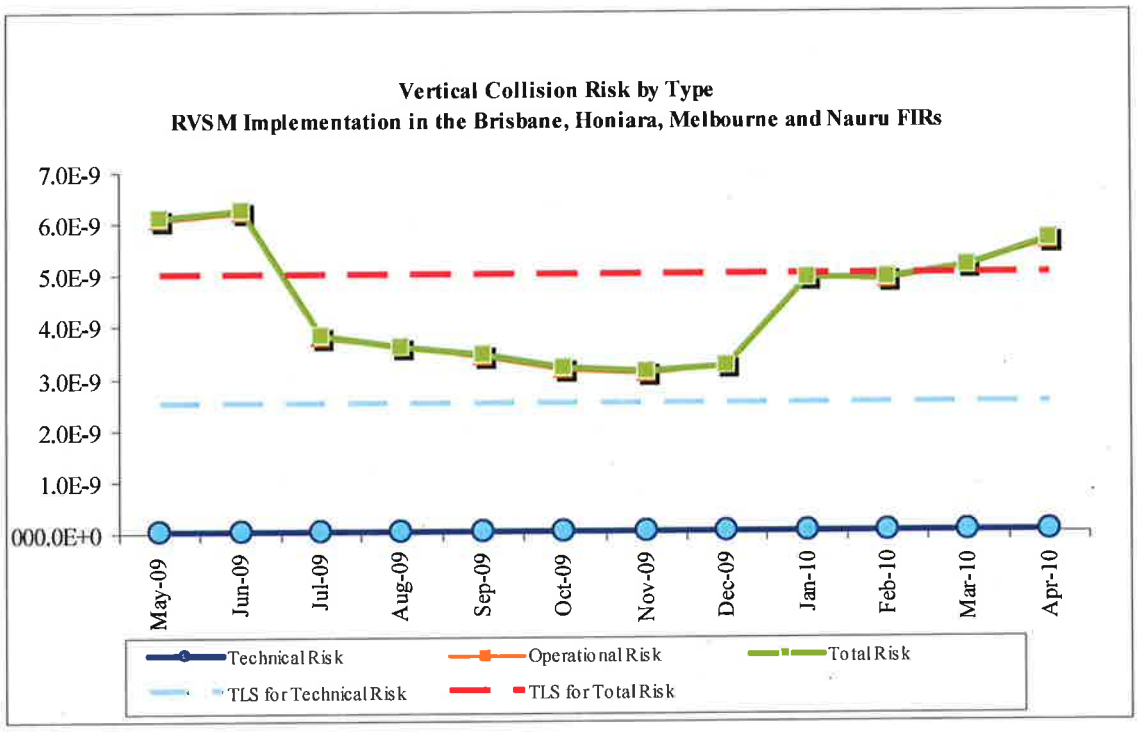
Airspace Safety Review of the RVSM Implementation in Australian, Nauru and Solomon Islands Airspace May 2009 to April 2010

Australian Airspace Monitoring Agency – RVSM Safety Assessment Report
Brisbane, Honiara, Melbourne and Nauru FIRs
May 2009 to April 2010

Role	Name and Position	Signature and Date
Prepared By	Robert Butcher Operational Analysis Manager & Dr Geoff Aldis Quantitative Modelling Manager	 
Endorsed	Dr Claire Marrison Manager, Safety Systems Risk and Analysis	

Executive Summary

For the period 1 May 2009 to 30 April 2010, the technical risk satisfies the agreed TLS value of no more than 2.5 x 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. As depicted in the graph below, **the operational and weighted total risk of 5.66 x 10^{-9} does not meet the specified TLS value** for these components of 5.0 x 10^{-9}.



There was an increase of 3 in the number of non-NIL LHDs for Category A . 'Flight crew failing to climb/descend the aircraft as cleared' during the month. Additionally LHDs resulting from turbulence or other weather events doubled from 3 to 6 but still had a low overall duration.

Three non-NIL Category A 'Flight crew failing to climb/descend the aircraft as cleared' report were assessed. One report was filed as ESIR 2010 2051 by UAS EAST and attributed to the pilot. The report identified the pilot incorrectly descended the aircraft to an uncleared level and maintained that level for a period of time following cancellation of a block level clearance.. The other two reports (ESIR 2010 2131 and 2010 2165) involved an aircraft operating outside of the cleared block levels; and an aircraft reporting within block levels after the block level clearance had been cancelled.

One Category B 'Flight crew climbing/descending without ATC Clearance' report was reported as ESIR 2010 2409 filed by BIGHT. The report involved an aircraft descending without a clearance to do so. .

Three non-NIL reports of Category E, 'Coordination Errors' were reported. One report was ESIR 2010 2178 of 2 minutes duration, reported by TOPS and attributed to ATS-

FOREIGN. The report identified a failure of the Ujung Pandang FIR controller to coordinate correctly the level at which an aircraft was to cross the FIR boundary. Another report of one minute duration was ESIR 2010 2049, reported by TOPS and related to incorrect level coordination from the Port Moresby FIR controller. The final report was filed as ESIR 2010 1953 by UAS EAST and related to the Airservices controller not updating a CFL following coordination from Nadi.

Three non-NIL Category I 'Turbulence or other weather related causes' reports were assessed. Two of these reports were received from the ATSB and were each assessed as being of 0.5 minutes duration. One report occurred near NONIX waypoint and involved an aircraft climbing 500feet above its cleared flight level due turbulence. The second report occurred near EGORE waypoint in Northern Australia and involved an aircraft descending 400feet from its cleared flight level due to turbulence. No corresponding ESIRs have been identified to date although it is not known if these occurrences were reported to ATC by the pilots concerned. A third report was filed as ESIR 2010 2275 and reported by UAS EAST. The aircraft involved had descended 500feet.

AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN AUSTRALIAN, NAURU AND SOLOMON ISLANDS AIRSPACE MAY 2009 TO APRIL 2010

Prepared by
Australian Airspace Monitoring Agency (AAMA) - *May 2010*
(An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

1.1 This report provides the summary of airspace safety oversight for the post RVSM implementation in the Asia Pacific Region, focusing on the Australian, Nauru and Solomon Islands airspace, i.e. the total areas of the Brisbane, Honiara, Melbourne and Nauru FIRs. The RVSM safety oversight is conducted based on a one-month traffic sample data (TSD) collected in **December 2009** and monthly Large Height Deviation (LHD) reports from **1 May 2009 to 30 April 2010**.

2. Data Submission

2.1 **Traffic Sample Data (TSD).** A TSD covering four weeks of the month of December 2009 of aircraft operating in the Australian, Nauru and Solomon Islands airspace was used to assess the safety of RVSM airspace, as required by ICAO Regional agreement between monitoring agencies.

2.2 **Large Height Deviation (LHD).** A series of cumulative 12-months of LHD reports were used in this safety assessment, namely May 2009 to April 2010.

3. Summary of LHD Occurrences

3.1 **Table 1** and **Figure 1** summarise the number of LHD occurrences and associated LHD duration (in minutes) by month from 1 May 2009 inclusive. The data is the total number of non-NIL LHDs assessed.

Month-Year	No. of Non-NIL LHD Occurrences	LHD Duration (Min)
2009		
May	2	2.0
June	8	6.5
July	2	1.0
August	5	14.0
September	7	39.0
October	9	98.5
November	5	20.5
December	4	12.5
2010		
January	6	41.5
February	5	5.5
March	5	15.5
April	11	17.0
Total (May 09 – Apr 10)	**69**	**273.5**

Table 1: Summary of Non-NIL LHD Occurrences and Duration

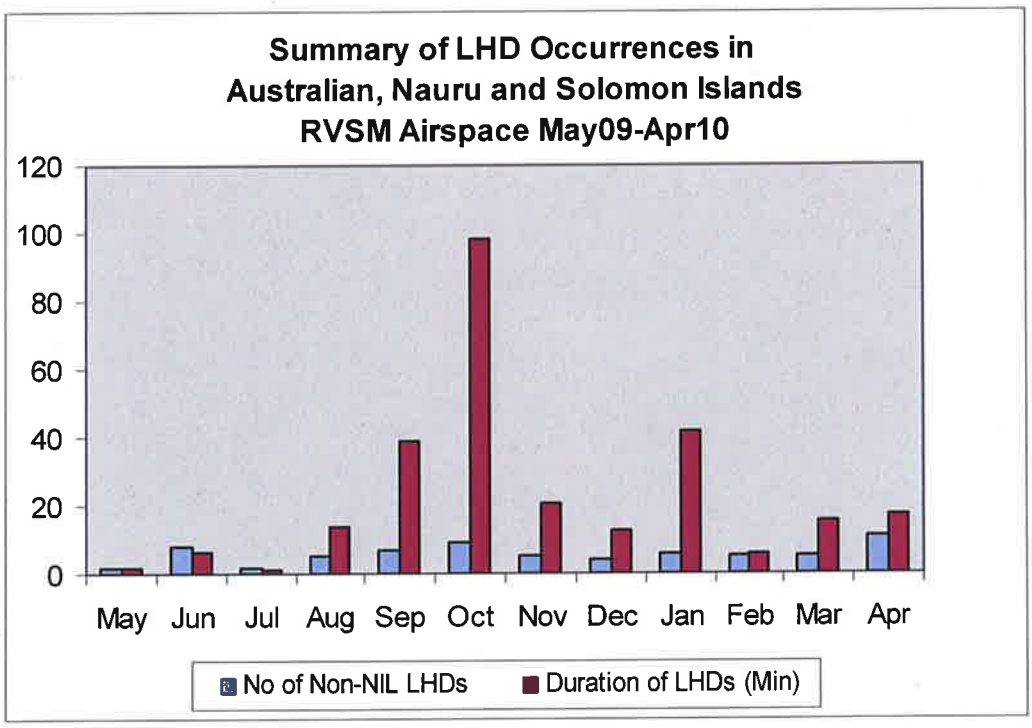


Figure 1: Summary of LHD Occurrences (by Month)

3.2 This month saw an increase in the duration of LHDs compared to the previous month while the monthly number of reports doubled from 5 to 11 (see Table 1 and Figure 1). A significant report of 8 minutes duration resulted from an aircraft descending to an incorrect level in the Tasman Sea area.

3.3 **Table 2** and **Figure 2** summarise the number of LHD occurrences, the associated LHD duration (in minutes) and number of flight levels crossed without clearance, by LHD category from 1 May 2009 inclusive.

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	12	18	6
B	Flight crew climbing/descending without ATC Clearance	5	11	2
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)	11	78	7
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)	27	101.5	26
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues	1	1	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	3	2	1
I	Deviation due to turbulence or other weather related cause	6	3	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)	3	57	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.	1	2	0
	Total (April 09 – March 10)	**69**	**273.5**	**42**

Table 2: Summary of LHD Occurrences and Duration by LHD Category

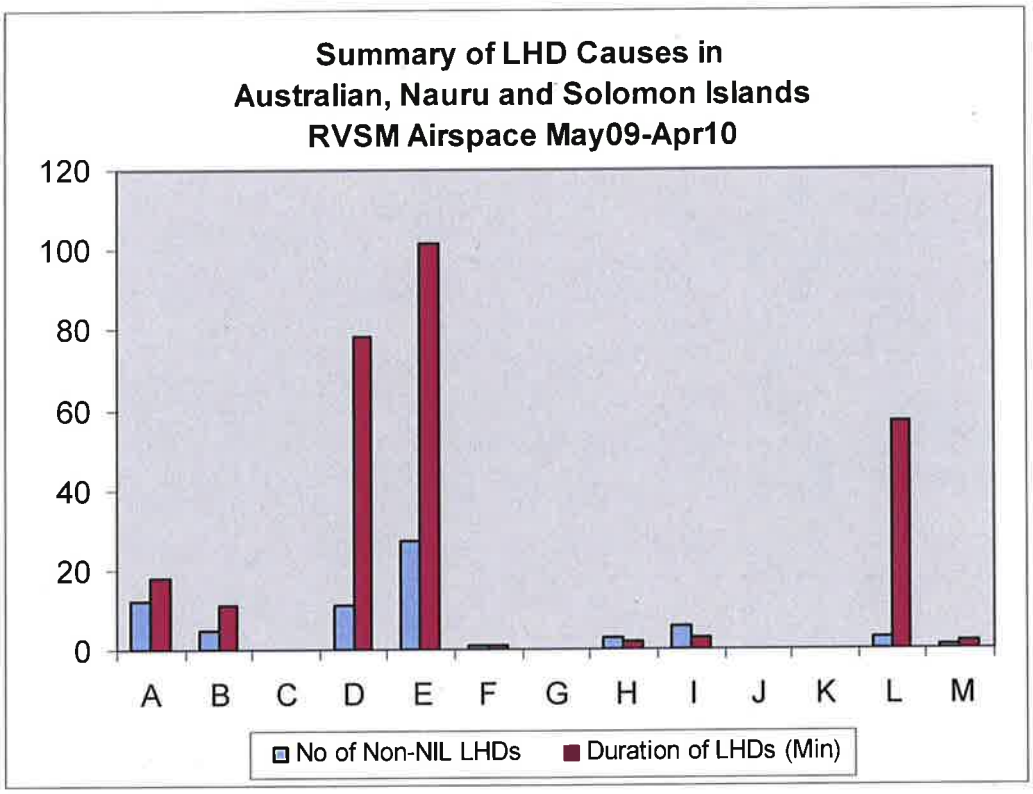


Figure 2: Summary of LHD Causes

3.4 There was an increase of 3 in the number of non-NIL LHDs for Category A . 'Flight crew failing to climb/descend the aircraft as cleared' during the month. Additionally LHDs resulting from turbulence or other weather events doubled from 3 to 6 but still had a low overall duration.

3.5 Three non-NIL Category A 'Flight crew failing to climb/descend the aircraft as cleared' report were assessed. One report was filed as ESIR 2010 2051 by UAS EAST and attributed to the pilot. The report identified the pilot incorrectly descended the aircraft to an uncleared level and maintained that level for a period of time following cancellation of a block level clearance.. The other two reports (ESIR 2010 2131 and 2010 2165) involved an aircraft operating outside of the cleared block levels; and an aircraft reporting within block levels after the block level clearance had been cancelled.

3.6 One Category B 'Flight crew climbing/descending without ATC Clearance' report was reported as ESIR 2010 2409 filed by BIGHT. The report involved an aircraft descending without a clearance to do so.

3.6 Three non-NIL reports of Category E 'Coordination Errors' were reported. One report was ESIR 2010 2178 of 2 minutes duration, reported by TOPS and attributed to ATS-FOREIGN. The report identified a failure of the Ujung Pandang FIR controller to coordinate correctly the level at which an aircraft was to cross the FIR boundary. Another report of one minute duration was ESIR 2010 2049, reported by TOPS and related to incorrect level coordination from the Port Moresby FIR controller. The final report was filed as ESIR 2010 1953 by UAS EAST and related to the Airservices controller not updating a CFL following coordination from Nadi.

3.7 Three non-NIL Category I 'Turbulence or other weather related causes' reports were assessed. Two of these reports were received from the ATSB and were each assessed as being of 0.5 minutes duration. One report occurred near NONIX waypoint and involved an aircraft climbing 500feet above its cleared flight level due turbulence. The second report occurred near EGORE waypoint in Northern Australia and involved an aircraft descending 400feet from its cleared flight level due to turbulence. No corresponding ESIRs have been identified to date although it is not known if these occurrences were reported to ATC by the pilots concerned. A third report was filed as ESIR 2010 2275 and reported by UAS EAST. The aircraft involved had descended 500feet.

4. Risk Assessment and Safety Oversight

4.1 This section updates the results of safety oversight for the RVSM implementation in the Australian airspace. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of the airspace.

4.2 A TSD of 4 weeks covering December 2009 and the LHD reports associated with the airspace during the period May 2009 to April 2010 (inclusive) are used to produce the risk estimates presented in this report.

4.3 **Estimate of the CRM Parameters.** The value and source material for estimating values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM) used to conduct the safety oversight for the RVSM airspace are summarized in **Table 3**.

Parameter	Description	Value
λ_x	Average aircraft length	0.0228 NM DOM (Uni-directional) 0.0279 NM DOM (Bi-directional) 0.0347 NM IND 0.0265 NM TAS (Uni-directional) 0.0253 NM TAS (Bi-directional)
λ_y	Average aircraft wingspan	0.0203 NM DOM (Uni-directional) 0.0253 NM DOM (Bi-directional) 0.0328 NM IND 0.0241 NM TAS (Uni-directional) 0.0227 NM TAS (Bi-directional)
λ_z	Average aircraft height	0.0069 NM DOM (Uni-directional) 0.008 NM DOM (Bi-directional) 0.0095 NM IND 0.0079 NM TAS (Uni-directional) 0.0075 NM TAS (Bi-directional)
$\overline{\lvert\Delta V\rvert}$	Average relative same-direction speed	28.4 kts DOM (Uni-directional) 20.8 kts DOM (Bi-directional) 17.5 kts IND 18.7 kts TAS (Uni-directional) 16.9 kts TAS (Bi-directional)
$\overline{\lvert V\rvert}$	Average aircraft speed	443.7 kts DOM (Uni-directional) 469.3 kts DOM (Bi-directional) 481.9 kts IND 456.7 kts TAS (Uni-directional) 460.5 kts TAS (Bi-directional)

Parameter	Description	Value
$\overline{\lvert\dot{y}\rvert}$	Average relative cross-track speed	13 kts
$\overline{\lvert\dot{z}\rvert}$	Average relative vertical speed during loss of vertical separation	1.5 kts if aircraft in level flight, 10 knots otherwise
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.355 DOM (Uni-directional) 0.412 DOM (Bi-directional) 0.492 IND 0.409 TAS (Uni-directional) 0.389 TAS (Bi-directional)

Table 3: Estimates of the Parameters in the CRM

4.4 **Safety Oversight for the RVSM implementation in Australian, Nauru and Solomon Islands Airspace**. The results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation are detailed in **Table 4**.

Australian, Nauru and Solomon Islands RVSM Airspace – estimated annual flying hours = 570,594.64 hours *(note: estimated hours based on December 2009 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.028×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	5.63×10^{-9}	-	-
Total Risk	**5.66×10^{-9}**	5.0×10^{-9}	**Above Overall TLS**

Table 4: Risk Estimates for the RVSM Implementation

4.5 In addition, **Figure 3** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports since 1 April 2009.

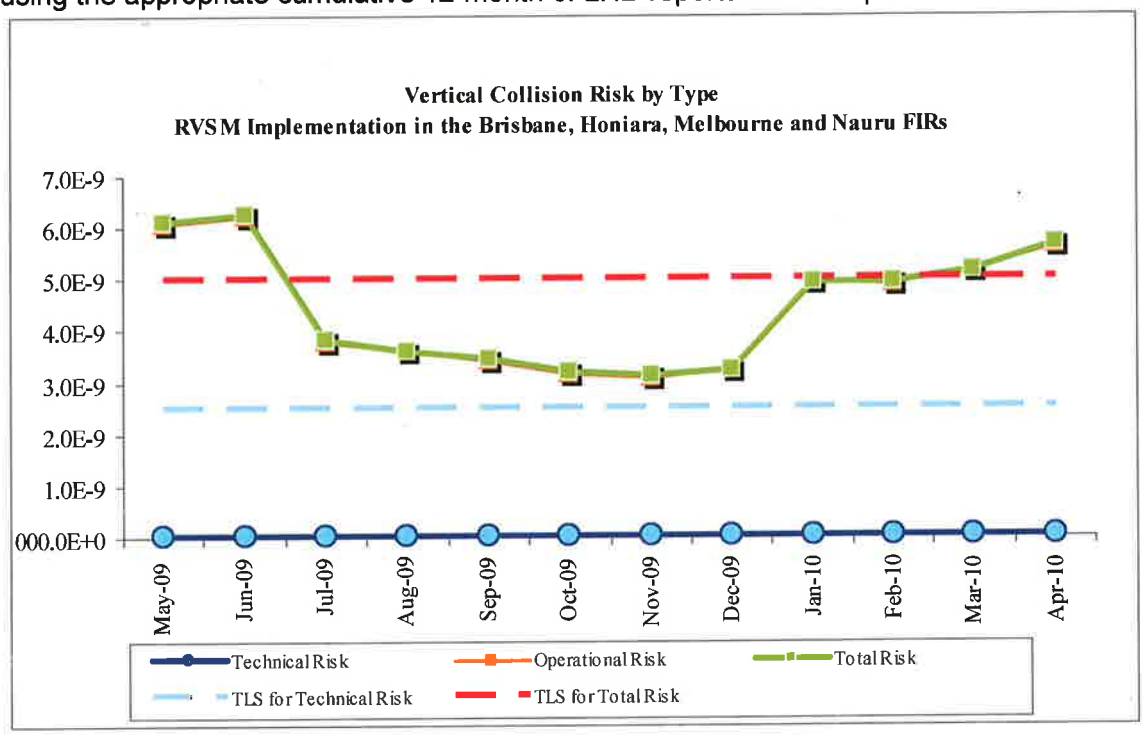


Figure 3: Trends of Risk Estimates for RVSM Airspace

4.6 The technical risk satisfies the agreed TLS value of no more than 2.5 x 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. As depicted in the graph above, **the operational and weighted total risk exceeds the specified TLS value** for these components of 5.0 x 10^{-9}.

4.7 The AAMA assesses LHD occurrences (specifically operational errors) in the Australian, Nauru, and Solomon Islands RVSM airspace from the perspective of individual occurrence contribution to total risk. Additionally a monthly risk value is determined in an attempt to provide real-time information on actual risk without reliance on historical high-time errors resident within the 12 month data sample. The data in Figure 4 below shows that the monthly risk for April 2010 has increased in comparison with the previous month, and is above the average monthly risk which gives an annual risk of 5.0 x 10^{-9} (red line in Figure 4 below). Reasons for the increase in monthly risk relate to the inclusion of a number of Category A, B and E type LHDs. These are explained in detail in section 3 above.

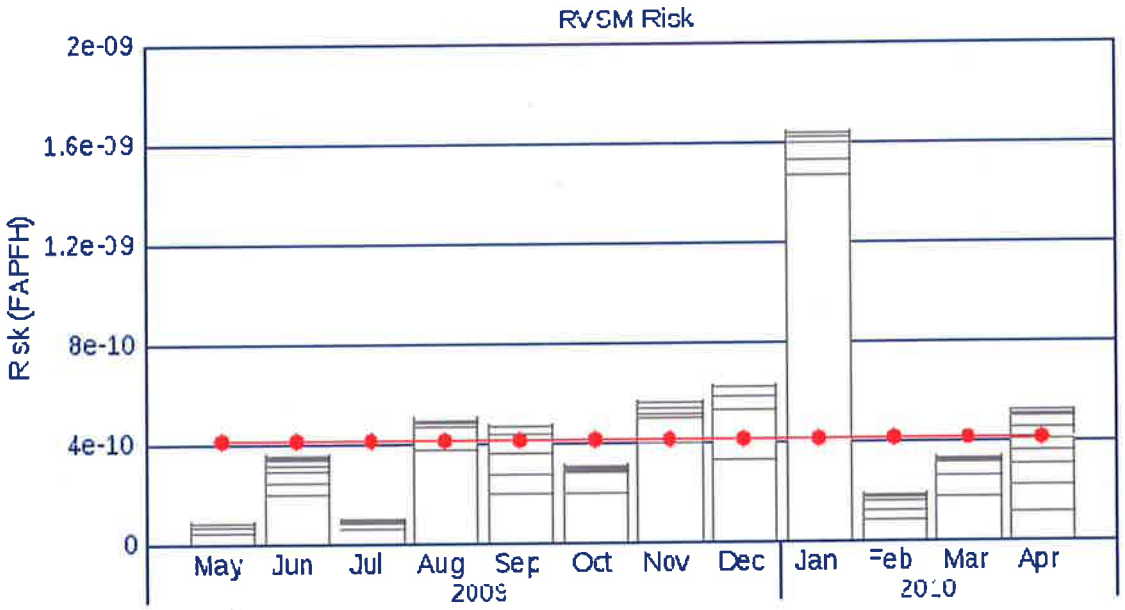


Figure 4: Monthly Risk Estimates for the Australian, Nauru and Solomon Islands RVSM Airspace.
Red line is the average monthly value for an annual risk of 5.0 x 10^{-9}. Risk is measure in Fatal Accidents per Flight Hour (FAPFH).

4.8 The graph shown at Figure 5 below indicates the risk contribution from each of the areas assessed by the AAMA for the Australian FIRs. The percentage distribution has increased for INDIAN from last month.

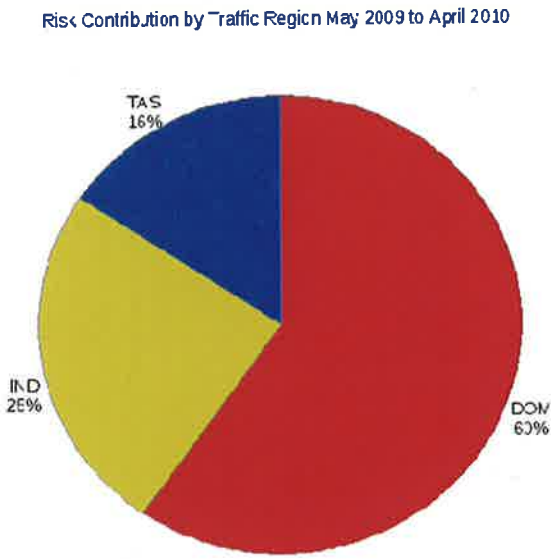


Figure 5: Risk Contribution by Traffic Region

5. Safety treatment of identified LHDs

5.1 Part of the assessment process should include a detailed review of specific operational errors by ANSPs with a view to identifying contributory factors and ensuring procedures and processes are implemented to reduce the likelihood of the same errors recurring. In the case of the Australian, Nauru and Solomon Islands airspace, the AAMA assessed operational errors identified through the Airservices Australia Electronic Safety Incident Reporting system and from aircraft operator reports, to identify the number of minutes that the errors were un-corrected. The total number of minutes calculated for the period 1 May 2009 to 30 April 2010 was 273.5 (an increase of 15 minutes) drawn from 69 assessed reports (see Table 1 above). Of the total calculated minutes, 211 minutes (78%) were credited to 15% of the LHDs assessed as being high time (5 mins or more duration) as detailed below.

ESIR	ERROR TIME ASSESSED	ESIR ATTRIBUTION
2009 3866 - MC	10	PILOT-FOREIGN REGISTERED AIRCRAFT
2009 4375 - BC	30	ATS-AUSTRALIAN MILITARY
2009 5053 - MC	12	ATS-AIRSERVICES
2009 5176 - MC	65	PILOT-FOREIGN REGISTERED AIRCRAFT
2009 5212 - MC	15	PILOT-AUSTRALIAN REGISTERED AIRCRAFT
2009 5769 - MC	15	ATS-FOREIGN
2009 6079 - BC	8	PILOT-FOREIGN

		REGISTERED AIRCRAFT
2010 0268 - BC	36	ATS-AIRSERVICES
2010 1790 - BC	12	ATS-FOREIGN
2010 2051 - BC	8	PILOT-AUSTRALIAN REGISTERED AIRCRAFT

Table 5: Assessed High-time LHD Occurrences

5.2 There was one high time report added to the assessment for April 2010. Details of this report are contained at paragraph 3.6 above.

5.3 Figure 6 provides a visual picture of the geographic location of all risk bearing (non-NIL) LHD reports within the rolling 12 month data set. Each report is identified as a red dot, with significant long duration reports identified as a red line showing approximate distance that equates to the assessed duration. The picture is intended to provide a means to identify specific risk hot spots related to RVSM operations.

5.4 For example the boundary between the Australian and Indonesian FIRs continues to show a number of reports, mostly all related to Category E coordination errors. The two reports in the south-west Indian Ocean area are attributed to pilot non-compliance. The high duration incident reported over off the east coast abeam Townsville and Cairns, indicated by the red line, resulted from a failure to coordinate a level change between 2 sectors, with the accepting controller not identifying the error. The high time report identified in Nauru airspace in March is identified as the red line in the Nauru FIR to the top right of the figure.

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References

[1] Anderson, D.H. *RVSM Safety Assessment for the Australian FIRs*, Airservices Australia, Research Environment & Training Services, 21September 1999.

[2] Summary of Pacific Reduced Vertical Separation Minimum (RVSM) Safety Assessment, Asia Pacific Approvals Registry and Monitoring Organization, December 2000.

[3] *Assurance of Safe Reduced Vertical Separation Minimum Implementation for Asia and Pacific Oceanic Airspace*, Appendix E to the Report of the Second Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF/2), Los Angeles, U.S.A, 1999.

[4] *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*, ICAO Doc 9574-AN/934, FIRST EDITION – 1992.

[5] Report of the Third Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF/3), Honolulu, U.S.A, May 1999.

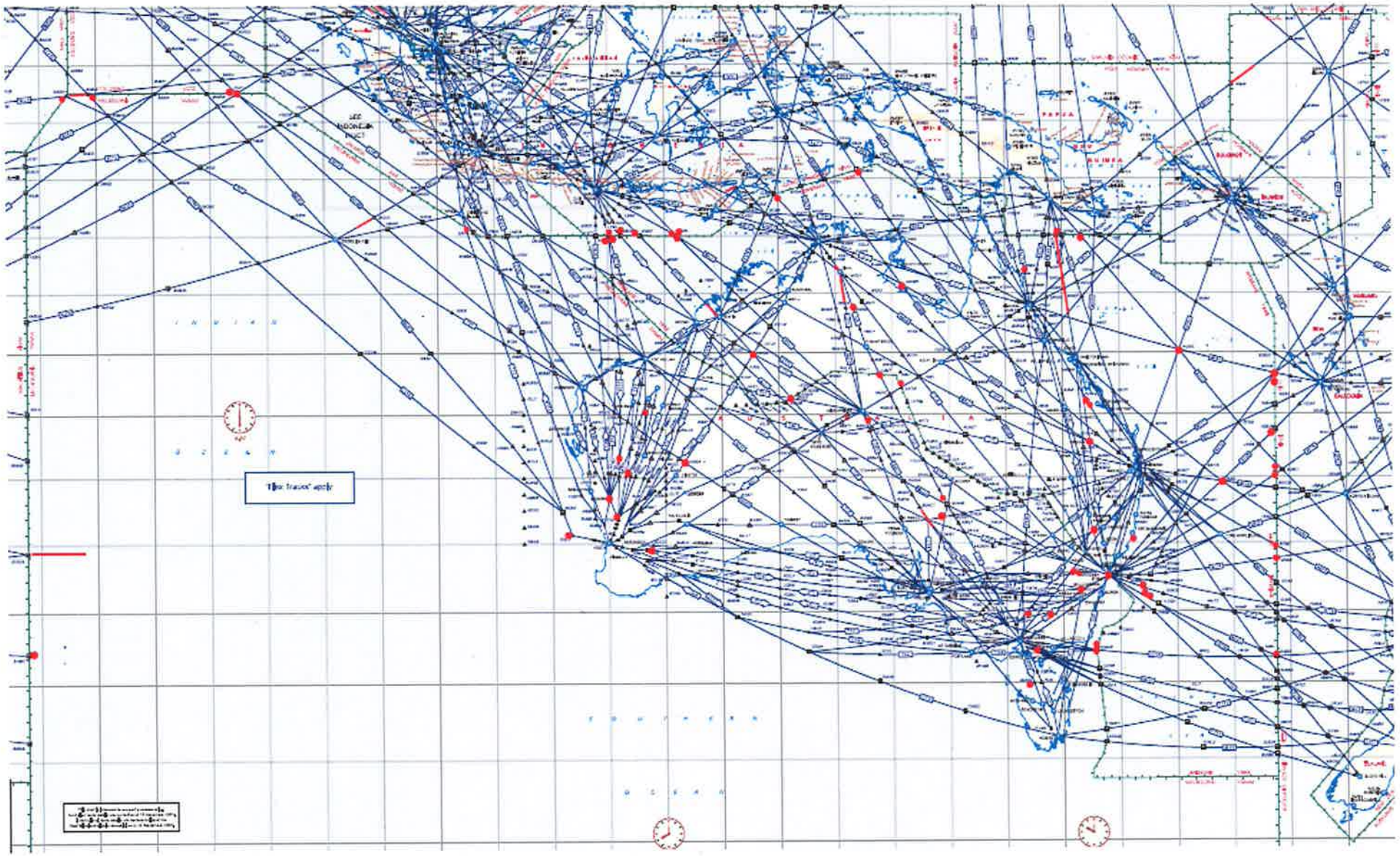


Figure 6: Brisbane, Honiara, Melbourne and Nauru FIRs – Risk Bearing (Non-NIL) RVSM Large Height Deviations May 2009 – April 2010

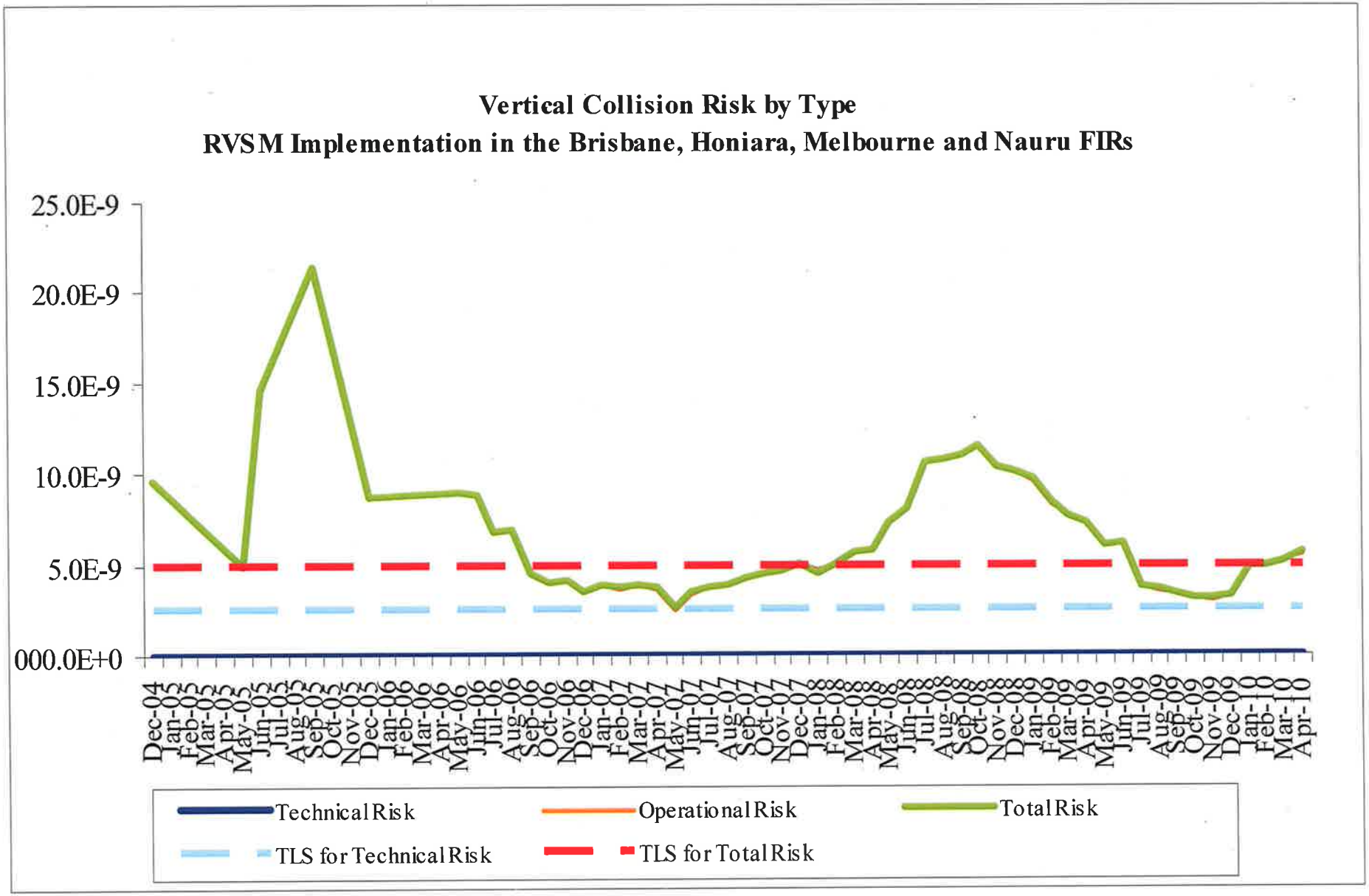


Figure 7: **Brisbane, Honiara, Melbourne and Nauru FIRs – Vertical Collision Risk (December 2004 – April 2010)**

AIRSERVICES AUSTRALIA

AUSTRALIAN AIRSPACE MONITORING AGENCY (AAMA)

SAFETY & ENVIRONMENT GROUP

SAFETY SYSTEMS, RISK & ANALYSIS

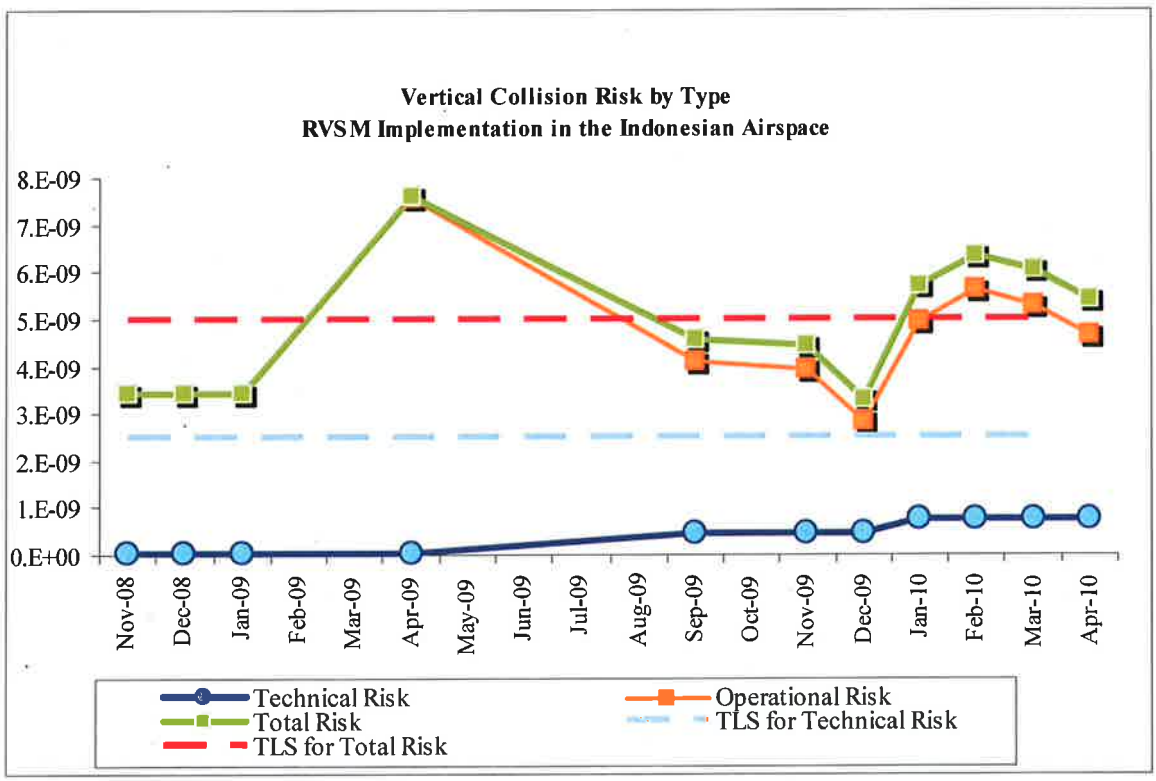
Operational Analysis

Airspace Safety Review of the RVSM Implementation in Indonesian Airspace May 2009 to April 2010

Role	Name and Position	Signature and Date
Prepared By	Robert Butcher Operational Analysis Manager & Dr Geoff Aldis Quantitative Modelling Manager	7/6/2010 GAldis 7/6/2010
Endorsed	Dr Claire Marrison Manager, Safety Systems Risk and Analysis	Claire Marrison 7.6.2010

Executive Summary

For the period 1 May 2009 to 30 April 2010, the technical risk satisfies the agreed TLS value of no more than 2.5 x 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. As depicted in the graph below, **the operational and weighted total risk of 5.43 x 10^{-9} does not meet the specified TLS value** for these components of 5.0 x 10^{-9}.



AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN INDONESIAN AIRSPACE – MAY 2009 TO APRIL 2010

Prepared by

Australian Airspace Monitoring Agency (AAMA) - *June 2010*

(An APANPIRG approved Regional Monitoring Agency)

1. Introduction

This report provides the summary of airspace safety oversight for the post RVSM implementation in the Asia Pacific Region, focusing on the **Indonesian airspace,** i.e. the total areas of the Jakarta and Ujung Pandang FIRs. The RVSM safety oversight is conducted based on a one-month traffic sample data (TSD) collected in **December 2009** and monthly Large Height Deviation (LHD) reports between **May 2009 and April 2010**.

2. Data Submission

2.1. Traffic Sample Data (TSD)

Traffic Sample data for the month of December 2009 of aircraft operating in the Indonesian airspace was used to assess the safety of RVSM airspace.

2.2. Large Height Deviation (LHD)

A series of cumulative 12-months of LHD reports were used in this safety assessment starting from May 2009 to April 2010. A number of LHDs were received from the Indonesian Air Navigation Service Providers. The AAMA continues to work with the Indonesian authorities to improve the reporting of operational errors and large height deviations.

Additionally the AAMA had access to a number of reports provided by Australia that included possible risk bearing LHDs relative to the Jakarta and Ujung Pandang FIRs. Assessment of these reports was made from the perspective of their impact within the Indonesian airspace.

3. Summary of LHD Occurrences in Indonesian Airspace

Table 1 and **Figure 1** summarise the number of LHD occurrences and associated LHD duration (in minutes) by month since May 2009 inclusive. The data is the total number of non-NIL LHDs assessed.

Month-Year	No. of Non-NIL LHD Occurrences	LHD Duration (Min)
2009		
May	3	4.0
June	1	1.0
July	0	0.0
August	2	2.0
September	1	2.0
October	0	0.0
November	1	3.0
December	0	0.0
2010		
January	0	0.0
February	0	0.0
March	1	15.0
April	2	2.0
Total (May09 – Apr10)	**11**	**29.0**

Table 1: Summary of Non-NIL LHD Occurrences and Duration in Indonesian RVSM Airspace

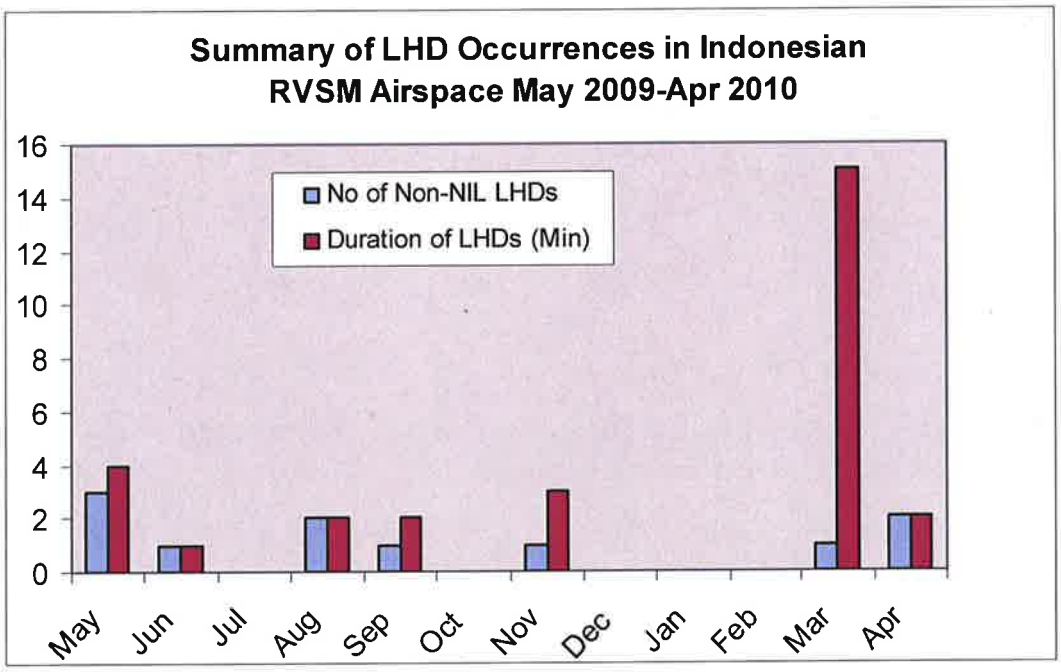


Figure 1: Summary of LHD Occurrences (by Month) in the Indonesian RVSM Airspace

Table 2 and **Figure 2** summarise the number of LHD occurrences and associated LHD duration (in minutes) by LHD category from 1 May 2009 inclusive. Attachment 1 provides specific detail of the LHDs used in the assessment.

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)
A	Flight crew failing to climb/descend the aircraft as cleared	1	2.0
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)	9	12.0
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)	1	15.0
M	Other – this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to	0	0.0

	establish normal air-ground communications with the responsible ATS unit.		
	Total (May 09 – April 10)	**11**	**29.0**

Table 2: Summary of LHD Occurrences and Duration by LHD Category in Indonesian RVSM Airspace

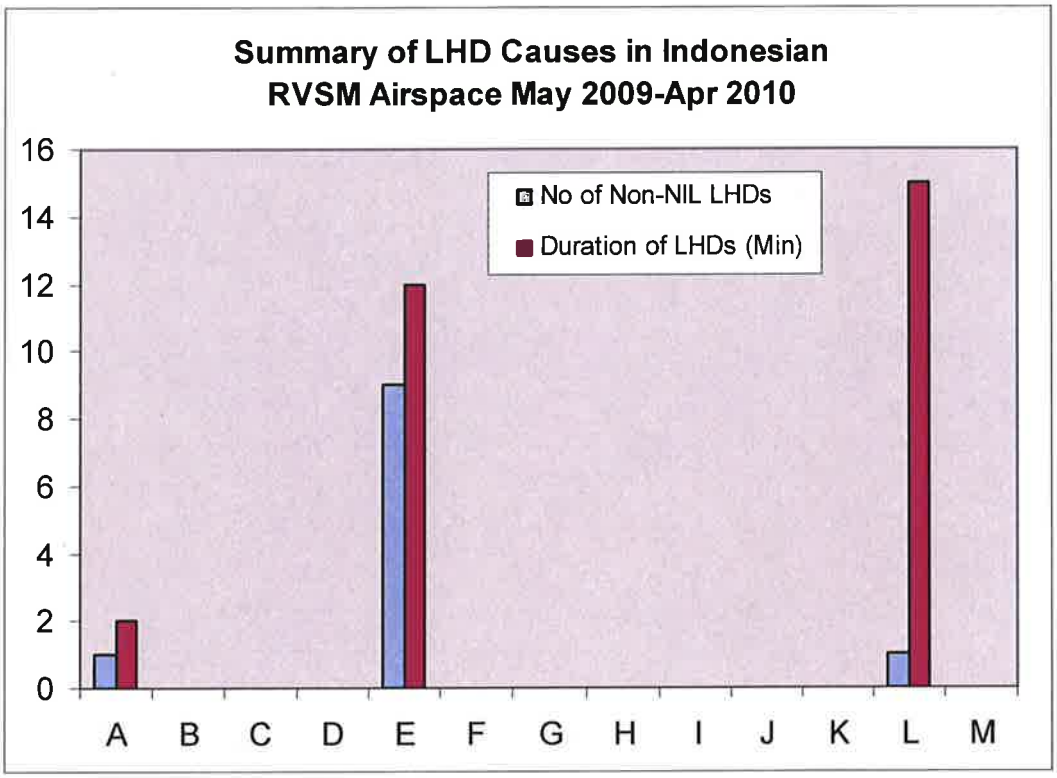


Figure 2: Summary of LHD Causes in the Indonesian RVSM Airspace

In light of the above, the non-nil LHD occurrences in the Indonesian RVSM airspace are summarised as follows:

- The spike identified in Figure 1 for March represents a single Category L LHD with a total duration of 15 minutes. This is a significant change from the previous months report where two L category LHDs were included in the data set with a cumulative total duration of 60 minutes.

- Nine Category E – ATC coordination error reports were identified in the 12 month data sample. Seven of these reports related to coordination errors between Jakarta and Makassar ACCs. Two other reports related to coordination errors from Brisbane FIR and had an assessed duration of one minute each.

- One Category A report– 'Flight crew failing to climb or descend the aircraft as cleared', was assessed in the data sample. This report was identified in the Australian incident data and related to an aircraft failing to meet a level requirement prior to transfer to Ujung FIR. The risk was assessed inside the Ujung FIR as a duration of 2 minutes.

- Three Category J reports – 'TCAS resolution advisory' were assessed. Of significance is the fact that these reports all related to the same incident near

Ambon in February 2010, and were risk assessed on the basis of the number of levels crossed without clearance. These reports added significantly to the risk calculated for the airspace.

4. Risk Assessment and Safety Oversight

This section updates the results of safety oversight for the RVSM implementation in the Indonesian airspace. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of the airspace. The Traffic Sample Data (TSD) of December 2009 and the LHD reports associated with the airspace during the period May 2009 to April 2010 (inclusive) are used to produce the risk estimates presented in this report.

4.1. Estimate of the CRM Parameters

Table 3 summarises the value and source material for estimating values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM) used to conduct the safety oversight for the RVSM airspace.

Parameter	Description	Value
λ_x	Average aircraft length	0.0257 NM (JAK) 0.0243 NM (UJU)
λ_y	Average aircraft wingspan	0.0231 NM (JAK) 0.0216 NM (UJU)
λ_z	Average aircraft height	0.0076 (JAK) 0.0072 (UJU)
$\overline{\lvert\Delta V\rvert}$	Average relative same-direction speed	18.3 kts (JAK) 42.3 kts (UJU)
$\overline{\lvert V\rvert}$	Average aircraft speed	439.2 kts (JAK) 435.5 kts (UJU)
$\overline{\lvert\dot{y}\rvert}$	Average relative cross-track speed	13 kts
$\overline{\lvert\dot{z}\rvert}$	Average relative vertical speed during loss of vertical separation	1.5 kts if aircraft in level flight, 10 knots otherwise
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.35863 (JAK) 0.42255 (UJU)

Table 3: Estimates of the Parameters in the CRM

4.2. Safety Oversight for the RVSM implementation in Indonesian Airspace

Table 4 summarises the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation in the Indonesian airspace.

Indonesian RVSM Airspace – estimated annual flying hours = 537625.57 hours ***(note: estimated hours based on Dec 2009 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.761×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	4.67×10^{-9}	-	-
Total Risk	**5.43 x 10-9**	5.0×10^{-9}	**Above Overall TLS**

Table 4: Risk Estimates for the RVSM Implementation in Indonesian Airspace

Figure 3 below presents the trends of collision risk estimates for the period from November 2008 to end of April 2010.

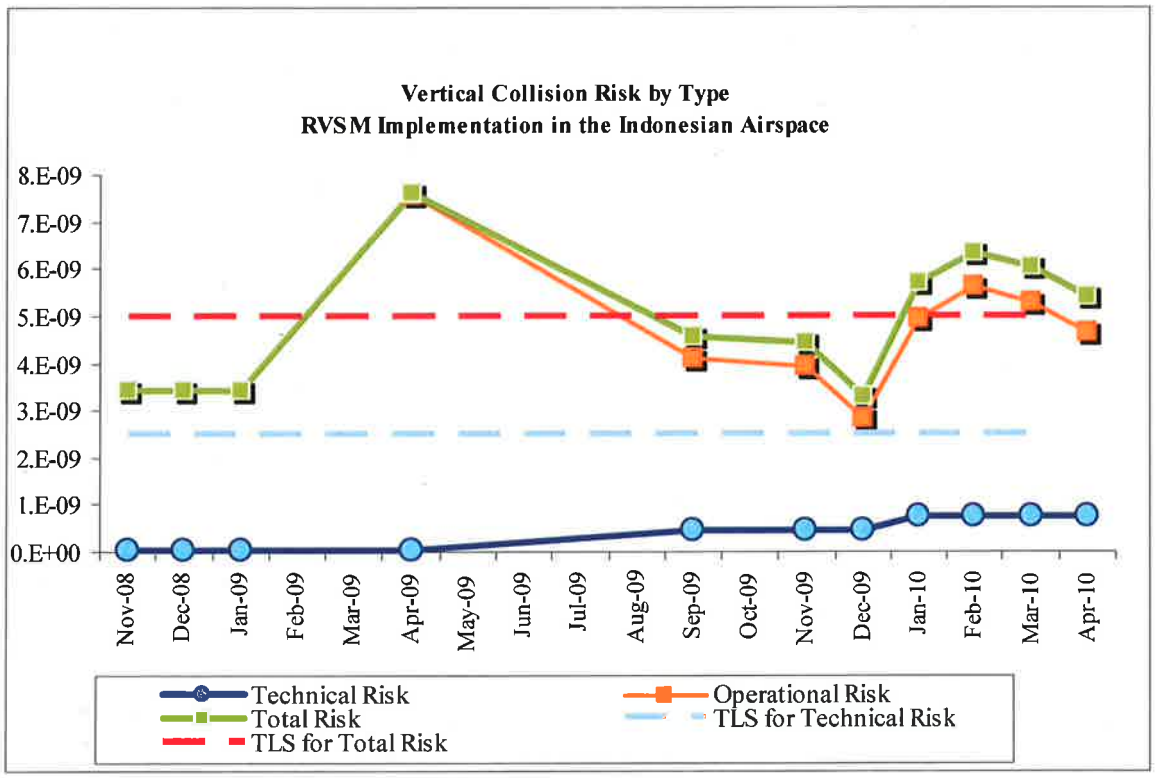


Figure 3: Trends of Risk Estimates for the Indonesian RVSM Airspace

Based on these collision risk estimates, the technical risk satisfies the agreed TLS value of no more than 2.5 x 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. As depicted in table 4 above, **the operational and weighted total risk does not meet the specified TLS value** for these components of 5.0 x 10^{-9}.

The observed decrease in risk this month was directly related to the deletions of long duration LHD (45 minutes) from the data sample. The risk still remains in excess of the TLS, primarily as a result of the three Category J – 'TCAS resolution advisory' reports that together added significantly to the calculated risk. Additionally, the traffic sample data provided to the AAMA for the month of December 2009 and used in the calculations reflected a significant increase in total flight hours and an increase in calculated passing frequencies. The AAMA has received a revised TSD for the Jakarta FIR and, as this is yet to be validated and used in the risk calculations it is unknown what effect this new data will have on the calculated risk.

5. Safety treatment of identified LHDs

5.1 Part of the assessment process should include a detailed review of specific operational errors by ANSPs with a view to identifying contributory factors and putting in place procedures and processes to reduce the likelihood of the same errors recurring. In the case of the Indonesian FIRs, the AAMA assessed LHDs forwarded to it by Indonesian ANSPs, and the Airservices Australia Electronic Safety Incident Reporting system.

5.2 Figure 4 provides a visual picture of the geographic location of all risk bearing (non-NIL) LHD reports within the rolling 12 month data set. Each report included in LHD reports

filed by Indonesian ANSPs is identified as a red dot. Additional risk bearing reports used by the AAMA, such as reported by Airservices Australia, are identified in purple. Significant long duration reports (identified as either a red or purple line) show the approximate distance that equates to the assessed duration. The picture is intended to provide a means to identify specific risk hot spots related to RVSM operations.

5.3 The cluster of LHDs located centrally at the boundary between the Jakarta and Ujung Pandang FIRs represents a number of risk bearing reports all related to Category E (coordination errors). Three LHDs reported in the Airservices Australia incident reporting system are shown in purple and are located adjacent to the boundary between the Ujung Pandang and Brisbane FIRs. These incidents relate to one where a flight crew did not climb the aircraft in accordance with the coordinated clearance, where coordination from the Brisbane FIR was in error, and where an aircraft without RVSM approval had been assumed to be RVSM approved within the Indonesian FIRs through incorrect flight plan data. All of the these particular LHDs were assessed by the AAMA as being risk bearing within the Indonesian FIRs however no complementary LHD reports were identified within the reports provided by Indonesian ANSPs.

5.4 The incident identified in red over Ambon represents three inter-related TCAS RA incidents described elsewhere in this report. An additional incident reported by Ujung near KIKEM was the result of incorrect coordination provided by Brisbane.

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References

[1] Anderson, D.H. *RVSM Safety Assessment for the Australian FIRs*, Airservices Australia, Research Environment & Training Services, 21September 1999.

[2] Summary of Pacific Reduced Vertical Separation Minimum (RVSM) Safety Assessment, Asia Pacific Approvals Registry and Monitoring Organization, December 2000.

[3] *Assurance of Safe Reduced Vertical Separation Minimum Implementation for Asia and Pacific Oceanic Airspace*, Appendix E to the Report of the Second Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF/2), Los Angeles, U.S.A, 1999.

[4] *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*, ICAO Doc 9574-AN/934, FIRST EDITION – 1992.

[5] Report of the Third Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF/3), Honolulu, U.S.A, May 1999.

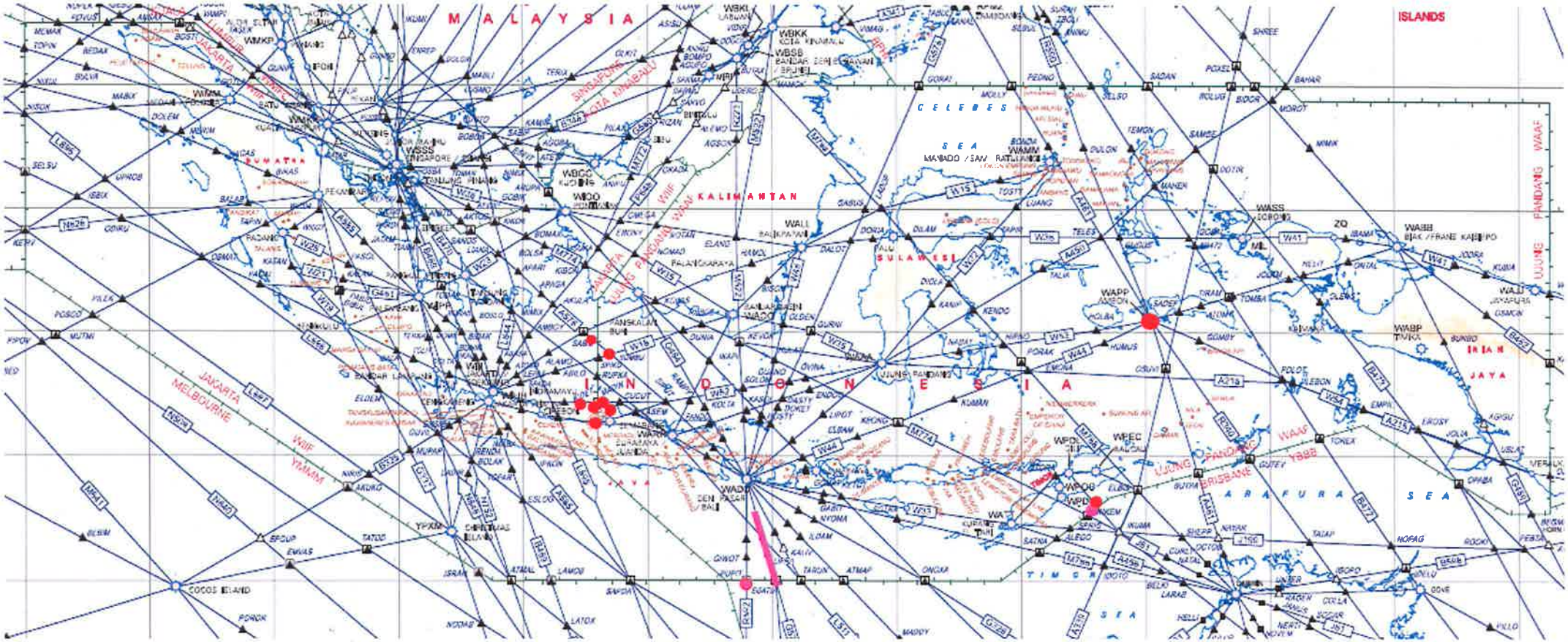

Figure 4: Jakarta and Ujung Pandang FIRs – Risk Bearing (Non-NIL) RVSM Large Height Deviations May 2009 – April 2010

AIRSERVICES AUSTRALIA

AUSTRALIAN AIRSPACE MONITORING AGENCY (AAMA)

SAFETY & ENVIRONMENT GROUP

SAFETY SYSTEMS, RISK & ANALYSIS

Operational Analysis

Airspace Safety Review of the RVSM Implementation in Papua New Guinea Airspace May 2009 to April 2010

Role	Name and Position	Signature and Date
Prepared By	Robert Butcher Operational Analysis Manager & Dr Geoff Aldis Quantitative Modelling Manager	28/7/10 28/7/10
Endorsed	Dr Claire Marrison Manager, Safety Systems Risk and Analysis	28.7.10

Executive Summary

For the period 1 May 2009 to 30 April 2010, the technical risk satisfies the agreed TLS value of no more than 2.5 x 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. As depicted in the graph below, **the operational and weighted total risk of 2.15 x 10^{-9} meets the specified TLS value** for these components of 5.0 x 10^{-9}.

AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN PAPUA NEW GUINEA AIRSPACE – MAY 2009 TO APRIL 2010

Prepared by

Australian Airspace Monitoring Agency (AAMA) - *July 2010*

(An APANPIRG approved Regional Monitoring Agency)

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1. Introduction

This report provides the summary of airspace safety oversight for the post RVSM implementation in the Asia Pacific Region, focusing on the **Papua New Guinea airspace,** i.e. the total areas of the Port Moresby FIR. The RVSM safety oversight is conducted based on a one-month traffic sample data (TSD) collected in **December 2007** and monthly Large Height Deviation (LHD) reports between **May 2009 and April 2010**.

2. Data Submission

2.1. Traffic Sample Data (TSD)

Traffic Sample data for the month of December 2007 of aircraft operating in the Papua New Guinea airspace was used to assess the safety of RVSM airspace. More recent data has been made available but quality issues with the data have meant it is currently not available for processing. These issues will be further explored and resolved by the AAMA in conjunction with Papua New Guinea.

2.2. Large Height Deviation (LHD)

A series of cumulative 12-months of LHD reports were used in this safety assessment starting from May 2009 to April 2010. No LHDs have been received from the Papua New Guinea Air Navigation Service Provider. The AAMA continues to work with the State authorities to improve the reporting of operational errors and large height deviations.

Additionally the AAMA had access to reports provided by Australia that included possible risk bearing LHDs relative to the Port Moresby FIR. Assessment of these reports was made from the perspective of their impact within the Papua New Guinea airspace.

3. Summary of LHD Occurrences in Indonesian Airspace

Table 1 and **Figure 1** summarise the number of LHD occurrences and associated LHD duration (in minutes) by month since May 2009 inclusive. The data is the total number of non-NIL LHDs assessed.

Month-Year	No. of Non-NIL LHD Occurrences	LHD Duration (Min)
2009		
May	0	0.0
June	0	0.0
July	0	0.0
August	0	0.0
September	0	0.0
October	0	0.0
November	0	0.0
December	0	0.0
2010		
January	1	2.0
February	0	0.0
March	0	0.0
April	0	0.0
Total (May09 – Apr10)	**1**	**2.0**

Table 1: Summary of Non-NIL LHD Occurrences and Duration in Indonesian RVSM Airspace

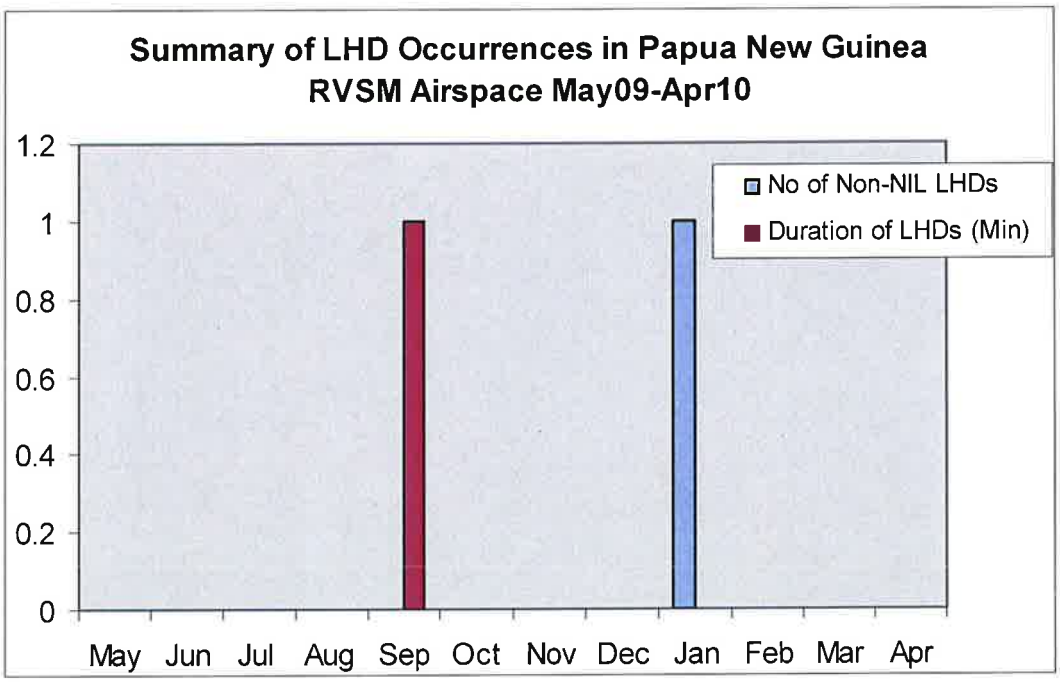

Figure 1: Summary of LHD Occurrences (by Month) in the Papua New Guinea RVSM Airspace

Table 2 and **Figure 2** summarise the number of LHD occurrences and associated LHD duration (in minutes) by LHD category from 1 May 2009 inclusive. Attachment 1 provides specific detail of the LHDs used in the assessment.

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)
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)	1	2.0
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	0	0.0

	communications with the responsible ATS unit.		
	Total (May 09 – April 10)	**1**	**2.0**

Table 2: Summary of LHD Occurrences and Duration by LHD Category in Papua New Guinea RVSM Airspace

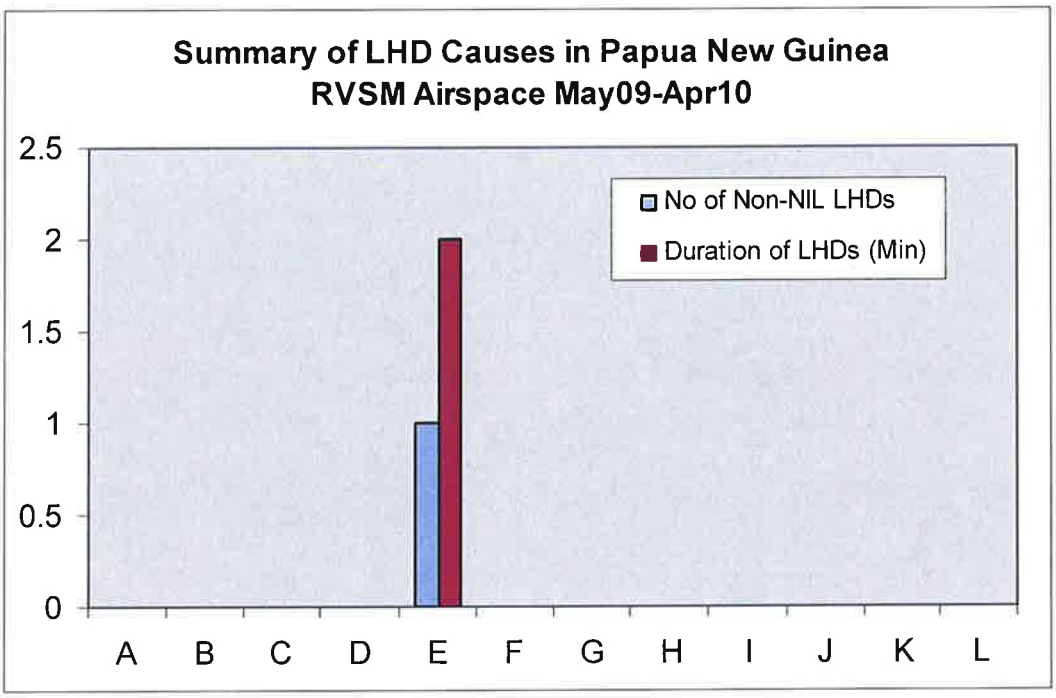

Figure 2: Summary of LHD Causes in Papua New Guinea RVSM Airspace

In light of the above, the non-nil LHD occurrences in the Papua New Guinea RVSM airspace are summarised as follows:

- The only non-NIL LHD report identified to the AAMA was a Category E report– 'Coordination errors in the ATC-to-ATC transfer of control responsibility'. This report was identified in the Australian incident data and related to an Brisbane ATC failing to provide the correct level coordination for an aircraft transferring to Port Moresby control. The risk was assessed inside the Port Moresby FIR as a duration of 2 minutes.

4. Risk Assessment and Safety Oversight

This section updates the results of safety oversight for the RVSM implementation in the Papua New Guinea airspace. Accordingly, the internationally accepted collision risk methodology is applied in assessing the safety of the airspace. The Traffic Sample Data (TSD) of December 2007 and the LHD reports associated with the airspace during the period May 2009 to April 2010 (inclusive) are used to produce the risk estimates presented in this report.

4.1. Estimate of the CRM Parameters

Table 3 summarises the value and source material for estimating values for each of the inherent parameters of the internationally accepted Collision Risk Model (CRM) used to conduct the safety oversight for the RVSM airspace.

Parameter	Description	Value
λ_x	Average aircraft length	0.0230 NM (Uni-Directional) 0.0286 NM (Bi-Directional)
λ_y	Average aircraft wingspan	0.021 NM (Uni-Directional) 0.0261 NM (Bi-Directional)
λ_z	Average aircraft height	0.0067 (Uni-Directional) 0.0079 (Bi-Directional)
$\overline{\lvert\Delta V\rvert}$	Average relative same-direction speed	26.84 kts (Uni-Directional) 22.0 kts (Bi-Directional)
$\overline{\lvert V\rvert}$	Average aircraft speed	462.6 kts (Uni-Directional) 462.86 kts (Bi-Directional)
$\overline{\lvert\dot{y}\rvert}$	Average relative cross-track speed	13 kts
$\overline{\lvert\dot{z}\rvert}$	Average relative vertical speed during loss of vertical separation	1.5 kts if aircraft in level flight, 10 knots otherwise
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.359 (Uni-directional) 0.423 (Bi-Directional)

Table 3: Estimates of the Parameters in the CRM

4.2. Safety Oversight for the RVSM implementation in Papua New Guinea Airspace

Table 4 summarises the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation in the Indonesian airspace.

PNG RVSM Airspace – estimated annual flying hours = 19170.66 hours ***(note: estimated hours based on Dec 2007 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.0264×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	2.13×10^{-9}	-	-
Total Risk	**2.15 x 10-9**	5.0×10^{-9}	**Below Overall TLS**

Table 4: Risk Estimates for the RVSM Implementation in Indonesian Airspace

Based on these collision risk estimates, the technical risk satisfies 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. As depicted in table 4 above, **the operational and weighted total risk meets the specified TLS value** for these components of 5.0×10^{-9}.

Due to the quality of the most recent (December 2009) TSD necessitating the AAMA to rely on the December 2007 TSD, and concerns regarding the availability of LHD reporting within the Port Moresby FIR, the AAMA has serious doubts as to the validity of the risk estimate determined above. The AAMA will work with the ANSP to resolve these issues and is confident this can be achieved in the short-term.

References

[1] Anderson, D.H. *RVSM Safety Assessment for the Australian FIRs*, Airservices Australia, Research Environment & Training Services, 21September 1999.

[2] Summary of Pacific Reduced Vertical Separation Minimum (RVSM) Safety Assessment, Asia Pacific Approvals Registry and Monitoring Organization, December 2000.

[3] *Assurance of Safe Reduced Vertical Separation Minimum Implementation for Asia and Pacific Oceanic Airspace*, Appendix E to the Report of the Second Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF/2), Los Angeles, U.S.A, 1999.

[4] *Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive*, ICAO Doc 9574-AN/934, FIRST EDITION – 1992.

[5] Report of the Third Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF/3), Honolulu, U.S.A, May 1999.