



International Civil Aviation Organization

The Twenty-First Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/21)

Bangkok, Thailand, 14-17 June 2016

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

AAMA VERTICAL SAFETY REPORT

(Presented by Australia)

SUMMARY

This paper presents the results of safety assessments undertaken by the Australian Airspace Monitoring Agency (AAMA) for the twelve month period ending 31 December 2015 for the Brisbane, Honiara, Melbourne, Nauru and Port Moresby FIRs. In addition results are provided for the Indonesian airspace of Jakarta and Ujung Pandang FIRs.

1. INTRODUCTION

1.1 This paper provides details of the airspace safety oversight assessment undertaken by the AAMA for the RVSM implementations in the Australian, Indonesian, Nauru, Papua New Guinea and Solomon Islands airspace. The full reports are detailed in **Attachments 1 and 2**.

2. DISCUSSION

2.1 The report shows that for the Australian, Nauru, Papua New Guinea and Solomon Islands airspace, the target level of safety (TLS) was not met by a small margin. For the Indonesian airspace the TLS was met.

2.2 The reporting of LHDs to the AAMA by Indonesia was problematic over the twelve-month period, with significant delays being experienced in reports reaching the AAMA. Additionally, the AAMA observed what appeared to have been a reduction in reporting compared to previous years which could not be explained. As a result, the AAMA was unable to effectively validate monthly assessments with any confidence. This situation has been the subject of direct coordination between the AAMA and the Indonesian authorities and the reporting culture seems to have improved, during 2016 particularly since the introduction of AirNav Indonesia's new reporting application.

2.3 In the Australian, Nauru, Papua New Guinea and Solomon Islands airspace, there have been a total of 36 occurrences of pilots climbing or descending an aircraft not in accordance with the clearance (n=18) or without a clearance (n=18). The occurrences involved a range of operators and locations and there does not appear to be any underlying common factor. The AAMA notes that the number of Category A and B LHDs represents an increase of 8 as reported for the 2014 year.

2.4 Seven Category D (ATC System Loop Errors) were reported in the 12-month period. Of these 5 were attributed to ATC error and of these 3 related to a controller not confirming or correcting an incorrect flight level read-back by flight crew, or providing a clearance to the wrong aircraft. Eleven Category E (ATC Coordination error) reports were assessed. Of the 11 reports, 8 were the result of incorrect flight levels being coordinated; 2 related to no coordination being provided with one occurrence resulting in the aircraft climbing to FL410; and 1 related to a controller providing an incorrect read-back of level coordination that was not picked up by the other sector controller.

2.5 One Category L (An aircraft being provided with RVSM separation is not RVSM approved) report was assessed. This report involved an aircraft operating in RVSM airspace with flight plan showing RVSM approval, but latterly reporting negative RVSM. At this time the aircraft was laterally in conflict with an aircraft that was also 1000ft above. The duration of the occurrence was determined to be 48 minutes.

2.6 Two other long duration occurrences were reported, both Category M – Other. In one report of 20 minutes duration, a controller incorrectly updated the cleared flight level information which resulted in system information that did not match the coordinated and cleared flight level of an aircraft. The error was only identified when the aircraft entered surveillance. In the second occurrence of 29 minutes duration, a B52 entered the Melbourne FIR at a position significantly different to the coordinated point and operated without communication within the RVSM flight levels.

2.7 A review of the types of LHDs assessed for Indonesian airspace shows a number of Category E Coordination errors related to incorrect waypoint or flight level. The number of Cat E LHDs reported over the year was four which compares to the 25 reports in the previous year.

2.8 Six non-nil Category A (Flight Crew Failing to climb/descend the aircraft as cleared) LHDs were reported in the 12-month sample. Five were assessed in terms of levels crossed with one having crossed 2 flight levels. One report had a duration estimated at 0.5 minutes.

2.9 There was only one non-nil Category D (ATC loop error) LHD reported which was the result of an ATC instruction to descend triggering a TCAS RA.

2.10 Two Category J (TCAS resolution advisory) reports were received. Both resulted in the pilots taking correct action.

Executive Summary

2.11 **Table 1** summarizes Australian, Nauru, Papua New Guinea and Solomon Islands airspace RVSM technical, operational, and total risks. **Figure 1** presents collision risk estimate trends during the period from 1January 2015 to 31December 2015.

Australian, Nauru, Papua New Guinea and Solomon Islands Airspace – estimated annual flying hours = 821,496 hours <i>(note: estimated hours based on Dec 2014 traffic sample data)</i>			
Source of Risk	Risk Estimation	TLS	Remarks
<i>RASMAG 20 Total Risk</i>	3.01×10^{-9}	5.0×10^{-9}	<i>Below TLS</i>
Technical Risk	0.0303×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	5.19×10^{-9}	-	-
Total Risk	5.22×10^{-9}	5.0×10^{-9}	Above TLS

Table 1: Australian, Nauru, Papua New Guinea and Solomon Islands Airspace RVSM Risk Estimates

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Figure 1: Australian, Nauru, Papua New Guinea and Solomon Islands Airspace RVSM Risk Estimate Trends

2.12 **Table 2** presents a summary of the LHD causes within Australian, Nauru, Papua New Guinea and Solomon Islands airspace from 1 January 2014 until 31 December 2014.

Code	LHD Category Description	No.
A	Flight crew fails to climb or descend the aircraft as cleared	18
B	Flight crew climbing or descending without ATC clearance	18
C	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	7
E	ATC transfer of control coordination errors due to human factors	11
F	ATC transfer of control coordination errors due to technical issues	0
G	Aircraft contingency leading to sudden inability to maintain level	4
H	Airborne equipment failure and unintentional or undetected level change	1
I	Turbulence or other weather related cause	8
J	TCAS resolution advisory and flight crew correctly responds	1
K	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	1
M	Other	3
Total		72

Table 2: Summary of LHD Causes within Australian, Nauru, Papua New Guinea and Solomon Islands Airspace

2.13 **Figure 2** provides the geographic location of risk bearing LHD reports within Australian, Nauru, Papua New Guinea and Solomon Islands Airspace during the assessment period.

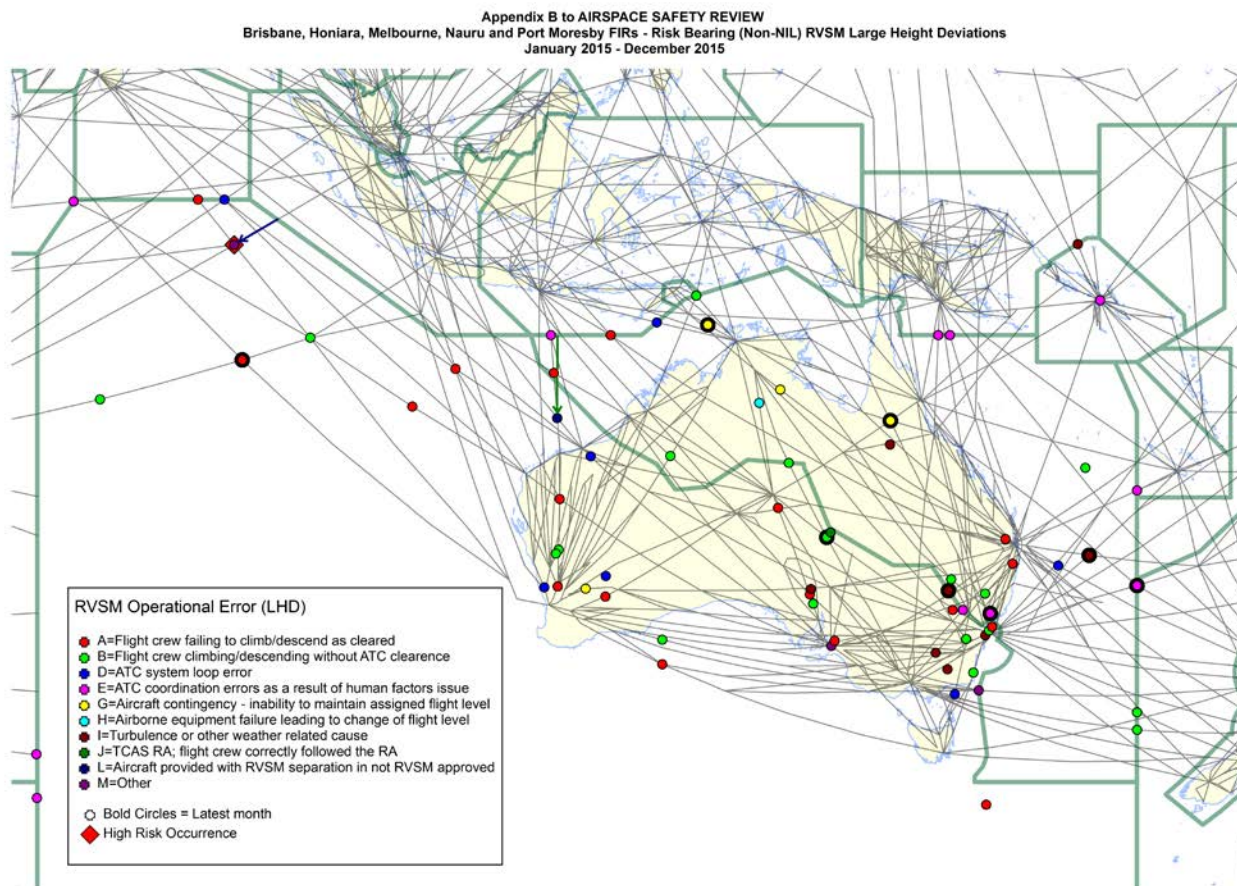


Figure 2: Australian, Nauru, Papua New Guinea and Solomon Islands Airspace – Risk Bearing LHD

2.14 **Table 1** summarizes Indonesian airspace RVSM technical, operational, and total risks. **Figure 1** presents collision risk estimate trends during the period from 1 January 2015 to 31 December 2015.

Indonesian Airspace – estimated annual flying hours = 343100 hours (note: estimated hours based on Dec 2014 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
<i>RASMAG 20 Total Risk (PREVIOUS RASMAG)</i>	2.18×10^{-9}	5.0×10^{-9}	<i>Below TLS</i>
Technical Risk	0.0845×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.02×10^{-9}	-	-
Total Risk	1.10×10^{-9}	5.0×10^{-9}	Below TLS

Table 1: Indonesian Airspace RVSM Risk Estimates

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Figure 1: Indonesian Airspace RVSM Risk Estimate Trends

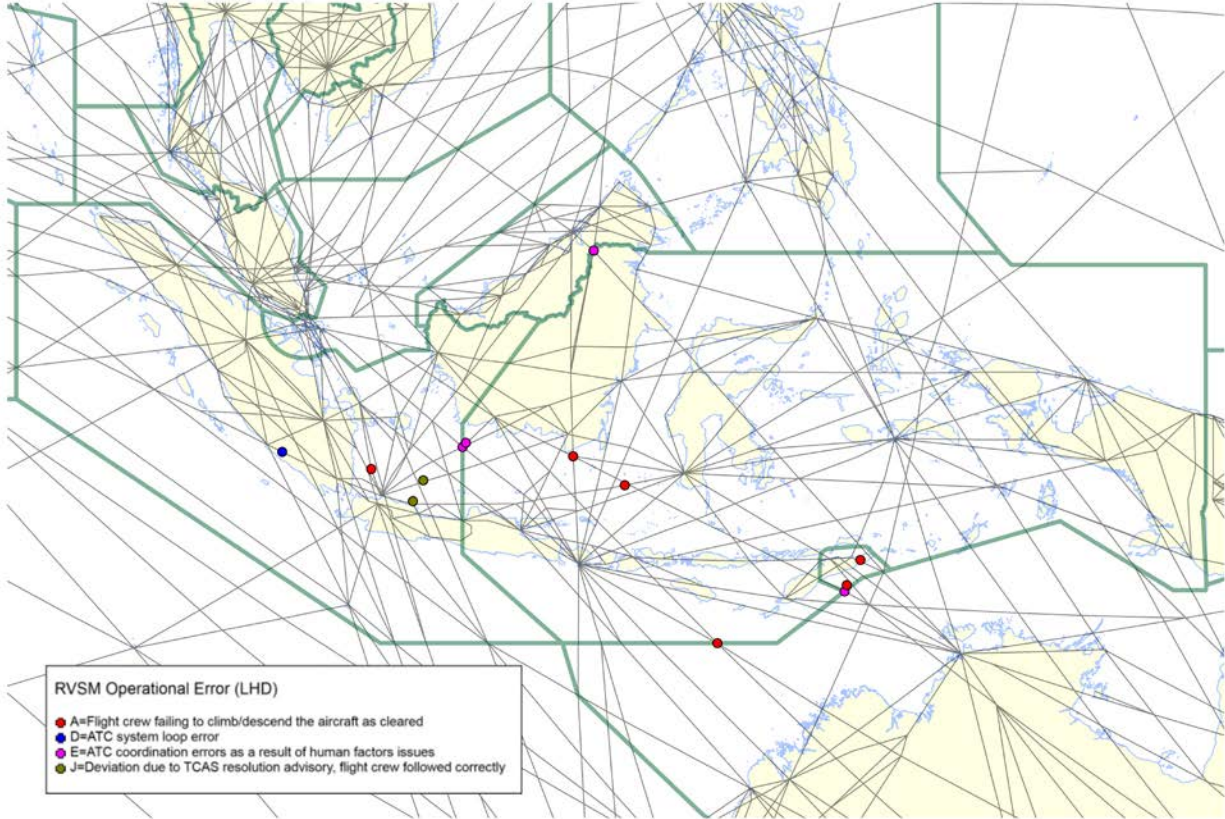
2.15 **Table 2** presents a summary of the LHD causes within Indonesian airspace from 1 January 2014 until 31 December 2014.

Code	LHD Category Description	No.
A	Flight crew fails to climb or descend the aircraft as cleared	6
B	Flight crew climbing or descending without ATC clearance	0
C	Incorrect operation or interpretation of airborne equipment	0
D	ATC system loop error	1
E	ATC transfer of control coordination errors due to human factors	4
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	2
K	TCAS resolution advisory and flight crew incorrectly responds	0
L	Non-approved aircraft is provided with RVSM separation	0
M	Other	0
Total		13

Table 2: Summary of LHD Causes within Indonesian Airspace

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

Appendix B to AIRSPACE SAFETY REVIEW
Jakarta and Ujung Pandang FIRs - Risk Bearing (Non-NIL) RVSM Large Height Deviations
January 2015 - December 2015



2.17 **Figure 2:** Indonesian Airspace – Risk Bearing LHD

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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AUSTRALIAN AIRSPACE MONITORING AGENCY (AAMA)



Airspace Safety Review of RVSM in Australian, Nauru, Papua New Guinea and Solomon Islands Airspace January 2015 to December 2015

Role	Name and Position	Signature and Date
Prepared By	Simon McDonald A/g Senior Safety Analyst	 14/01/16
	& Dr Geoff Aldis Quantitative Modelling Specialist	 14/01/16
Reviewed By	Rob Butcher Systemic Analysis, Monitoring and Review Manager	 14/01/16

Executive Summary

For the period 1 January 2015 to 31 December 2015 inclusive, the total risk exceeds the agreed Target Level of Safety (TLS) value of 5.0×10^{-9} . **Table A** summarises RVSM technical, operational and total risks. **Figure A** presents collision risk estimate trends.

Australian, Nauru, Papua New Guinea and Solomon Islands RVSM Airspace – estimated annual flying hours = 821,496 hours (note: estimated hours based on December 2014 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	0.0303×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	5.19×10^{-9}	-	-
Total Risk	5.22×10^{-9}	5.0×10^{-9}	Above Overall TLS

Table A: Australian, Nauru, Papua New Guinea and Solomon Islands Airspace RVSM Risk Estimates

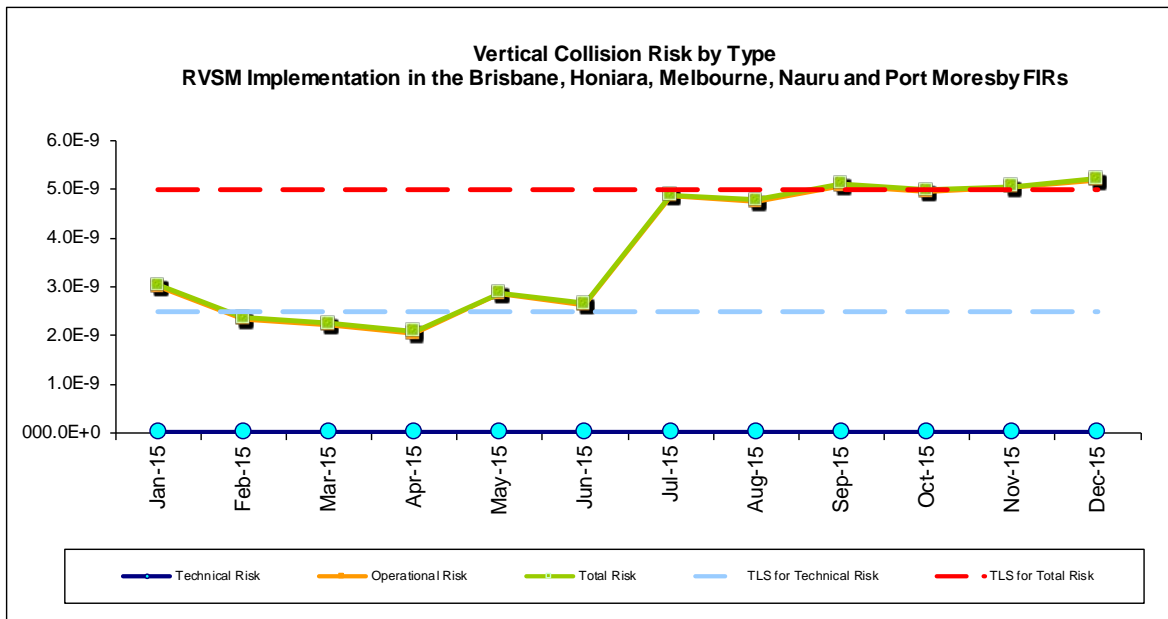


Figure A: RVSM Risk Estimate Trends

**AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN
AUSTRALIAN, NAURU, PAPUA NEW GUINEA AND SOLOMON ISLANDS
AIRSPACE
JANUARY 2015 TO DECEMBER 2015**

Prepared by
Australian Airspace Monitoring Agency (AAMA) – January 2016
(An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

1.1 This report provides an airspace safety review of RVSM airspace risk in the Brisbane, Honiara, Melbourne, Nauru and Port Moresby 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 2014 of aircraft operating in the Brisbane, Honiara, Melbourne, Nauru and Port Moresby FIRs was used as required by ICAO Regional agreement.

2.2 **Large Height Deviation (LHD).** A cumulative 12-month data set of LHD reports was used, covering December 2014 to November 2015. **Table 1** indicates those FIRs which submitted LHD reports including nil returns. **Appendix A** provides details of LHD reports.

FIR Name	Brisbane	Honiara	Melbourne	Nauru	Port Moresby
January 2015	✓	✓	✓	✓	X
February 2015	✓	✓	✓	✓	X
March 2015	✓	✓	✓	✓	✓
April 2015	✓	✓	✓	✓	✓
May 2015	✓	✓	✓	✓	✓
June 2015	✓	✓	✓	✓	✓
July 2015	✓	✓	✓	✓	✓
August 2015	✓	✓	✓	✓	✓
September 2015	✓	✓	✓	✓	✓
October 2015	✓	✓	✓	✓	✓
November 2015	✓	✓	✓	✓	✓
December 2015	✓	✓	✓	✓	✓

Table 1: Summary of LHD Reports submitted by FIRs

3. Summary of LHD Occurrences

3.1 **Table 2** and **Figure 2** summarise the number of LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed, by month from 1 January 2015 to 31 December 2015 inclusive.

Month-Year	No. of Non-NIL LHD	LHD Duration (Min)	No. Levels Crossed
2015			
January	5	0	5
February	2	1	1
March	6	2.5	4
April	6	12	4
May	11	26.9	6
June	3	1	2
July	6	83	7
August	1	0	1
September	10	13.5	18
October	7	4.0	4
November	7	6.0	5
December	8	0.5	16
Total	72	150.4	73

Table 2: Summary of Non-NIL LHD Occurrences and Duration

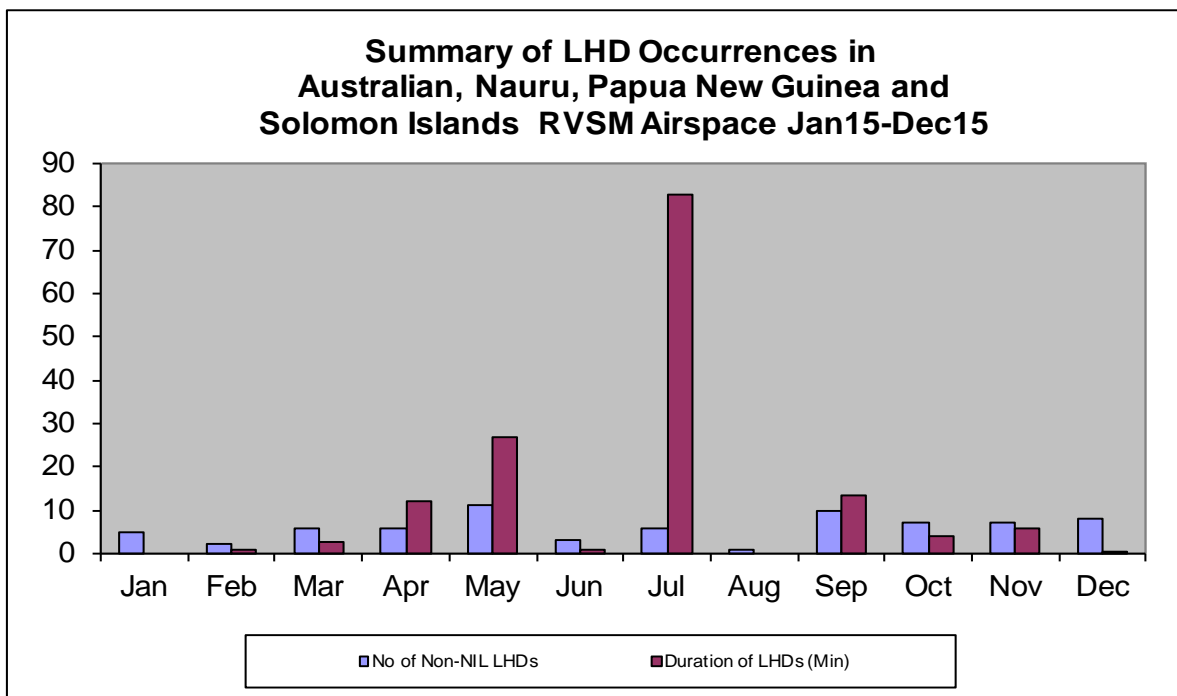


Figure 2: Summary of LHD Occurrences (by Month)

3.2 Eight non-Nil LHDs were reported for the month of December which is one more than the previous month. The December 2015 assessed total duration of LHDs decreased compared to the previous month. (See Table 2 and Figure 2).

3.3 **Table 3** and **Figure 3** 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 January 2015 to 31 December 2015 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	18	26.4	10
B	Flight crew climbing/descending without ATC Clearance	18	7.5	13
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)	7	1	6
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)	11	16.5	14
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)	4	0	19
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level	1	0	2
I	Deviation due to turbulence or other weather related cause	8	0	8
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory	1	0	1

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	48	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.	3	51	0
Total		72	150.4	73

Table 3: Summary of LHD Occurrences and Duration by LHD Category

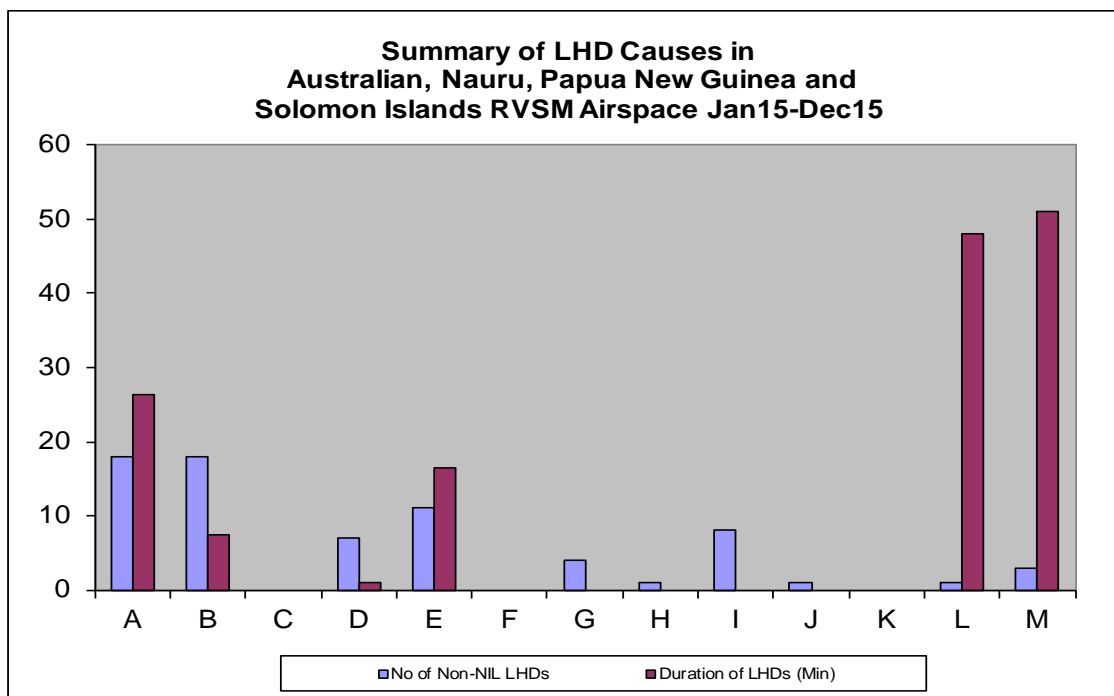


Figure 3: Summary of LHD Causes

3.4 One **Category A** (Flight crew failing to climb/descend the aircraft as cleared) reports was assessed:

- **ATS-0141713** was filed by OTS – West and involved an aircraft climbing through its cleared block level after it was amended due to traffic. The risk was assessed as one level crossed.

3.5 Two **Category E** (Coordination errors in the ATC to ATC transfer or control responsibility as a result of human factors issues) reports were assessed:

- **ATS-0141360** was filed by ECSN – Gwydir and involved ATC failing to coordinate a change of level to the adjacent sector during a period of high work load. The risk was assessed as one level crossed.
- **ATS-0141708** was filed by OTS – East and involved Auckland ATC coordinating the wrong block level to Tasman ATC. The risk was assessed as the nominal time to identify and resolve (0.5 min).

3.6 Two **Category G** (Aircraft contingency event leaving to sudden inability to maintain assigned flight level) reports were assessed:

- **ATS-0141438** was filed by OTS – Outback and involved an aircraft descending below the assigned level without approval due to cabin depressurization. The risk was assessed as nine levels crossed.
- **ATS-0141598** was filed by OTS – Tops and involved an aircraft descending below their assigned altitude on multiple occasions due to an aircraft malfunction. The aircraft was finally descended below RVSM airspace. The risk was assessed as two levels crossed.

3.7 Two **Category I** (Deviation due to turbulence or other weather related cause) reports were assessed:

- **ATS-0141417** was filed by OTS – East and involved an aircraft climbing above its assigned level due to turbulence. The risk was assessed as one level crossed.
- **ATS-0141487** was filed by OTS – Central and involved an aircraft climbing above its assigned level due to turbulence. A pilot report and CLAM alert were received. The risk was assessed as one level crossed.

3.8 One **Category J** (TCAS resolution advisory (RA); flight crew correctly following the resolution advisory) report was assessed:

- **ATS-0141334** was filed by OTS – Central and involved an aircraft climbing through its assigned altitude due to a TCAS RA. The risk was assessed as one level crossed.

3.9 **Appendix B** 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 coloured dot. Reports assessed as being high risk during the current month of this report are identified as a red diamond (nil for December 2015) or a 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.

4. Risk Assessment and Safety Oversight

4.1 **Estimate of the CRM Parameters.** The value of the parameters in the Collision Risk Model (CRM) used to estimate risk in the RVSM airspace, are summarized in **Table 4.**

Parameter	Description	Value
λ_x	Average aircraft length	0.0231 NM DOM (Uni-directional) 0.0296 NM DOM (Bi-directional) 0.0330 NM IND (Uni-directional) 0.0350 NM IND (Bi-directional) 0.0278 NM TAS (Uni-directional) 0.0255 NM TAS (Bi-directional)
λ_y	Average aircraft wingspan	0.0206 NM DOM (Uni-directional) 0.0275 NM DOM (Bi-directional) 0.0309 NM IND (Uni-directional) 0.0324 NM IND (Bi-directional) 0.0257 NM TAS (Uni-directional) 0.0233 NM TAS (Bi-directional)
λ_z	Average aircraft height	0.0068 NM DOM (Uni-directional) 0.0083 NM DOM (Bi-directional) 0.0092 NM IND (Uni-directional) 0.0097 NM IND (Bi-directional) 0.0083 NM TAS (Uni-directional) 0.0076 NM TAS (Bi-directional)
$ \overline{\Delta V} $	Average relative same-direction speed	22.9 kt DOM (Uni-directional) 18.8 kt DOM (Bi-directional) 10.4 kt IND (Uni-directional) 12.9 kt IND (Bi-directional) 20.6 kt TAS (Uni-directional) 21.2 kt TAS (Bi-directional)
$ \overline{V} $	Average aircraft speed	445.2 kt DOM (Uni-directional) 467.7 kt DOM (Bi-directional) 461.0 kt IND (Uni-directional) 475.3 kt IND (Bi-directional) 476.5 kt TAS (Uni-directional) 460.6 kt TAS (Bi-directional)
$ \overline{\dot{y}} $	Average relative cross-track speed	13 kt
$ \overline{\dot{z}} $	Average relative vertical speed during loss of vertical separation	1.5 kt if aircraft in level flight, 10 kt otherwise
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.353 DOM (Uni-directional) 0.429 DOM (Bi-directional) 0.474 IND (Uni-directional) 0.499 IND (Bi-directional) 0.428 TAS (Uni-directional) 0.391 TAS (Bi-directional)
$P_z(1000)$	Probability two aircraft nominally separated vertically by 1000 feet are in vertical overlap	2.46E-8
$P_y(0)$	Probability two aircraft nominally on the route centreline are in lateral overlap	0.061 DOM (Uni-directional) 0.081 DOM (Bi-directional) 0.092 IND (Uni-directional) 0.096 IND (Bi-directional) 0.076 TAS (Uni-directional) 0.069 TAS (Bi-directional)

$E_z(\textit{same})$	Same direction occupancy	0.102 DOM (Uni-directional) 0.238 DOM (Bi-directional) 0.0057 IND (Uni-directional) 0.123 IND (Bi-directional) 0.113 TAS (Uni-directional) 0.187 TAS (Bi-directional)
$E_z(\textit{opp})$	Opposite direction occupancy	0.0055 DOM (Uni-directional) 0.0352 DOM (Bi-directional) 0.0 IND (Uni-directional) 0.019 IND (Bi-directional) 0.019 TAS (Uni-directional) 0.0186 TAS (Bi-directional)
$E_z(\textit{cross})$	Crossing occupancy	0.017 DOM (Uni-directional) 0.038 DOM (Bi-directional) 0.028 IND (Bi-directional) 0.019 TAS (Uni-directional) 0.013 TAS (Bi-directional)
T	Daily flight hours	809.5 DOM (Uni-directional) 1094.2 DOM (Bi-directional) 25.2 IND (Uni-directional) 115.5 IND (Bi-directional) 28.1 TAS (Uni-directional) 178.1 TAS (Bi-directional)

Table 4: Estimates of the Parameters in the CRM

4.2 **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 5**. The technical risk meets the agreed TLS value of no more than 2.5×10^{-9} fatal accidents per flight hour. The operational and weighted total risk exceeds the specified TLS value for these components of 5.0×10^{-9} .

Australian, Nauru, Papua New Guinea and Solomon Islands RVSM Airspace – estimated annual flying hours = 821,496 hours (note: estimated hours based on December 2014 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	0.0303×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	5.19×10^{-9}	-	-
Total Risk	5.22×10^{-9}	5.0×10^{-9}	Above Overall TLS

Table 5: Australian, Nauru, Papua New Guinea and Solomon Islands Airspace RVSM Risk Estimates

4.3 **Figure 5** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month data set of LHD reports.

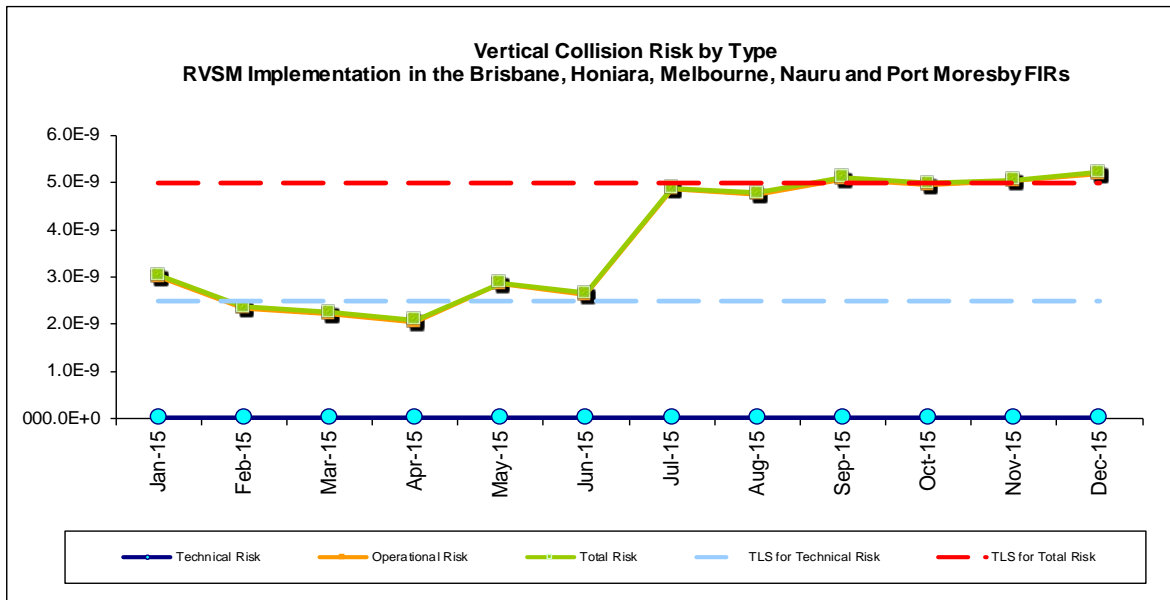


Figure 5: Trends of Risk Estimates for RVSM Airspace

4.4 A monthly LHD risk value is determined 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 6** below shows the monthly risk for December 2015 as below the average monthly risk for an annual risk of 5.0×10^{-9} (red line in Figure 6 below).

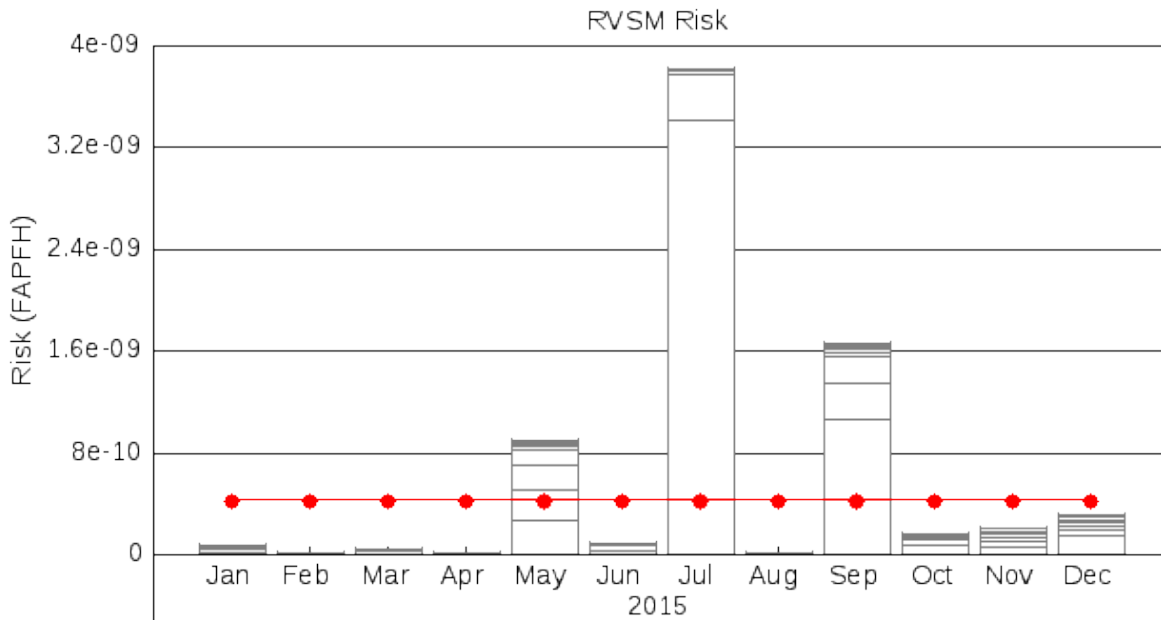


Figure 6: Monthly LHD Risk Estimates for the Australian, Nauru, Papua New Guinea and Solomon Islands RVSM Airspace.

(Red line is the average monthly value for an annual risk of 5.0×10^{-9} . Risk is measured in Fatal Accidents per Flight Hour (FAPFH).)

5. Additional analysis.

5.1 The graph shown at **Figure 7** below indicates the risk contribution from each of the areas assessed by the AAMA for the Australian FIRs. The percentage distribution remains stable.

Risk Contribution by Traffic Region January 2015 to December 2015

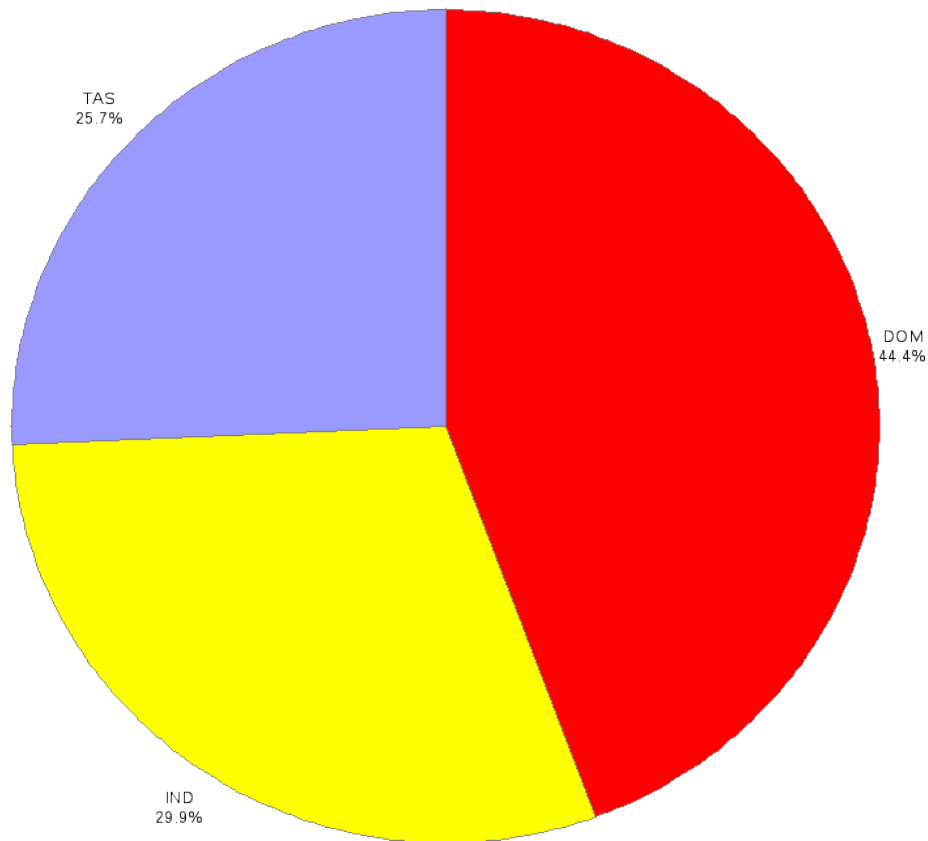


Figure 7: Risk Contribution by Traffic Region

5.2 **Figure 8** identifies the risk contribution by attribution for the operational errors and large height deviations in the twelve month data sample. The risk pattern shows Other at 55.5% as the highest contributor to risk.

Risk Contribution by Attribution January 2015 to December 2015

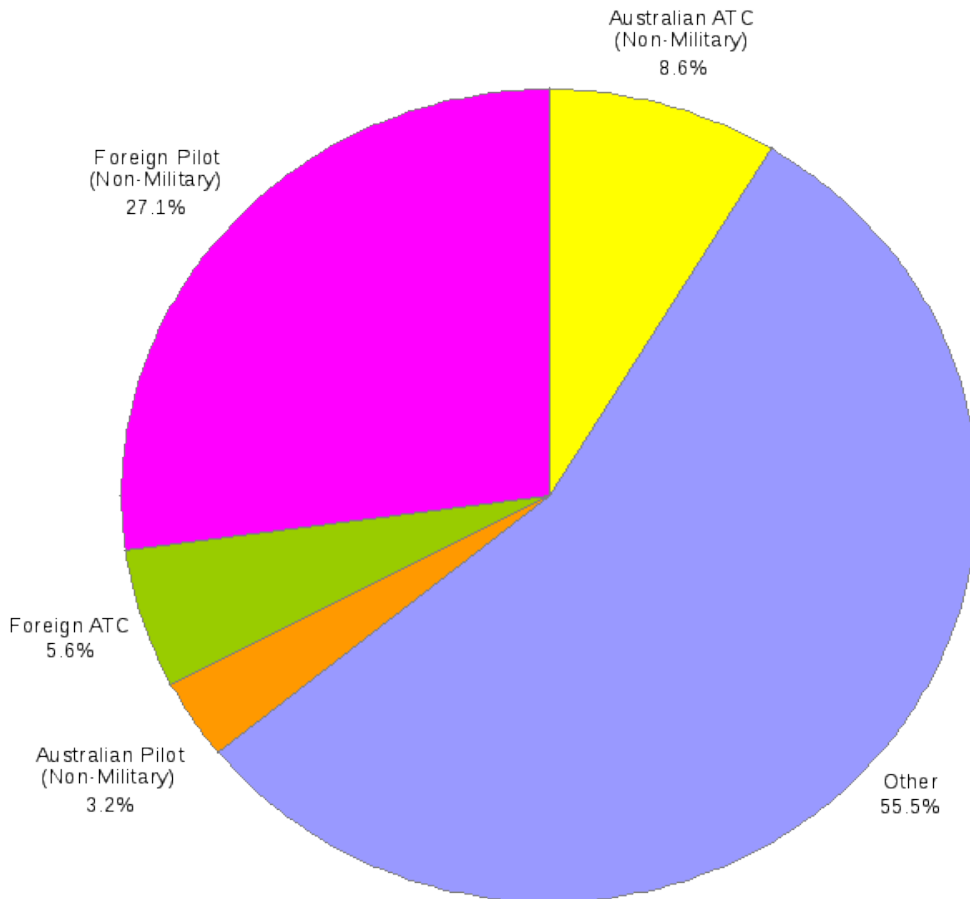


Figure 8: Risk Contribution by Attribution

6. Long Term Height-keeping Monitoring (LTHM)

6.1 To meet the ICAO Annex 6 LTHM requirements, the AAMA undertakes a monitoring program. The current monitoring burden data for Australia, Papua New Guinea and the Solomon Islands is detailed in **Table 6** below.

State	Total RVSM Approved Airframes	Resultant Monitoring Burden	Total Airframes Remaining to be Monitored
Australia	592	199	31
Papua New Guinea	17	10	1
Solomon Islands	1	1	0

Table 6: LTHM Burden

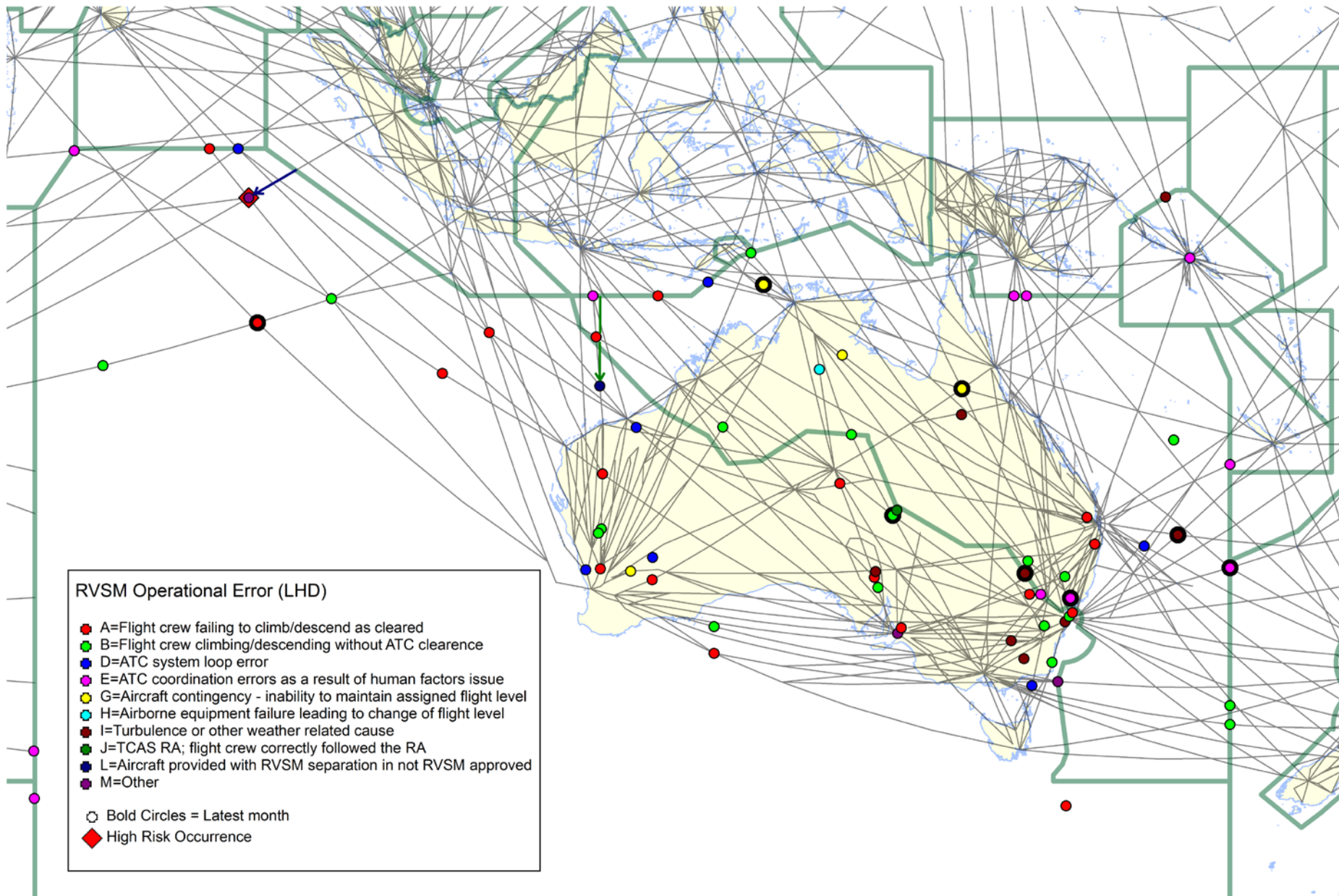
Appendix A to AIRSPACE SAFETY REVIEW
Details of the Reported LHD Events

LHD date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Cause	Category /Sub category
January 2015	Airservices	FL320	FL327	1 level crossed	Aircraft climbed through assigned level	A
January 2015	Airservices	FL410	Descending	1 level crossed	Aircraft commenced a descent without a clearance most likely as a result of call sign confusion	B
January 2015	Airservices	FL370	FL374	1 level crossed	Aircraft commenced a climb without a clearance most likely as a result of call sign confusion	B
January 2015	Airservices	FL370	FL364	1 level crossed	Vertical deviation below cleared level due to turbulence	I
January 2015	Tiger Air	FL360	FL356	1 level crossed	Vertical deviation below cleared level due to turbulence	I
February 2015	Airservices	FL380	FL370	1 min	Aircraft was cleared to FL380 however reported at FL370. CLAM alerted shortly after	A
February 2015	Airservices	FL320	Descending	1 level crossed	Incorrect aircraft instructed to descend as the result of call sign confusion	D
March 2015	Airservices	FL360 – FL400	FL352	1 level crossed	Aircraft commenced a descent without a clearance	B
March 2015	Airservices	UNK	Descending	0.5 min	Aircraft commenced a descent without a clearance	B
March 2015	Airservices	FL300	Climbing	1 level crossed	Aircraft climbing above assigned level due to the pilot misunderstanding a controllers instruction and a hear back error by controllers	D
March 2015	Airservices	FL370	FL375	1 level crossed	Vertical deviation above cleared level due to turbulence	I
March 2015	Airservices	FL360	FL363	1 level crossed	Vertical deviation above cleared level due to turbulence	I
March 2015	Airservices	FL400	FL400	2 min	Non RVSM aircraft operating within 1000ft of another aircraft	M
April 2015	Airservices	FL280	FL330	9 min	Aircraft did not descend when required.	A
April 2015	Airservices	FL380	Climbing	1 level crossed	Aircraft climbing above assigned level	A
April 2015	Airservices	FL320	Climbing	1 level crossed	Aircraft climbing above assigned level due to the pilot misunderstanding a controllers instruction	B
April 2015	Airservices	FL360 – FL370	FL377	1 level crossed	Aircraft was cleared in block level FL360 – FL370 and following a CLAM alert was observed at FL377	B
April 2015	Airservices	FL330 – FL340	Climbing	1 level crossed	Vertical deviation above cleared block level due to weather	B
April 2015	Airservices	F360 – FL390	FL330 – FL370	3 min	Coordination error by ATS	E
May 2015	Airservices	FL390	Descending	1 min	Aircraft descended as a result of call sign confusion	A
May 2015	Airservices	FL300	Climbing	1 level crossed	Aircraft climbing above assigned level	A
May 2015	Airservices	FL350	Climbing	52 seconds	Aircraft did not reach cleared flight level by time required	A

LHD date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Cause	Category /Sub category
May 2015	Airservices	FL400	FL410	1 level crossed	Aircraft did not descend as required	A
May 2015	Airservices	FL380	FL372	2 min	Aircraft did not reach cleared flight level by time required	A
May 2015	Airservices	FL390	Descending	0.5 min	Aircraft commenced a descent without a clearance	B
May 2015	Airservices	FL390	Descending	0.5 min	Aircraft commenced a descent without a clearance	B
May 2015	Airservices	FL360	FL340	2 levels crossed	Erroneous time estimate entered into TAAATS by ATS	D
May 2015	Airservices	FL330	FL300	2 min	Coordination error by ATS	E
May 2015	Airservices	FL360	Descending	2 levels crossed	Emergency descent	G
May 2015	Airservices	FL380	FL330	20 min	Erroneous Cleared Flight Level entered into TAAATS by ATS	M
June 2015	Airservices	FL340	Descending	1 level crossed	Aircraft commenced a descent without a clearance	B
June 2015	Airservices	FL380	FL370	1 level crossed	Aircraft commenced a descent without a clearance	B
June 2015	Airservices	FL350	FL330	1 min	Coordination error by ATS	E
July 2015	Airservices	FL280	FL285 – FL305	3.0 min	Aircraft climbed without a clearance	B
July 2015	Airservices	FL370	FL368	1 level crossed	Aircraft commenced a descent without a clearance	B
July 2015	Airservices	FL330	FL350	3.0 min	Coordination error by ATS	E
July 2015	Airservices	FL350	Descending	6 levels crossed	Emergency descent	G
July 2015	Airservices	FL320	FL320	48 min	Aircraft operating in RVSM without RVSM capability	L
July 2015	Airservices	UNK	FL310	29 min	Aircraft operating inside Australian FIR without coordination	M
August 2015	Airservices	FL390	Climbing	1 level crossed	Aircraft climbing above assigned level due to the pilot misunderstanding a controller request	D
September 2015	Airservices	FL370	FL365	9 min	Aircraft did not reach cleared flight level by time required	A
September 2015	Airservices	FL290	FL303	0.5 min	Aircraft did not reach cleared flight level by time required	A
September 2015	Airservices	FL320	FL340	3.0 min	Aircraft climbed without a clearance	B
September 2015	Airservices	FL350	Descending	1 level crossed	Aircraft commenced a descent without a clearance	B
September 2015	Airservices	FL270	FL290	1 level crossed	Aircraft climbed without a clearance	B
September 2015	Airservices	FL340 – FL360	FL365	1 level crossed	Aircraft climbed without a clearance	B
September 2015	Airservices	FL410	FL410	13 levels crossed	No departure coordination provided by ATS	E
September 2015	Airservices	FL380	FL360	0.5 min	Coordination error by ATS	E
September 2015	Airservices	FL390	FL310	0.5 min	Coordination error by ATS	E
September 2015	Airservices	FL390	FL369	2 levels crossed	Aircraft descended as a result of an autopilot failure	H
October 2015	Airservices	FL280	FL285	1 level crossed	Aircraft climbing above assigned level	A
October 2015	Airservices	FL340	FL345	1 level crossed	Aircraft climbing above assigned level	A

LHD date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Cause	Category /Sub category
October 2015	Airservices	FL370 – FL380	FL384	1 level crossed	Aircraft climbed without a clearance	B
October 2015	Airservices	FL370	FL350	0.5 min	Controller did not issue an agreed and coordinated climb instruction	D
October 2015	Airservices	FL350	FL330	0.5 min	Aircraft not at expected level as the controller had issued the aircraft a level instruction meant for another aircraft	D
October 2015	Airservices	FL300	Descending below FL330	1 level crossed	Controller assigned the aircraft an incorrect level (FL300 vice FL330) which was not picked up in pilot readback	D
October 2015	Airservices	FL390	FL410	3.0 min	Coordination error by ATS	E
November 2015	Airservices	FL390	FL396	1 level crossed	Aircraft climbed without a clearance	A
November 2015	Airservices	F370 – FL380	FL385	1 level crossed	Aircraft climbed without a clearance	A
November 2015	Airservices	FL380	FL360	3 min	Aircraft was maintaining the incorrect level	A
November 2015	Airservices	FL280	FL277	1 level crossed	Aircraft commenced a descent without a clearance	A
November 2015	Airservices	FL300	FL380	3 min	Nadi ATC had not provided coordination of an amended flight level	E
November 2015	Airservices	FL360	FL340	1 level crossed	Aircraft commenced a descent without a clearance due to severe turbulence.	I
November 2015	Airservices	FL350	FL346	1 level crossed	Aircraft commenced a descent without a clearance due to severe turbulence.	I
December 2015	Airservices	FL330 – FL340	FL344	1 level crossed	Aircraft climbed above cleared block level without a clearance	A
December 2015	Airservices	FL400	Climbing above FL400	1 level crossed	ATC did not coordinate a change of level to the adjacent sector	E
December 2015	Airservices	FL370 – FL380	FL360 – FL370	0.5 min	Auckland ATC coordinated the wrong block level	E
December 2015	Airservices	FL390	FL300	9 levels crossed	Aircraft descended below assigned level due to cabin depressurization	G
December 2015	Airservices	FL400 FL340	FL397 FL334	2 levels crossed	Due to an aircraft malfunction aircraft was unable to maintain the assigned altitude on multiple occasions	G
December 2015	Airservices	FL410	FL414	1 level crossed	Aircraft commenced a climb without a clearance due to turbulence.	I
December 2015	Airservices	FL390	FL393	1 level crossed	Aircraft commenced a climb without a clearance due to turbulence.	I
December 2015	Airservices	FL370	Climbing above FL370	1 level crossed	Aircraft commenced a climb without a clearance due to TCAS RA	J

Appendix B to AIRSPACE SAFETY REVIEW
Brisbane, Honiara, Melbourne, Nauru and Port Moresby FIRs - Risk Bearing (Non-NIL) RVSM Large Height Deviations
January 2015 - December 2015








AUSTRALIAN AIRSPACE MONITORING AGENCY (AAMA)



**Airspace Safety Review of RVSM
in
Indonesian Airspace
January 2015 to December 2015**

Role	Name and Position	Signature and Date
Prepared By	Simon McDonald <i>Acting Senior Safety Analyst</i> & Dr Geoff Aldis Quantitative Modelling Specialist	 29/01/16
		 29/01/16
Reviewed By	Robert Butcher Systemic Analysis, Monitoring and Review Manager	 29/01/16

Executive Summary

For the period 1 January 2015 to 31 December 2015 inclusive, the total risk meets the agreed Target Level of Safety (TLS) value of 5.0×10^{-9} . **Table A** summarises RVSM technical, operational and total risks. **Figure A** presents collision risk estimate trends.

Indonesian RVSM Airspace – estimated annual flying hours = 343100 hours (note: estimated hours based on Dec 2014 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	0.0845×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.02×10^{-9}	-	-
Total Risk	1.10×10^{-9}	5.0×10^{-9}	Below TLS

Table A: Indonesian Airspace RVSM Risk Estimates

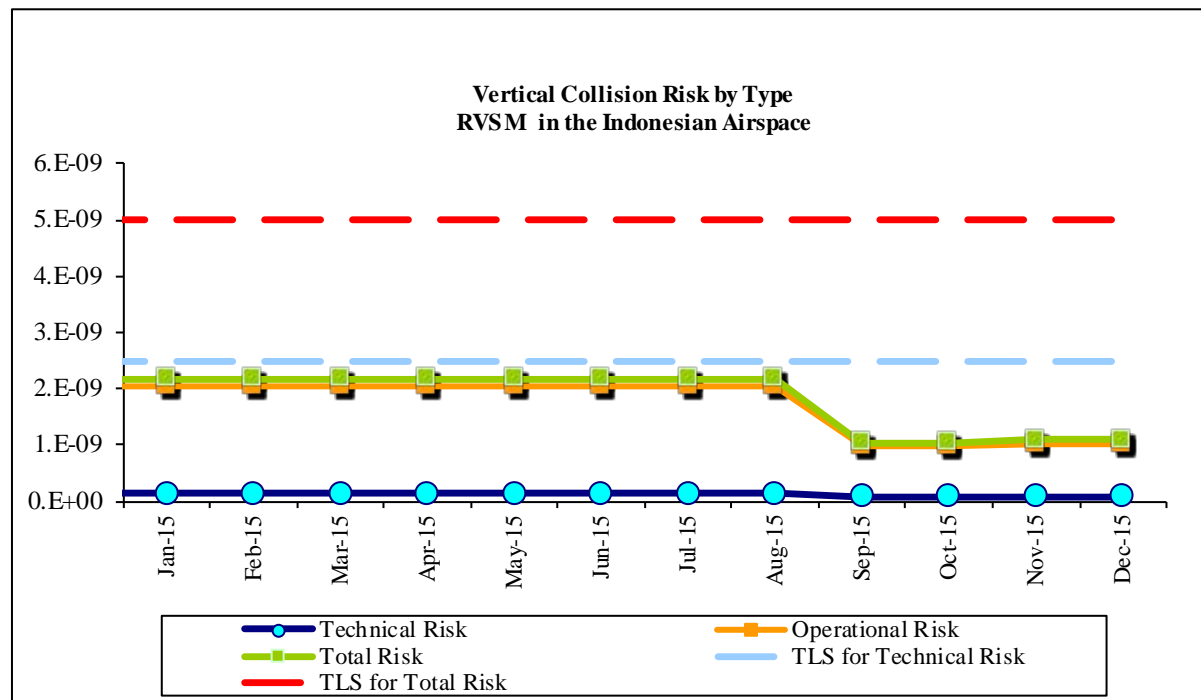


Figure A: RVSM Risk Estimate Trends

**AIRSPACE SAFETY REVIEW OF THE RVSM IMPLEMENTATION IN
INDONESIAN AIRSPACE
JANUARY 2015 TO DECEMBER 2015**

Prepared by

Australian Airspace Monitoring Agency (AAMA) - January 2016
(An ICAO APANPIRG approved Regional Monitoring Agency)

1. Introduction

This report provides an airspace safety review of RVSM airspace risk in the Jakarta and Ujung Pandang 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 2014 of aircraft operating in the Jakarta and Ujung Pandang FIRs was used as required by ICAO Regional agreement.

2.2. Large Height Deviation (LHD). A cumulative 12-month data set of LHD reports was used, covering January 2015 to December 2015. **Table 1** indicates those FIRs which submitted LHD reports including nil returns. **Appendix A** provides details of LHD reports.

FIR Name	Jakarta	Ujung
January 2015	✓	✓
February 2015	✓	✓
March 2015	X	✓
April 2015	X	X
May 2015	X	X
June 2015	✓	✓
July 2015	✓	X
August 2015	✓	X
September 2015	✓	✓
October 2015	✓	✓
November 2015	✓	✓
December 2015	✓	✓

Table 1: Summary of LHD Reports submitted by FIRs

3. Summary of LHD Occurrences

3.1 **Table 2** and **Figure 2** summarise the number of LHD occurrences assessed and associated LHD duration (in minutes) or number of levels crossed, by month from 1 January 2015 – 31 December 2015 inclusive.

Month-Year	No. of Non-NIL LHD Occurrences	LHD Duration (Min)	No. Levels Crossed
2015			
January	2	1	0
February	0	0	0
March	2	0	2
April	0	0	0
May	2	0.5	2
June	1	0	1
July	0	0	0
August	3	1	2
September	0	0	0
October	1	0	1
November	2	0.5	1
December	0	0	0
Total	13	3.0	9

Table 2: Summary of Non-NIL LHD Occurrences and Duration

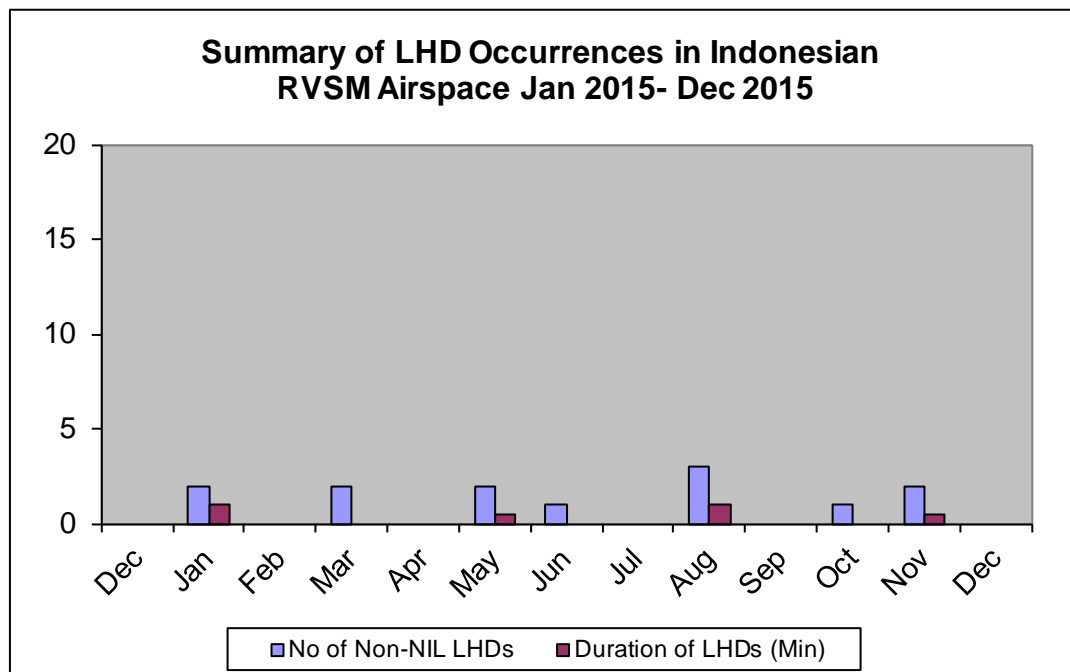


Figure 2: Summary of LHD Occurrences (by Month)

3.2 A total of 14 non-nil LHDs were reported during the 12 months period to end of December 2015.

3.3 **Table 3** and **Figure 3** 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 January 2015 to 31 December 2015 inclusive.

LHD Category Code	LHD Category Description	No. of LHD Occurrences	LHD Duration (Min)	Levels Crossed
A	Flight crew failing to climb/descend the aircraft as cleared	6	1	5
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)	1	0	2
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	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	2	0	2
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		13	3	9

Table 3: Summary of LHD Occurrences and Duration by LHD Category

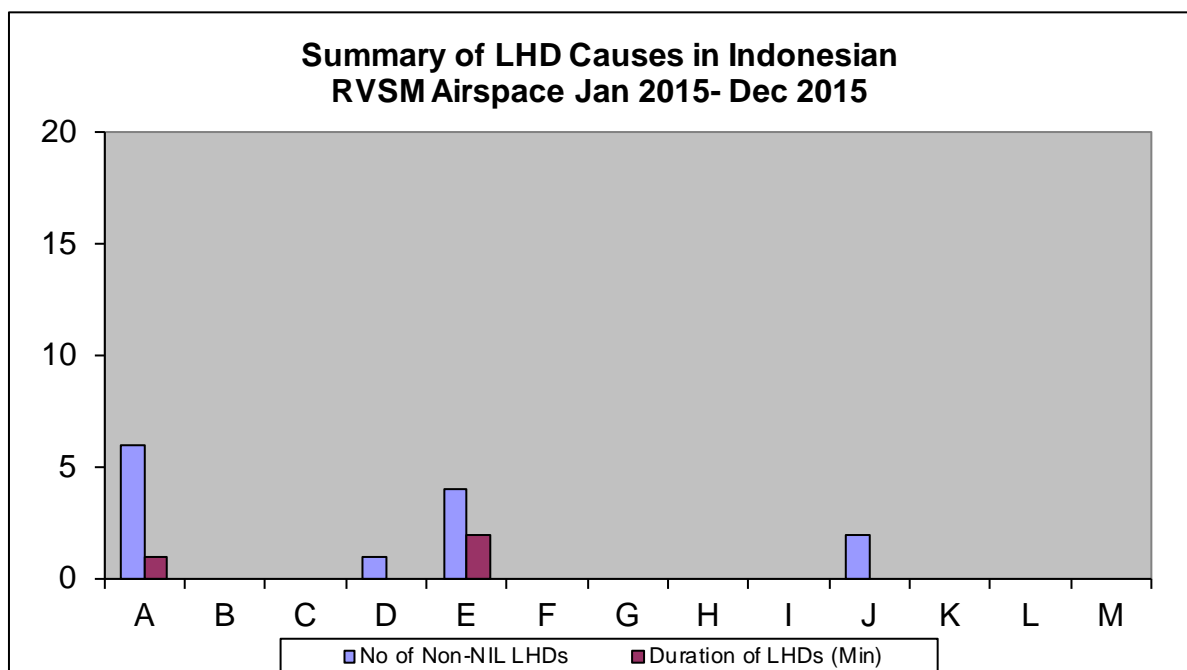


Figure 3: Summary of LHD Causes

3.4 Six non-nil Category A (Flight Crew Failing to climb/descend the aircraft as cleared) LHDs were reported in the 12 month sample. Four were assessed in terms of levels crossed with two having crossed 2 flight levels. The remaining two occurrences were assessed as a nominal time of 0.5 minutes. The LHDs were distributed across a range of Indonesian operators.

3.5 One non-nil Category D (ATC loop error) LHD was reported by Jakarta ACC and involved an aircraft instructed to descend to FL290 which triggered a TCAS RA. The RA was followed by the pilot and ATC was informed.

3.6 Four Category E (Coordination errors) LHDs were reported over the 12 months ending November 2015. Of these two were the result of errors attributed to Jakarta ACC with both of these involving incorrect information coordinated. Two reports were related to errors attributed to foreign ANSPs in the Kota Kinabalu and Brisbane FIRs.

3.7 Two Category J (TCAS resolution advisory) reports were received. One report (June 15) does not identify any corrective action. The latest report (October 2015) identifies that the pilot took appropriate action.

3.8 **Appendix B** 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 coloured dot. Reports assessed as being high risk during the current month of this report are identified as a red diamond (nil for December 2015) or a 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.

4. Risk Assessment and Safety Oversight

4.1 **Estimate of the CRM Parameters.** The value of the parameters in the Collision Risk Model (CRM) used to estimate risk in the RVSM airspace, are summarised in **Table 4**

Parameter	Description	Value
λ_x	Average aircraft length	0.025 NM (JAK) 0.025 NM (UJU)
λ_y	Average aircraft wingspan	0.023 NM (JAK) 0.023 NM (UJU)
λ_z	Average aircraft height	0.0074 (JAK) 0.0074 (UJU)
$ \overline{\Delta V} $	Average relative same-direction speed	19.9 KT (JAK) 19.9 KT (UJU)
$ \overline{V} $	Average aircraft speed	455 KT (JAK) 455 KT (UJU)
$ \overline{\dot{y}} $	Average relative cross-track speed	13 KT
$ \overline{\dot{z}} $	Average relative vertical speed during loss of vertical separation	1.5 KT if aircraft in level flight, 10 knots otherwise
$P_z(0)$	Probability two aircraft at the same nominal level are in vertical overlap	0.55 (JAK) 0.55 (UJU)
E_z same	Same direction occupancy	0.293 (JAK) 0.293 (UJU)
E_z opp	Opposite direction occupancy	0.044 (JAK) 0.044 (UJU)
	Annual RVSM flight hours	171550 HR (JAK) 171550 HR (UJU)

Table 4: Estimates of the Parameters in the CRM derived from the Dec 2014 TSD

4.2 **Risk Estimation Results.** The results for the technical, operational, and total risk for the RVSM implementation are detailed in **Table 5**. The technical risk meets the agreed TLS value of no more than 2.5×10^{-9} fatal accidents per flight hour. The operational and weighted total risk meets the specified TLS value for these components of 5.0×10^{-9} .

Indonesian RVSM Airspace – estimated annual flying hours = 343100 hours (note: estimated hours based on Dec 2014 traffic sample data)			
Source of Risk	Risk Estimation	TLS	Remarks
Technical Risk	0.0845×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.02×10^{-9}	-	-
Total Risk	1.10×10^{-9}	5.0×10^{-9}	Below TLS

Table 5: Indonesian Airspace RVSM Risk Estimates

4.3 **Figure 5** presents the trends of collision risk estimates for each month using appropriate cumulative 12-month data set of LHD reports.

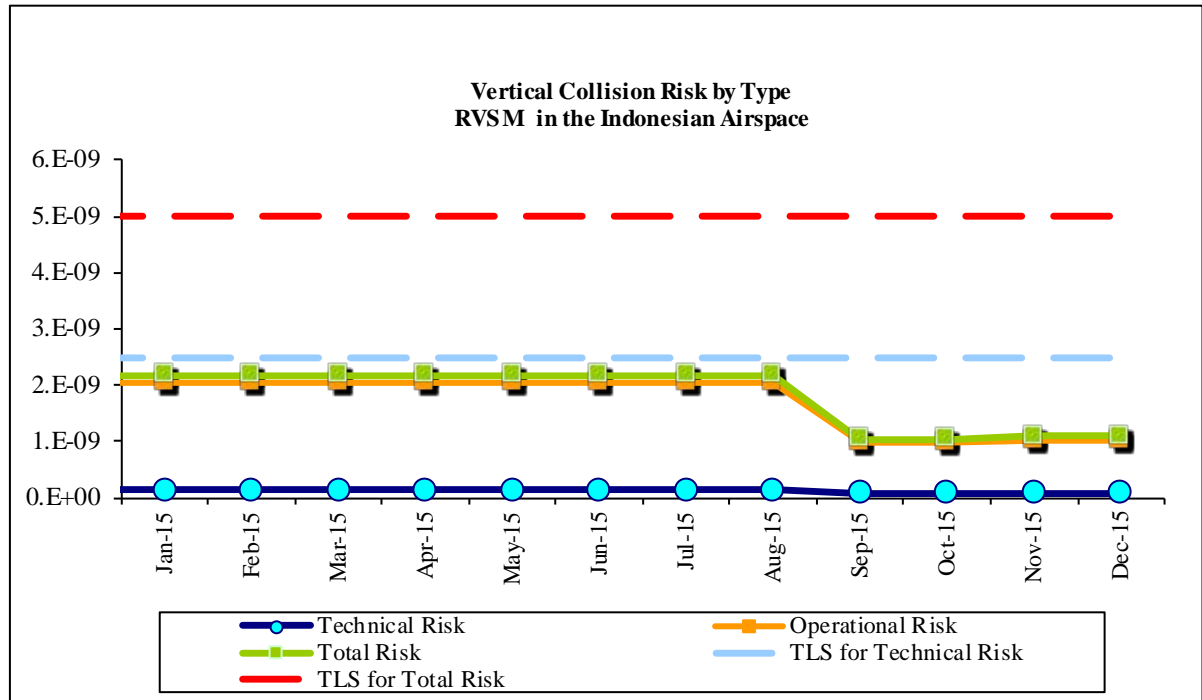


Figure 5: Trends of Risk Estimates for RVSM Airspace

5. Long Term Height-keeping Monitoring (LTHM)

5.1 To meet the ICAO Annex 6 LTHM requirements, the AAMA undertakes a monitoring program. The current monitoring burden data for Indonesia is detailed in **Table 7** below.

State	Total RVSM Approved Airframes	Resultant Monitoring Burden	Total Airframes Remaining to be Monitored
Indonesia	490	114	53

Table 7: LTHM Burden

Appendix A to AIRSPACE SAFETY REVIEW
Details of the Reported LHD Events

LHD date	Source	Assigned FL	Observed/ Reported FL	Duration at Incorrect FL	Cause	Category /Sub category
January 2015	Ujung	FL370	FL330	0.5 min	Aircraft not at expected level by waypoint	E
January 2015	Jakarta	FL350	FL300	0.5 min	Aircraft not at expected level by waypoint	E
March 2015	Ujung	FL330	FL320	1 level crossed	Aircraft descended below cleared level	A
March 2015	Ujung	FL350	FL370	1 level crossed	Aircraft climbed above cleared level	A
May 2015	Ujung	FL380	FL394	2 levels crossed	Aircraft climbed above cleared level	A
May 2015	Airservices	FL400	FL390	0.5 min	Aircraft not at expected level by waypoint	A
June 2015	Jakarta	FL350	FL350	1 level crossed	TCAS RA on aircraft in holding pattern	J
August 2015	Jakarta	FL290	FL330 on descent	2 levels crossed	Aircraft received a TCAS RA after being instructed to descend by ATC	D
August 2015	Ujung	FL380	FL360	0.5 min	Coordination error by ATS	E
August 2015	Airservices	FL380	FL373	0.5 min	Aircraft did not climb as expected	A
October 2015	Ujung	FL310	FL320	1 level crossed	Aircraft received a TCAS RA after being instructed to climb by ATC	J
November 2015	Jakarta	FL340	FL345	1 level crossed	Aircraft climbed above cleared level	A
November 2015	Ujung	FL350	FL370	0.5 min	Aircraft climbed above cleared level	E

Appendix B to AIRSPACE SAFETY REVIEW
Jakarta and Ujung Pandang FIRs - Risk Bearing (Non-NIL) RVSM Large Height Deviations
January 2015 - December 2015

