INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE FOURTEENTH MEETING OF THE REGIONAL AIRSPACE SAFETY MONITORING ADVISORY GROUP (RASMAG/14)

BANGKOK, THAILAND, 21 – 25 FEBRUARY 2011

The views expressed in this report should be taken as those of RASMAG and not of ICAO.

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HISTORY OF THE MEETING

1. **Introduction**

1.1 The Fourteenth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/14) was held in Bangkok, Thailand from 21 to 25 February 2011 at the Kotaite Wing of the ICAO Asia and Pacific Regional Office.

2. **Attendance**

2.1 The meeting was attended by 45 participants from Afghanistan, Australia, China, India, Japan, Malaysia, Mongolia, New Zealand, Philippines, Republic of Korea, Singapore, Thailand, the United States and Vietnam. A list of participants is at **Appendix A** to this report.

3. **Officers & Regional Office**

3.1 Mr. Robert Butcher, Operational Analysis Manager, Safety and Assurance Group, Airservices Australia, chaired the meeting.

3.2 Mr. Len Wicks, Regional Officer ATM, ICAO Asia and Pacific Office, was the Secretary for the meeting, assisted by Mr. Kyotaro Harano, Regional Officer ATM.

4. **Opening of the Meeting**

4.1 Mr. Robert Butcher welcomed participants to the meeting noting that this meeting is the first one where all Asia/Pacific States were invited to attend. He remarked at the high level of participation from many States within the Region and stated that he expected this would have positive results for safety. Mr. Butcher also reminded the meeting that this was now the 7th year since RASMAG was established and that the group had achieved much in that time to be proud of. He noted some of these achievements as:

- Enabling an ongoing mechanism for close coordination between the Region's RMAs and EMAs
- The support given to both Japan and China to enable those States to have APANPIRG approved RMAs
- Provision of direct oversight of China's implementation of RVSM
- Development of the concept of EMAs and the endorsement of Singapore as the EMA for South China Sea area
- Development of the EMA Manual
- Provision of coordinated direct input to the global RMA Coordination Group and the development of the RMA Manual
- Development of the Data Link End-to-End Performance Monitoring Guidance Material which was endorsed by APANPIRG, and
- Development of a seminar for States on safety incident reporting, risk management and responsibilities in terms of data provision to RMAs

4.2 Mr Butcher also extended his and RASMAGs thanks to Mr Harano who would be retiring from ICAO in May. He also welcomed Mr. Wicks as the new Secretary.

4.3 On behalf of Mr. Mokhtar A. Awan, Regional Director of ICAO Asia and Pacific Office, Mr. Len Wicks welcomed all the participants to the meeting.

5. **Documentation and Working Language**

5.1 The working language of the meeting and all documentation was English. There were 27 working papers and 6 information papers considered by the meeting. A list of papers is included at **Appendix B** to this report.

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REPORT ON AGENDA ITEMS

Agenda Item 1: Adoption of Agenda

1.1 The following agenda was adopted by the meeting:

Agenda Item 1: Adoption of Agenda

Agenda Item 2: Review Outcomes of Related Meetings

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

Agenda Item 4: Airspace Safety Monitoring Documentation and Regional Guidance Material

Agenda Item 5: Airspace Safety Monitoring Activities/Requirements in the Asia/Pacific Region

Agenda Item 6: Review and Update of the RASMAG Task List

Agenda Item 7: Any Other Business

Agenda Item 8: Date and Venue of the Next RASMAG Meeting

Agenda Item 2: Review Outcomes of Related Meetings

Outcomes of APANPIRG/21

2.1 The meeting reviewed the outcomes of the 21st Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/21, September 2010) held in Bangkok, Thailand. It was noted that APANPIRG was informed that the result of APAC Metric 1 (the percentage of RMA sub-regions achieving the regional TLS for RVSM operations), referenced as of April, was 77.8 %.

Outcomes of the Seventh Meeting of PBN Task Force (PBN/TF/7)

2.2 The outcomes of the Seventh Meeting of PBN Task Force (PBN/TF/7, September 2010) were reviewed. The full report of the meeting is placed at the ICAO Asia and Pacific Office website and can be accessed at: http://www.icao.or.th/meetings/2010/pbn_tf7/index.html.

2.3 Information was presented on the PBN implementation status and difficulties encountered while proceeding with the PBN Implementation Project, especially PBN safety assessment issues. In line with the PBN safety assessment, developing a validation procedure was suggested, providing States in the region with PBN safety assessment assistance including experts and providing contracting States with safety assessment guidance material.

2.4 The meeting noted that PBN/TF/7 had been informed that the matter of safety assessment had been taken up with ICAO HQ under APANPIRG Conclusions 20/37 and 20/42. The Air Navigation Commission (ANC) had noted the request and directed that the matter relating to PBN issues be addressed through the appropriate ANC Panels and Study Groups.

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

AAMA's RMA activities

Australian, Nauru and Solomon Islands Airspace

3.1 Australia presented the result of the safety assessment 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 December 2009 to 30 November 2010.

3.2 **Table 1** below summarizes the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation.

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	5.19×10^{-9}	-	-
Total Risk	$\mathbf{5.21 \times 10^{-9}}$	5.0×10^{-9}	**Above Overall TLS**

Table 1: Risk Estimates for the RVSM Implementation

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

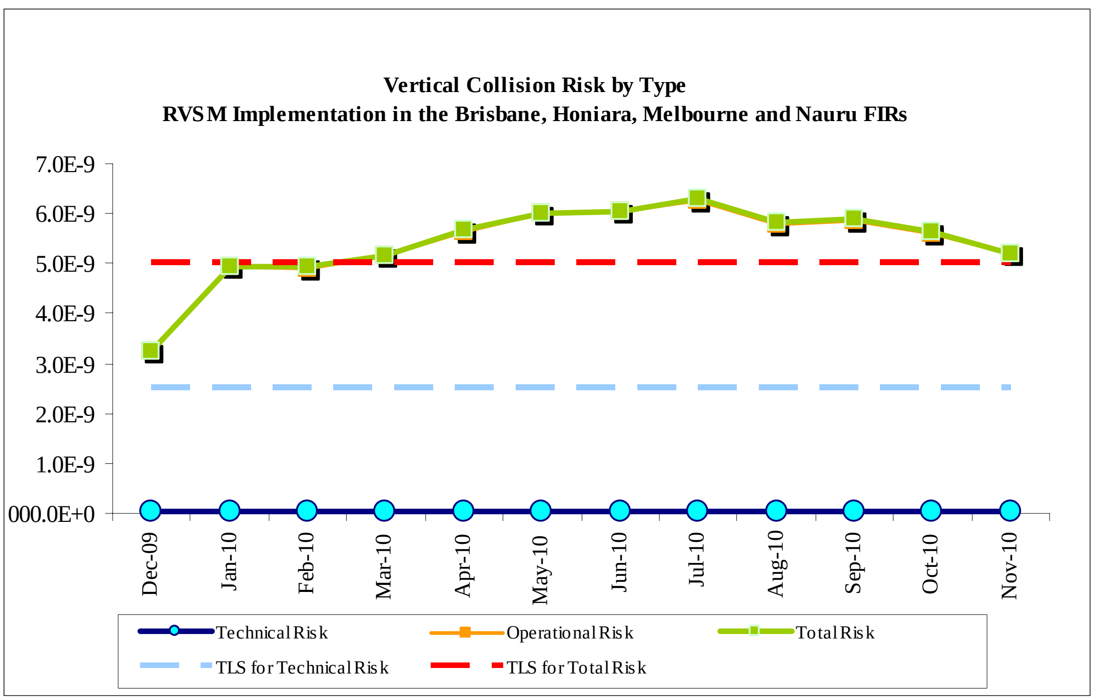

Figure 1: Trends of Risk Estimates for RVSM Airspace

3.4 The meeting noted that the AAMA has completed further assessments for the months of December 2010 and January 2011 for the Australian, Nauru and Solomon Islands airspace. These assessments show that the assessed risk has reduced to approximate 3.33E^{-9}.

Indonesian Airspace

3.5 Australia presented the results of a safety assessment for the Jakarta and the Ujung Pandang FIRs. The RVSM safety oversight is conducted based on a one-month TSD collected in December 2009 and monthly LHD reports between January 2010 and December 2010.

3.6 A number of LHDs were received from the Indonesian ANSPs. While there has been notable improvement in the reporting of LHDs by the two Indonesian ANSPs, the AAMA continues to work with the Indonesian authorities to improve the reporting of operational errors and LHD.

3.7 **Table 2** summarizes 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 = 537,625.57 hours ***(note: estimated hours based on Dec 2009 traffic sample data)***			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.761 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	6.07 x 10^{-9}	-	-
Total Risk	**6.83 x 10-9**	5.0 x 10^{-9}	**Above Overall TLS**

Table 2: Risk Estimates for the RVSM Implementation in Indonesian Airspace

3.8 **Figure 2** presents the trends of collision risk estimates for the period from November 2008 to end of November 2010.

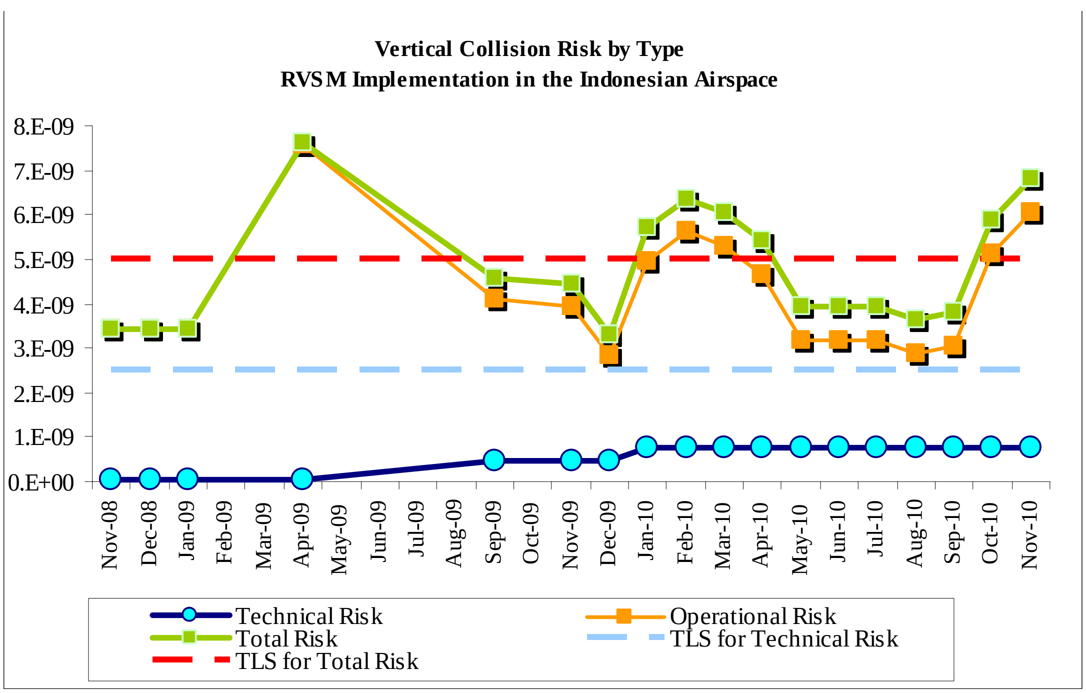

Figure 2: Trends of Risk Estimates for the Indonesian RVSM Airspace

3.9 The AAMA commented that for the Indonesian airspace, the calculated risk has continued to increase since November 2010. The AAMA believes this has been primarily the result of the inclusion of a number of additional LHDs in the Indonesian data set which has resulted from an observed improvement in the reporting culture. Indonesia should be congratulated on this outcome. The meeting was informed that the AAMA recognises that the continued use of the December 2009 TSD, while awaiting resolution to errors in the initial December 2010 TSD, may be significantly negatively impacting the assessed risk. As a result, RASMAG should note the AAMA's lack of confidence in the calculated risk values. Work is being undertaken to resolve these issues as soon as practical.

China RMA's Activities

3.10 China briefed the meeting on the outcomes of the most recent safety estimate for the Chinese domestic airspace and the Pyongyang FIR.

China Domestic Airspace

3.11 The LHD occurrences in the China RVSM airspace are summarized as follows:

- There were 29 reported LHDs during the reporting period. Twenty-six (26/28.84min) of the deviations were reported within the domestic Chinese airspace, and three (3/0 min) were reported by neighbouring RMAs. Six events contributed to technical risk. Twenty-three events contributed to the operational risk.

- Two events with longer duration occurred in the oceanic airspace of Sanya FIR were related to coordination errors in the ATC-unit to ATC-unit transfer of control responsibility (Category E).

- The main contributor to the operational risk of Chinese RVSM airspace in this reporting period was flight crew failing to climb/descend the aircraft as cleared (Category A).

3.12 **Table 3** below summarizes the results of the airspace safety oversight, as of November 2010, in terms of the technical, operational, and total risks for the RVSM implementation in the Chinese domestic RVSM airspace.

Chinese domestic RVSM Airspace – estimated annual flying hours = 1 866 247 hours *(note: estimated hours based on the December 2009 traffic sample data. Estimate represents the sum of total flying hours for Radar and Procedural control area)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	1.741×10^{-10}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.602×10^{-9}	-	-
Total Risk	$\mathbf{1.776 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Below Overall TLS**

Table 3: Risk Estimates for the RVSM Implementation in Chinese domestic RVSM Airspace

3.13 **Figure 3** below presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports since June 2009.

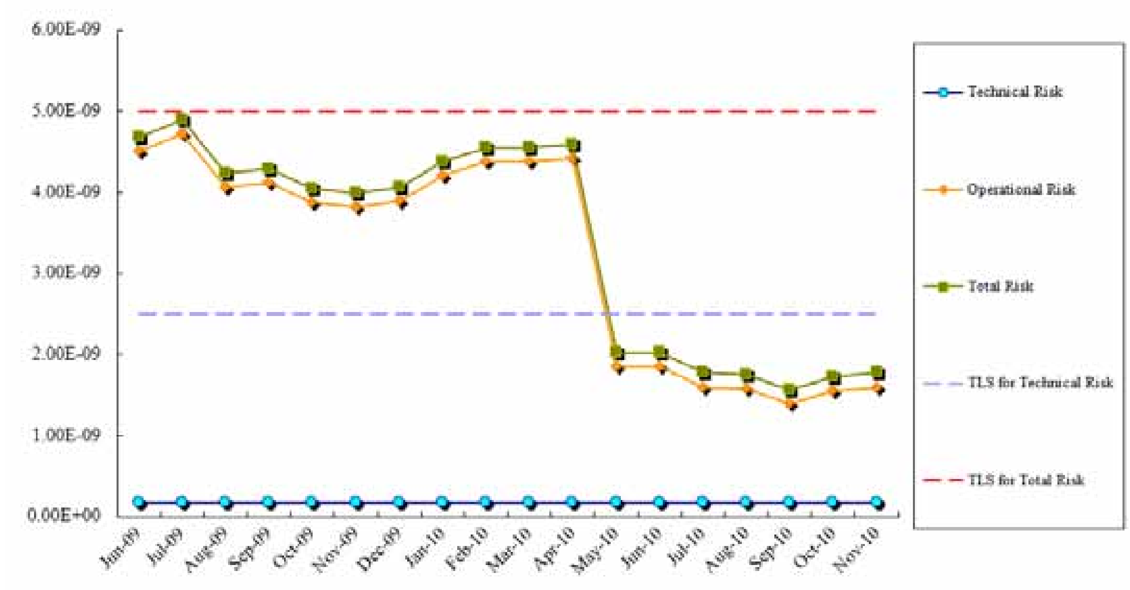

Figure 3: Trends of Risk Estimates for the RVSM Implementation in Chinese domestic Airspace

3.14 Based on these collision risk estimates, both the estimates of technical and total risks from the available TSD and LHD reports satisfy the agreed TLS value of no more than 2.5×10^{-9} and 5.0×10^{-9} fatal accidents per flight hour.

Pyongyang FIR

3.15 China RMA informed the meeting that LHDs have been monitored in the Pyongyang FIR since 2009. The Democratic People's Republic of Korea has continued to collect records of traffic movements and LHDs in the Pyongyang FIR however there has been no report of an LHD in the Pyongyang FIR.

3.16 To make a conservative estimate for the operational risk, China RMA applied the same operational risk value used in the preliminary assessment for Pyongyang FIR reported to RASMAG/11. In response to a question from the Chairman, China RMA stated that they have confidence in the flight hours determined for the TSD and that in regards to the absence of any reported LHDs, that the DPRK has full knowledge of what is required to be reported under as LHDs.

3.17 **Table 4** below provides the results of the airspace safety oversight, as of November 2010, in terms of the technical, operational, and total risks for the airspace of DPR Korea.

RVSM Airspace of DPR Korea – estimated annual flying hours = 6 044 hours *(note: estimated hours based on the December 2009 traffic sample data. Estimate represents the sum of total flying hours for Pyongyang FIR)*			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	4.02×10^{-10}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.55×10^{-9}	-	-
Total Risk	1.95×10^{-9}	**5.0×10^{-9}**	**Below Overall TLS**

Table 4: Risk Estimates for the RVSM Implementation in the Airspace of DPR Korea

3.18 **Figure 4** presents the trends of collision risk estimates for each month using the estimated LHD data since February 2009.

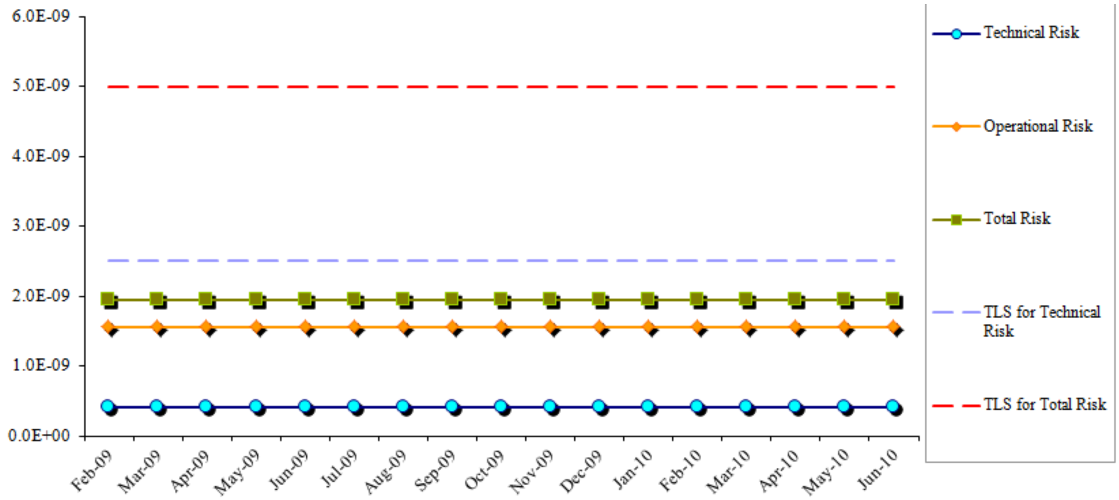

Figure 4: Trends of Risk Estimates for the RVSM Implementation in the Airspace of DPR Korea

3.19 The meeting noted that the estimates of both technical and total risks from the available TSD and LHD reports satisfy the agreed TLS value of no more than 2.5×10^{-9} and 5.0×10^{-9} fatal accidents per flight hour.

JCAB's RMA Activities

3.20 Japan presented the meeting with the result of the most recent RVSM airspace safety assessment for the Fukuoka FIR, which was derived from the December 2009 TSD and LHD reports for the period of December 2009 to November 2010. The LHD of longest duration was due to HF radio miscommunication between an HF operator and a pilot. Three LHDs due to HF miscommunication occurred consecutively in three months (June to August, 2010). The Air Traffic Management Center (ATMC) which provides oceanic ATC and Tokyo Radio, which provides HF voice communication, discussed measures to prevent miscommunication in September 2010. Since then, no LHD related to HF miscommunication has been reported.

3.21 **Table 5** below presents the estimates of vertical collision risk for Japanese airspace. The technical risk was estimated to be 0.31×10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk was 9.42×10^{-9} fatal accidents per flight hour, which does not satisfy the globally agreed TLS value of 5.0×10^{-9} fatal accidents per flight hour.

Japanese RVSM Airspace – estimated annual flying hours = 957,711.25 hours *(note: estimated hours based on December 2009 traffic sample data)*			
Source of Risk	**Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.31×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	9.11×10^{-9}	-	-
Total Risk	$\mathbf{9.42 \times 10^{-9}}$	5.0×10^{-9}	**Above Overall TLS**

Table 5: Risk Estimates for the RVSM Implementation in the Japanese airspace

3.22 **Figure 5** below presents the trends of collision risk estimates by type, e.g. technical, operational, and total, for each month using the appropriate cumulative 12-month of LHD reports during the reporting period.

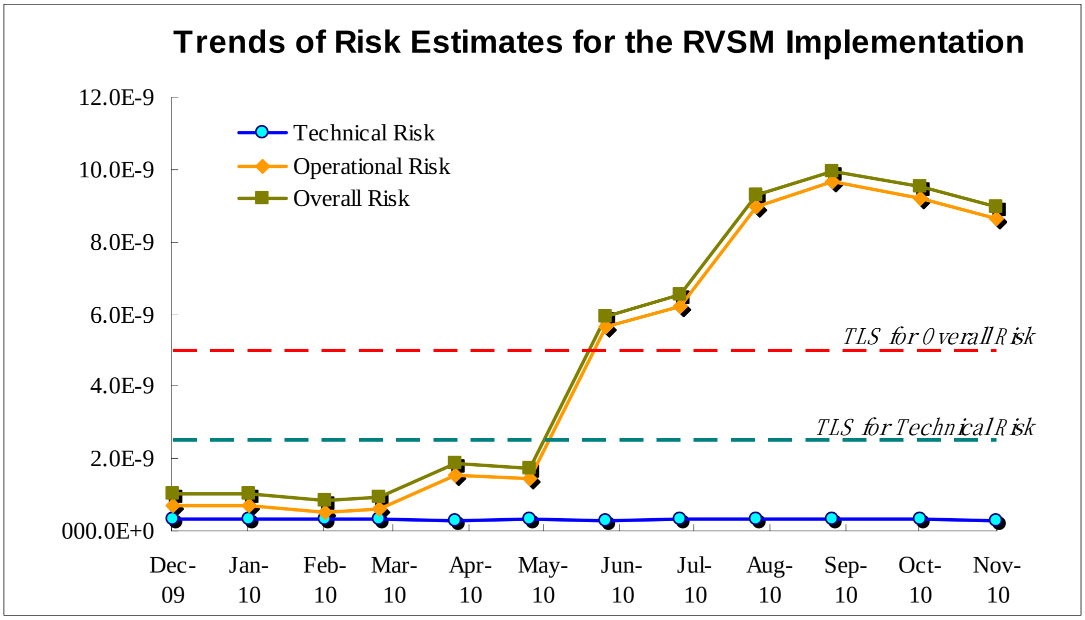

Figure 5: Trends of Risk Estimates for the RVSM Implementation in Japanese Airspace

3.23 Fukuoka FIR consists of domestic radar-control airspace and oceanic non-radar airspace. JCAB RMA has tried a risk calculation to add the flight levels crossed to the operational risk in accordance with WP/19 of RASMAG/13. The details are in **Appendix C** to this report.

3.24 The meeting noted that the risk calculated for the Fukuoka FIR does not meet the TLS but recognised that work was being undertaken by JCAB to identify and resolve problems. In discussing the issue of the identified HF communication read back/hear back errors, the meeting was informed that many of these related to coordination with Manila FIR. The Philippines explained to the meeting that it was expected that AIDC between the two FIRs would be implemented in 2013. The Republic of Korea commented that in relation to the errors identified on their joint boundary with Japan, they had undertaken a review of the coordination issues identified and could not resolve these from their controller's perspective. In an attempt to address these issues more effectively, the Republic of Korea proposed that the two States establish a scrutiny group to look at the complexity of the airspace which could be triggering these types of errors, and also the lack of response by controllers to AIDC messaging which are left in 'unprocessed' state. The meeting encouraged Japan and the Republic of Korea to progress this activity and to report any outcomes to RASMAG/15.

MAAR's RMA Activities

Bay of Bengal Airspace

3.25 The Monitoring Agency for Asia Region (MAAR) provided the summary of airspace safety oversight for the RVSM implementation in the Bay of Bengal (BOB) airspace. The RVSM safety oversight had been conducted based on a one-month traffic sample data (TSD) collected in

December 2009 and monthly Large Height Deviation (LHD) reports between December 2009 and November 2010 submitted by States in the BOB region.

3.26 A series of cumulative 12-month of LHD reports were used in this safety assessment starting from December 2009 to November 2010. The LHD occurrences in the BOB RVSM airspace are summarized as follows:

- Compared with the report at the previous meeting, the number of LHD occurrences increased from 11 to 33 occurrences while the total LHD duration increased from 32 to 57 minutes;

- In July 2010, there was one LHD report with a duration of 28 minutes which was caused by equipment failure (Category M: Other). This occurrence accounted for 49% of total duration;

- There were significant numbers of LHD reports in September and October 2010, but most of these events were zero duration as there was surveillance coverage in the area and thus the errors were detected in advance; and

- The number of such events significantly improved in November 2011, contributable to discussion/coordination between the two units concerned.

3.27 **Table 6** below summarizes the results of the airspace safety oversight, as of November 2010, in terms of the technical, operational, and total risks for the RVSM implementation in the BOB airspace.

Bay of Bengal RVSM Airspace – Estimated annual flying hours = 1,566,154 hours (Note: Estimated hours based on December 2009 TSD)			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.51×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	1.08×10^{-9}	-	-
Total Risk	$\mathbf{1.59 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Below Overall TLS**

Table 6: Risk Estimates for the RVSM Implementation in BOB Airspace

3.28 In addition, **Figure 6** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports since December 2009.

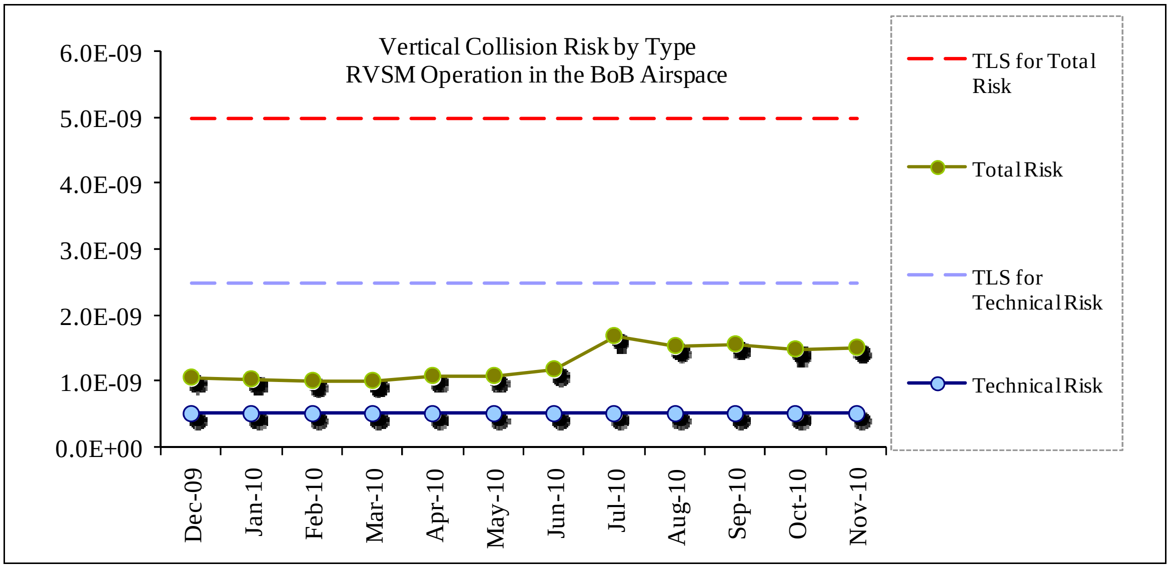

Figure 6: Trends of Risk Estimates for the RVSM Implementation in BOB Airspace

3.29 MAAR reminded States at the meeting that it is important that relevant information be provided to MAAR in order to provide accurate and effective safety reports. The meeting strongly urged that States provide information to MAAR such that any adverse trends are able to be identified as early as possible.

<u>Western Pacific/South China Sea Airspace</u>

3.30 MAAR also provided the summary of airspace safety oversight for the post RVSM implementation in the Western Pacific/South China Sea (WPAC/SCS) airspace**.** The RVSM safety oversight analysis is conducted based on a one-month Traffic Sample Data (TSD) collected in December 2009 and monthly Large Height Deviation (LHD) reports between December 2009 and November 2010 submitted by concerning States in the WPAC/SCS region.

3.31 The LHD occurrences in the WPAC/SCS RVSM airspace are summarized as follows:

- Compared with the previous report, the total LHD duration increased from 98 minutes to 176 minutes while the number of LHD occurrences increased from 74 to 116 occurrences;

- There were two main factors constituting a significant portion of the LHD occurrence in the WPAC/SCS region;

  - A LHD event in July 2010 with a duration of 28 minutes caused by equipment failure (Category M: Other); and

  - A significant number of Category E LHD occurrences (a total of 100 occurrences accounted for 129 minutes in duration).

- Furthermore, according to the Category E LHD occurrences:

  - The number of LHD occurrences and duration increased significantly from March to September 2010, but started to decline in October and also continue in November 2010; and

- The most common locations (Top 5) where such events occurred in term of duration included ARESI, GORAI, LAXOR, SADAN and PEDNO.

3.32 **Table 7** below summarizes the results of the airspace safety oversight, as of November 2010, in terms of the technical, operational, and total risks for the RVSM operation in the WPAC/SCS airspace.

South China Sea RVSM Airspace – estimated annual flying hours = 905,147 hours (note: estimated hours based on December 2009 traffic sample data)			
Source of Risk	**Lower Bound Risk Estimation**	**TLS**	**Remarks**
Technical Risk	0.64×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	5.07×10^{-9}	-	-
Total Risk	$\mathbf{5.71 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Above Overall TLS**

Table 7: Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

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

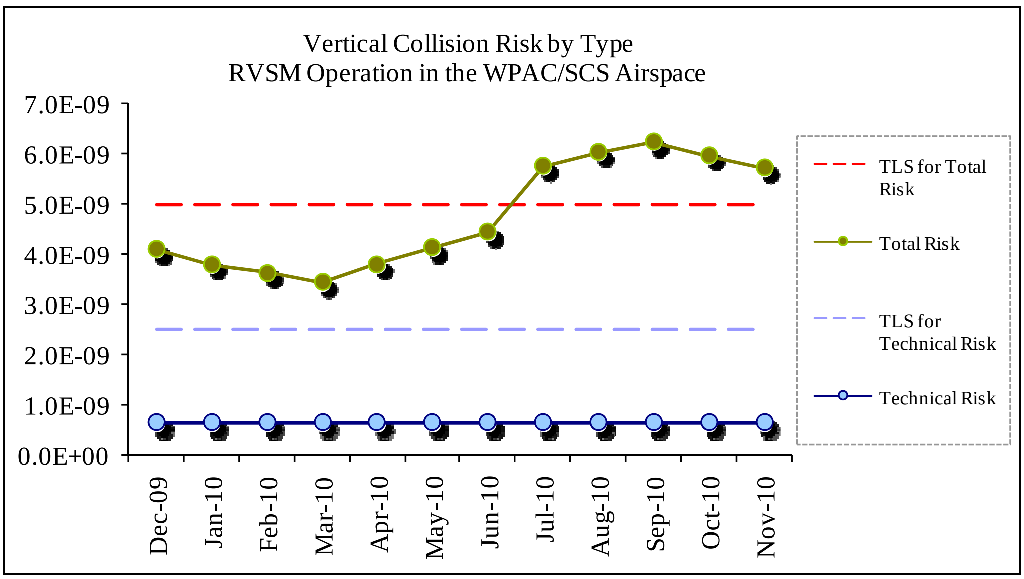

Figure 7: Trends of Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

3.34 It was strongly encouraged that States concerned take any remedial and preventive actions necessary to persistently maintain the number of LHD occurrence as well as duration to a minimum. The Chairman asked if a scrutiny group would need to be established to resolve the high number of Category E LHDs now being reported and which are adversely affecting the risk. MAAR responded that at the time of the reporting of these LHDs, the ACC supervisors had discussed the incidents and identified the causes. The Chair commented that while that is commendable, it is after the fact, and that in his view work should be undertaken to proactively resolve these issues systemically. MAAR agreed and noted the previously established scrutiny group had identified the need for automated processes. The Secretary asked whether there was any additional assistance that the Region could provide to assist the early implementation of AIDC however no assistance was deemed necessary at this time. The meeting encouraged the States affected by these types of errors to work to resolve these issues as soon as possible through use of available technologies.

3.35 The meeting recognised that Manila was often the receiving centre for some of the errors occurring and that other States involved must recognise this and work to resolve the issues. In discussing this further, the meeting was concerned that the issues should be resolved quickly by the States concerned and proposed that possibly MAAR could coordinate a meeting of those States. MAAR stated they would need time to consider this and would appreciate assistance from the Regional office in this regard. Further discussion on this issue by the meeting resulted in a proposal by the Philippines that possibly a SEACG working group discussion to resolve Cat E errors may be appropriate. Singapore agreed that the right operational people will be in place to undertake that work in a side meeting. The Secretary agreed to ensure that such a meeting was convened at the SEACG/18 meeting during 3-6 May 2011. The Chairman stated that he would inform Indonesia of this outcome at a forthcoming meeting between the AAMA and the DGCA.

3.36 Vietnam thanked MAAR for the report noting that often the State authorities who can best deal with issues identified in the safety assessments do not receive copies of the RMA assessments. The meeting agreed that RMAs should ensure, where possible, the timely distribution of risk assessments to the relevant authorities of the States for which they are the responsible RMA. The Secretariat would send a State Letter with the F1 form attached to ensure that up-to-date contact details were provided to the relevant RMA.

PARMO's RMA Activities

3.37 The Pacific Approvals Registry and Monitoring Organization (PARMO) provided an update to the meeting including summary of LHD reports, results of traffic data analysis and estimates of vertical risk for the airspace under their responsibility. The report covered the reporting period 1 December 2009 to 30 November 2010.

3.38 PARMO, a service provided by the U.S. Federal Aviation Administration's Technical Center, serves as the regional monitoring agency (RMA) for Pacific and for a portion of Northeast Asia airspace. The PARMO produces two reports each calendar year following the standardized reporting period and format guidelines set forth by RASMAG. The report includes information relevant to continued safe use of the RVSM in a portion of Northeast Asia airspace as well as the Pacific airspace.

3.39 The report detailed the large height deviation reports received by the PARMO during the reporting period and the corresponding update to the vertical collision risk estimate. There were a total of 33 such reports submitted to the PARMO during the reporting period. A slight increase in the number of reported risk-bearing events for Pacific airspace was observed. The number of risk-bearing events for the portion of Northeast Asia airspace was zero for the current twelve-month reporting period.

3.40 The LHD reports are separated by categories based on the details provided for each deviation. There are three such categories: large deviations contributing to technical risk, large height deviations contributing to operational risk and large height deviations occurring outside of RVSM airspace or airspace for which the PARMO is the responsible RMA. The two LHD reports in relation to technical risk involved aircraft correctly following an ACAS advisory and were considered to be non-risk bearing. All the 16 LHDs contributing to operational risk were reported for Pacific airspace.

3.41 Ten of the 16 events that contribute to operational risk were related to air traffic control. It was noted that the cause of six of these 10 events related to air traffic control involved errors in coordination of control between ATC facilities. Five of these six events were related to human factor issues, the remaining event was related to technical issues.

3.42 Two events related to air traffic control were ATC loop errors. One of these errors occurred in the South Pacific (SOPAC) traffic flow and accounted for 20 minutes of operation at the incorrect flight level. The other error took place in the Central Pacific (CENPAC) traffic flow and was estimated to be 5 minutes in duration.

Estimate of Vertical Collision Risk for Pacific Airspace

3.43 **Table 8** below presents the estimates of vertical collision risk for Pacific airspace. The technical risk was estimated to be 0.064 x 10^{-9} fatal accidents per flight hour. The operational risk estimate was 4.374 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk was 4.438 x 10^{-9} fatal accidents per flight hour. This estimate meets the regionally agreed TLS value of 5.0 x 10^{-9} fatal accidents per flight hour. This new estimate is based on the most recent 12 months of LHD reporting and recently updated collision risk parameters based on the December 2009 TSD collected.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.064 x 10^{-9}	2.5 x 10^{-9}	Below Technical TLS
Operational Risk	4.374 x 10^{-9}	-	
Total Risk	4.438 x 10^{-9}	5.0 x 10^{-9}	Below Overall TLS

Table 8: Vertical Collision Risk Estimates for Pacific Airspace

3.44 **Figure 8** below provides the PARMO's updated risk estimates for Pacific RVSM airspace based on recent reports of LHD. The estimated flying hours in the portion of Pacific RVSM airspace for which the PARMO is the responsible RMA is 880,700 flying hours per year.

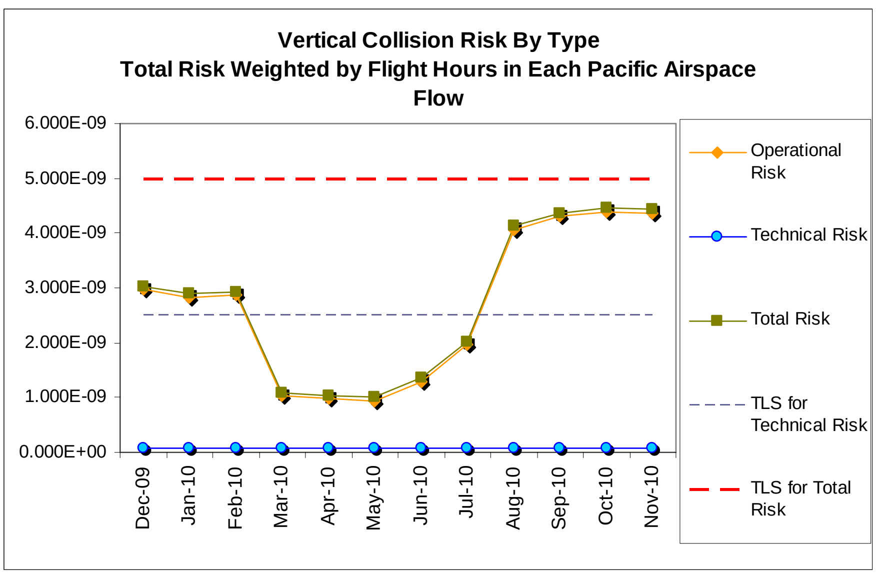

Figure 8: Vertical Collision Risk for Pacific RVSM Airspace

3.45 PARMO noted that in the preparation of the report for the Pacific Airspace, no account had been made to include the Arctic airspace managed by the United States. This airspace is not included in any other RMA safety assessment. The PARMO sought RASMAG agreement to include this airspace in future reporting which was supported by the meeting.

Estimate of Vertical Collision Risk for North East Asia Airspace

3.46 The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) is met in a portion of Northeast Asia airspace. **Table 9** below presents the estimates of vertical collision risk for a portion of Northeast Asia airspace. The technical risk was estimated to be 1.786×10^{-9} fatal accidents per flight hour. The LHD reports received during the most recent 12 calendar months are included in the estimate of vertical operational risk. Because there were no risk-bearing events reported for the Incheon FIR during the time period used for this safety monitoring report, the current operational risk value for November 2010 is 0.00×10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 1.786×10^{-9} fatal accidents per flight hour. This estimate meets the regionally agreed TLS value of 5.0×10^{-9} fatal accidents per flight hour. This new estimate was based on the most recent 12 months of LHD reporting and the traffic sample received in December 2009. The estimated annual flying hours for this portion of Northeast Asia airspace is 133,399 flying hours per year.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	1.786×10^{-9}	2.5×10^{-9}	Below Technical TLS
Operational Risk	0.00×10^{-9}	-	
Total Risk	1.786×10^{-9}	5.0×10^{-9}	Below Overall TLS

Table 9: Vertical Collision Risk Estimates for North East Asia Airspace

3.47 **Figure 9** below provides the PARMO's updated risk estimates for a portion of Northeast Asia RVSM airspace based on recent reports of LHD.

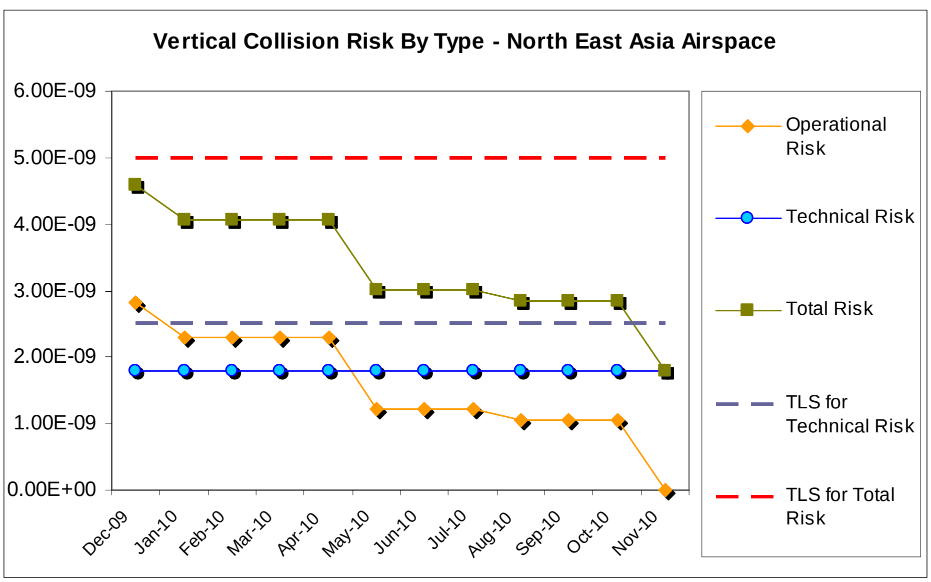

Figure 9: Vertical Collision Risk for Northeast Asia RVSM Airspace

AIDC Implementation

3.48 Japan informed the meeting that it has analyzed the trend of Category E LHD occurrences before and after the Japan-ROK (Republic of Korea) AIDC implementation. The limited trial operation of AIDC between Incheon ACC and Naha/Fukuoka ACC was begun in May 2009, and the successive full-time trial operation was begun in June 2009. The official implementation of AIDC commenced in February 2010.

3.49 **Figure 10** shows the number of LHD occurrences caused by transfer errors at ATOTI between December 2008 and November 2010. A dot expresses one LHD report. The line graph represents the total number of aircraft transited over ATOTI. Despite the gradual increase of traffic in the last one year, the number of transfer errors decreased significantly after the implementation of AIDC.

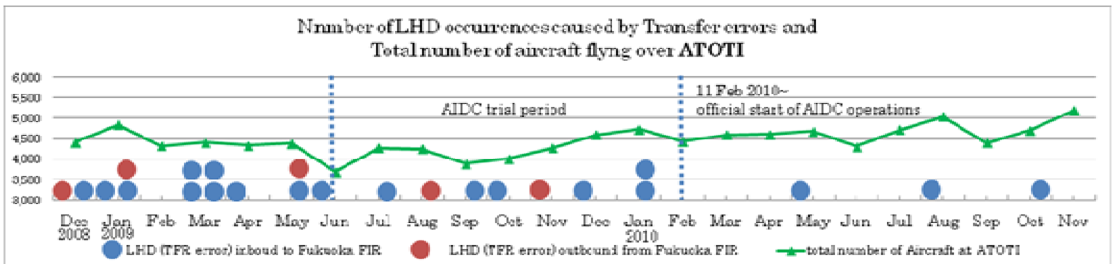

Figure 10: Number of LHD occurrences caused by Transfer errors and Total number of aircraft flying over ATOTI

3.50 The meeting discussed this information in some detail with the Republic of Korea requesting a more rigorous process to identify and resolve these types of issues. They also noted that investigation of these occurrences had not determined any error on the part of ROK controllers. The Chairman reminded the meeting that the intent of bringing this type of information to RASMAG was to ensure that States were taking appropriate action to identify and resolve these errors. He noted that it was evident that the two States involved had undertaken some level of coordination in this regard but that possibly that could be enhanced. Additionally he commented that in his view, the data presented was a ‘good news story’ in that it demonstrated the effectiveness of AIDC in controlling coordination errors that impacted on the airspace risk. The meeting congratulated Japan and Republic of Korea on a successful implementation of AIDC.

Analysis of ATC to ATC Coordination Errors

3.51 At RASMAG/13, Australia presented the detailed results of an analysis of ATC to ATC Coordination and Pilot Failure to Comply incidents located near the boundaries of Australian airspace where AIDC had not been implemented. Australia identified significant coordination issues attributed to foreign ATS providers where aircraft information related to track deviations, position estimates and levels upon entry to the Australian FIRs are not effectively communicated to Australian ATS.

3.52 The meeting noted that Australia had already introduced AIDC to facilitate coordination across FIR boundaries in a number of areas including the Tasman Sea/Pacific. However other boundaries which do not currently have AIDC continue to see significant ATC to ATC coordination errors. The Australian Airspace Monitoring Agency (AAMA) and Airservices Australia maintain a close oversight on incidents and associated safety risks involving Australia's airspace boundaries.

3.53 **Figure 11** shows the distribution of Airservices Australia Electronic Safety Incident Reporting (ESIR) Occurrence Attribution over the 12 month period of the source data in order to show the seasonal pattern.

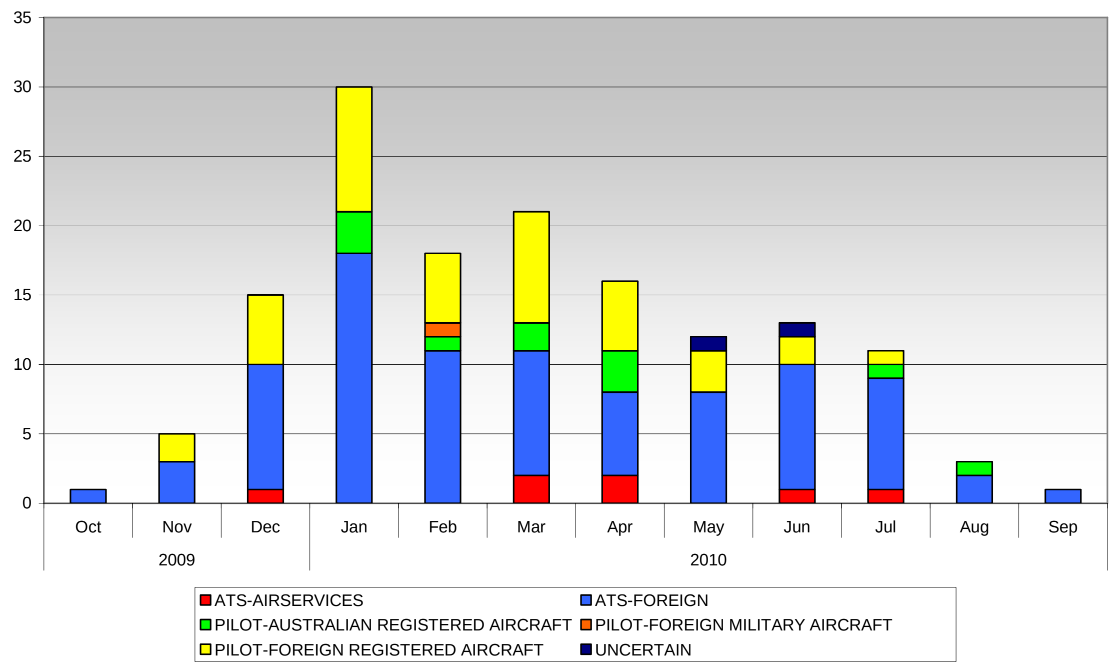

Figure 11: Occurrence Attribution for ESIRs by month, 1 October 2009-30 September 2010

3.54 Australia continues to monitor coordination incidents relative to its FIR boundaries and has updated the data analysed above in this paper. **Figure 12** below identifies Breakdowns of Coordination relative to all adjoining FIRs and shows a declining trend during the last year although a small spike is evident for the 4th quarter of 2010. The data shows a continuing decrease during the first quarter in 2011 based on reported incidents to date.

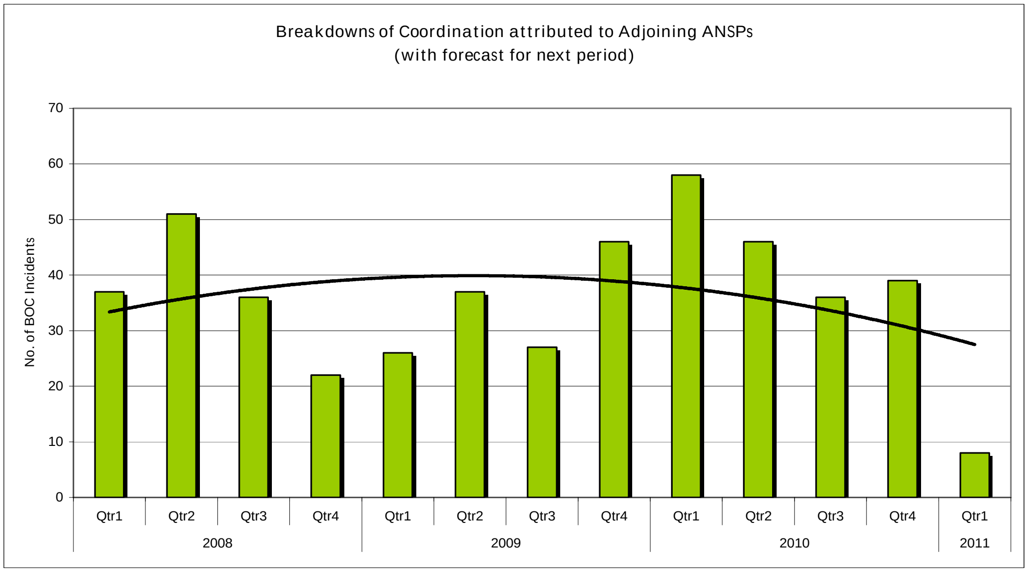

Figure 12: Breakdowns of Coordination attributed to Adjoining ANSPs

3.55 Based on reports to date, that trend is expected to continue during the first quarter of 2011. Airservices Australia and the AAMA believe this reduction in coordination errors has been the result in part to the trial implementation of AIDC that commenced in July 2010 and the sharing of ADSB surveillance data between Ujung and Brisbane FIRs that commenced in January 2011. This latter implementation means that coordination type errors can be more readily identified through surveillance data and system safety nets prior to aircraft transiting from one FIR to the next. Additionally, ANSPs have worked through means of scrutiny groups to resolve the re-occurrence of these coordination errors.

3.56 The meeting thanked Australia for the updated information and encouraged all RMAs and States to continue to analyse these types of occurrences and provide reports to RASMAG where negative safety impacts are identified.

Transition of Regional Monitoring Agency Services for the Sanya FIR

3.57 In October 2010, China RMA received formal authorization from ICAO Asia and Pacific Office that APANPIRG/21 supported the recommendation from RASMAG for the transfer of MAAR's responsibilities in the Sanya FIR to the China RMA. China RMA and MAAR also sought the opportunity to share knowledge and experience in matters relating to RMA operations.

Transition Seminar between MAAR and China RMA

3.58 China RMA and MAAR held a seminar in Sanya on 15 December 2010 to coordinate the transition arrangement of the RMA services for Sanya oceanic airspace. China RMA and MAAR reached agreement on the following aspects, which took effect from January 2011:

- Data Collection:
    - Traffic Sample Data (TSD) Collection. The formal collection of December TSD datasheet for Sanya oceanic airspace will be provided to MAAR before 1 February to support the safety assessment for the South China Sea area.

- Large Height Deviation (LHD) Report. China RMA is responsible for providing detailed information of LHD occurrences in Sanya oceanic airspace to RASMAG meetings, when necessary, and will assist MAAR when a further investigation is needed.

■ Safety Assessment:

The collision risk in the Sanya oceanic airspace will be included in the risk estimate for the entire Chinese RVSM airspace using the weighted average method. The same data set will also be utilized by MAAR to support the safety assessment for South China Sea.

3.59 The meeting noted the excellent cooperation that continues between the two RMAs and MAAR thanked China RMA for arranging the meeting to ensure the smooth transfer of responsibilities. The Secretary asked if there was a formalised agreement between the two RMAs setting out the agreed process. He suggested that such formal agreements should possibly be put in place between RMAs where specific coordination has been developed.

Airframes Continuously Conducted RVSM Flights with No Registration in RMA's Approval Data

3.60 Japan recalled that the primary systemic reason for failure to match operations and approvals was a delay in State notification of the approval status of some operators to the appropriate RMA. The meeting was provided with the results of once-a-month comparison between RMAs' approval databases and actual flight plans operated within the RVSM airspace of Fukuoka FIR from December 2009 to November 2010.

3.61 JCAB RMA compared more than 70,000 plans of RVSM flights with the global RMA's latest approval databases uploaded to the KSN website. Some operator-aircraft combinations were continuously detected as non-registered airframes. Japan RMA has identified seventy-seven (77) airframes which were flying in the RVSM airspace of Fukuoka FIR with "W" on their flight plans but without the registration in RMAs' RVSM approval databases between December 2009 and November 2010. **Appendix D** to this report details a list of airframes which conducted RVSM flights with no registration in RMAs' approval databases.

Non-RVSM-Approved Aircraft Operating in Asian RVSM Airspace

3.62 MAAR provided an updated assessment of operators/aircraft types operating within RVSM airspace, for which RVSM approval records were not found in the RMA database.

<u>Assessment Results</u>

3.63 **Table 10** indicates airlines operating in RVSM airspace in the Asia Region, with no RVSM approval in the RMA database.

Operator Code	AC Type	Operator Name	State
HVN	A332	Vietnam Airlines	Vietnam
HVN	A333	Vietnam Airlines	Vietnam
PIC	B734	Pacific Airlines	Vietnam
PIC	A320	Pacific Airlines	Vietnam

Operator Code	AC Type	Operator Name	State
RBA	A320	Royal Brunei Airlines	Brunei
RBA	A319	Royal Brunei Airlines	Brunei

Operator Code	AC Type	Operator Name	State
PAL	B773	Philippine Airlines	Philippines

Operator Code	AC Type	Operator Name	State
AIC	A321	Air India Limited	India
AIC	A320	Air India Limited	India
AIC	A319	Air India Limited	India
AIC	B77L	Air India Limited	India
AIC	B77W	Air India Limited	India
AIC	A332	Air India Limited	India
AIC	B738	Air India Limited	India
AIC	B773	Air India Limited	India
AIC	A321	Air India Limited	India
AXB	B738	Air India Express	India
IGO	A320	IndiGo Airlines	India
JLL	B737	JetLite	India
JLL	CRJ2	JetLite	India
JLL	B738	JetLite	India
KFR	A332	Kingfisher Airlines	India

Operator Code	AC Type	Operator Name	State
BBC	DC10	Biman Bangladesh Airlines	Bangladesh
BBC	A310	Biman Bangladesh Airlines	Bangladesh
BBC	B742	Biman Bangladesh Airlines	Bangladesh

Operator Code	AC Type	Operator Name	State
MMA	A320	Myanmar Airways International	Myanmar
JAB	F100	Air Bagan	Myanmar

Table 10: Assessment of Non-RVSM-Approved Aircraft Operating in the Asia RVSM Airspace

3.64 In discussing the reports from both the JCAB RMA and MAAR, the Chairman suggested that States represented in the data provided by the RMAs should update the information directly to the RMAs in the first instance and then on advice from the RMAs, ICAO can send out the follow-up State Letter to the relevant States. The meeting requested that this task be completed by the end of March 2011.

RVSM Implementation in the Kabul FIR

3.65 The State of Afghanistan plans to implement RVSM within the Kabul FIR at the same time as the Eurasian States in November 2011. Given that the Kabul FIR is under the ICAO Asia and Pacific Region, a number of issues need to be addressed, especially on the matter of airspace safety monitoring for the RVSM implementation.

3.66 In October 2010, the Middle East Regional Monitoring Agency (MIDRMA) contacted MAAR to request the RVSM approval records of Afghanistan-registered aircraft. In this regard, MAAR notified the MIDRMA that MAAR does not have the approval record of any Afghanistan-registered aircraft since MAAR understood that the State of Afghanistan was under the responsibility of the MIDRMA based on the most updated RMA Manual (Appendix B to the manual).

3.67 A series of communications were made between the ICAO Headquarters, ICAO Asia and Pacific Office, ICAO Middle East Office, Chairman of RASMAG, and MAAR regarding clarification on the responsible RMA for the Kabul FIR. The following information was provided:

- The State of Afghanistan is now part of the ICAO Asia and Pacific Region. Hence, the MAAR was expected to be the responsible RMA for RVSM implementation in the Kabul FIR.

- As Airspace Control Authority in Afghanistan and at the Minister of Transport Civil Aviation's request, the United States Air Force Central Command (USAFCENT) is charged with developing an RVSM implementation plan, which the USAFCENT has partnered with a contract company MITRE to perform the safety assessment for the RVSM pre-implementation.

- The USAFCENT also contacted the MAAR for the procedure and protocol to include the State of Afghanistan (Kabul FIR) as part of the MAAR.

3.68 MAAR was willing to provide its full support in the RVSM implementation in the Kabul FIR. Nonetheless, there are currently many parties involved in the RVSM implementation and its preliminary safety assessment including the State of Afghanistan, USAFCENT, and MITRE. As MAAR is intended to be the responsible RMA for Kabul FIR RVSM implementation, it was important that Appendix B of the RMA Manual reflects such a change in responsibility.

3.69 A sidebar meeting was held on Tuesday 22 February 2011 between parties concerned with RVSM implementation in November 2011, including representatives from MAAR, Afghanistan and Mongolia. A copy of the meeting notes is attached as **Appendix E**.

3.70

Report from the South East Asia Safety Monitoring Agency

3.71 The South East Asia Safety Monitoring Agency (SEASMA) provided a report on operations on the six major ATS routes in the South China Sea airspace in order to determine compliance with Asia and Pacific Regions safety goals for the established lateral and longitudinal separation standards. The report covered the period of 1 December 2009 through 30 November 2010.

3.72 **Table 11** summarizes the results of the airspace oversight, as of November 2010.

Type of Risk	Risk Estimation	TLS	Remarks
Lateral Risk	1.54×10^{-9}	5×10^{-9}	Below TLS
Longitudinal Risk	1.00×10^{-9}	5×10^{-9}	Below TLS

Table 11: Lateral and Longitudinal Risk Estimation

3.73 **Figure 13** presents the results of the collision risk estimates for each month using the cumulative 12-month LLD and LLE reports since December 2009.

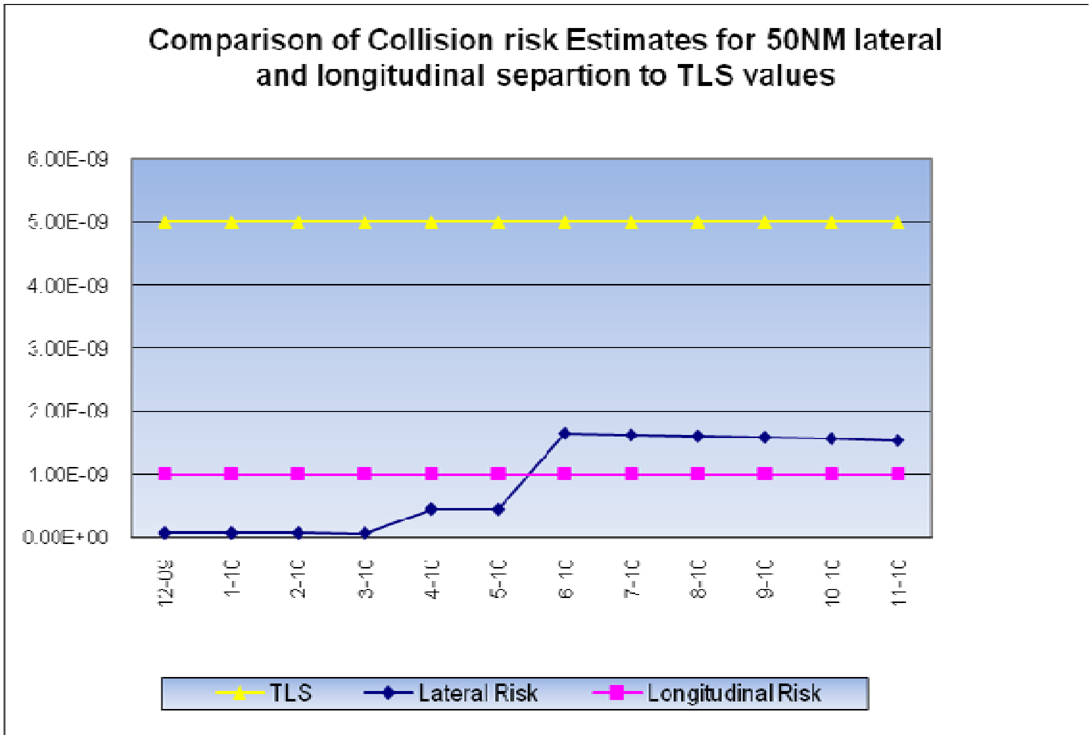

Figure 13: Assessment of Compliance with Lateral and Longitudinal TLS Values Based on Navigational Performance Observed During South China Monitoring Program

Assessment of the 50 NM Lateral and 50 NM Longitudinal Separation Standard for the Bay of Bengal

3.74 At BOB-RHS/TF4 (October 2010, Bangkok), India requested the SEASMA to support and assist in the conduct of the initial safety assessment of Phase 1 implementation of reduced horizontal separation in the Bay of Bengal region, as well as to provide continued safety monitoring services until such time when India is endorsed by RASMAG and APANPIRG as a competent EMA.

Risk Assessment and Safety Oversight

3.75 The safety assessment has been conducted using the internationally applied collision risk methodology which has supported airspace separation changes in several ICAO regions. As applied to a proposed separation change, the methodology consists of using a mathematical model to estimate the risk of midair collision for the proposed standard and comparing the estimated risk to a safety goal, the Target Level of Safety (TLS), which is a value of risk, agreed as tolerable by decision makers. If the estimated risk is less than the TLS, the outcome of applying the methodology is to support the proposed change.

3.76 No lateral error of 15 NM or greater magnitude and no longitudinal error events have been reported on L301, L510, L759, M300, M770, N563, N571, N877, P570, P574, P628 and P762. India had also confirmed that there was no report of LLD since the implementation of 50 NM lateral separation minima.

Safety Oversight - Lateral

3.77 As the monitoring program for the Bay of Bengal only commenced in July 2010, there were only six month of traffic being monitored. The risk assessment employed two methods of analysis.

a) Sequential Sampling

It can be concluded with 95 percent statistical confidence that the continued use of 50 NM lateral separation standard for all the 12 routes meet the TLS.

b) Direct Estimation

This approach was used as a confirmation that the lateral risk can meet the TLS. The lateral risk was estimated based on the number of navigation error reports received. Using this method, the lateral collision risk is estimated to be 0.195×10^{-9} which met the TLS.

Safety Oversight – Longitudinal

3.78 The longitudinal collision risk was estimated to be 0.380×10^{-9}.

Conclusion

3.79 **Table 12** below summarises the result of the airspace oversight.

Type of risk	Risk estimation	TLS	Remarks
Lateral Risk	0.195×10^{-9}	5×10^{-9}	Below TLS
Longitudinal Risk	0.380×10^{-9}	5×10^{-9}	Below TLS

Table 12: Summary of the Result of the Airspace Oversight

Preliminary Air Space Analysis of the Bay of Bengal by the Indian Monitoring Agency

3.80 Recognizing the necessity for a formal monitoring program on a sub-regional basis for lateral and longitudinal navigation errors in the Bay of Bengal to support implementation of reduced horizontal separations and that limitations in the availability of safety monitoring services would hinder the implementation, India accepted the responsibility of establishing an En-route Monitoring Agency (EMA).

3.81 India highlighted the work accomplished in preparation for the introduction of 50 NM longitudinal separation on RNP 10 routes over the Bay of Bengal, Arabian Sea and Indian Ocean. The document attached herewith includes the airspace analysis as **Appendix F** and collision risk assessment as **Appendix G** in respect of the Bay of Bengal/Arabian Sea areas.

3.82 The quantitative risk assessment for the lateral collision risk has been carried out using the internationally recognized Reich Collision Risk Model. The CRM uses TSD of December 2010, radar surveillance data from Chennai, Kolkata, Mumbai, Yangon and Kuala Lumpur Air Traffic Control and the Gross Navigational Error data collected from July 2010 to December 2010.

3.83 The safety assessment and airspace analysis had been carried out by a team of ATM and mathematical experts from the Indian Statistical Institute and DGCA the regulator. India (BOBASMA) and Singapore (SEASMA) had been sharing the data and experience towards achieving the goal.

3.84 The lateral collision risk is estimated to be 0.601881 x 10^{-9} and the longitudinal collision risk 0.371804 x 10^{-9}, both of which are well below the TLS of 5 x 10^{-9} fatal accidents per flight hour. Thus it was concluded that the safety assessment supported the continued use of 50 NM lateral separation and also the implementation of 50 NM longitudinal separation on L510, N571, P628 and P762.

3.85 The meeting noted the TLS arrived at through the safety assessment for the Bay of Bengal and the Arabian Sea areas, which is well below the TLS prescribed for the airspace under consideration for the introduction of reduced horizontal separation of 50 NM. In addition the meeting noted the desire of India to have its competencies in this type of work endorsed by RASMAG and to support its application to become an EMA.

3.86 Further, India clarified that the area of responsibility of the planned enroute monitoring agency would be:

> Chennai, Colombo, Dhaka, Delhi, Kabul, Karachi, Kolkata, Lahore, Male, Mumbai, Yangon FIRs (data from the Jakarta and Kuala Lumpur FIRs would be assessed as part of the BOB route structure).

3.87 The Chairman reminded the meeting that the need for an EMA for the sub-regional area of Bay of Bengal was identified some time ago and it was recognised that India was possibly best placed to fill this role. He stated that he considered the work undertaken jointly by the United States, SEASMA and India to enhance the capabilities of India in this regard as highly commendable and this was supported by the meeting. The Chairman proposed that on the basis of the impressive analysis and risk assessment undertaken by India that the meeting should be prepared to endorse the work undertaken to date and to work to preparing a recommendation to be presented to APANPIRG in September 2011 to approve India as an EMA for the identified sub-region. The meeting supported this proposal. The Chairman commented that further training should be undertaken before the next RASMAG in August 2011 so that the recommendation to APANPIRG can be finalised. Additionally, he suggested that in the interim, India should continue to develop its expertise by having assessment work peer reviewed by either SEASMA or PARMO. The meeting agreed with these proposals and again congratulated India on their success to date.

3.88 SEASMA stated that they would be happy to support India in any peer review. India thanked both SEASMA and the United States for the support provided to India in order to acquire airspace monitoring capability.

Preliminary Assessment Work to Support Use of the 30NM Lateral and Longitudinal Separation

3.89 In December 2005, the FAA introduced the 30NM lateral and 30NM longitudinal separation standards into the Oakland FIR as an operational trial. The reduced horizontal separation standards are available for suitably equipped RNP4 aircraft conducting operations in the Oakland FIR. The application of the reduced horizontal separation standards is done on a target-of-opportunity basis; this means that the application of the separation standard is not planned prior to oceanic entry.

3.90 In March 2007, the FAA introduced the Ocean21 oceanic automation system into full-time operation in oceanic sectors 10 and 11 in the Anchorage FIR. In November 2008, the FAA introduced the 50NM longitudinal separation in the Anchorage oceanic FIR for suitably equipped RNP10 operations. In November 2010, the FAA introduced the 50 NM lateral separation standard into Anchorage arctic oceanic airspace for RNP10 operations.

3.91 The FAA intends to introduce the 30NM lateral and 30NM longitudinal separation standards in the Anchorage FIR in the near future. This paper contains details of preliminary safety assessment work to support this planned implementation. An overview of the Anchorage airspace is provided which includes a description of observed airspace operations. In addition, an examination of operations which are eligible for the application of the reduced horizontal separation standards is presented.

3.92 **Figure 14** shows the location of the Anchorage Oceanic Airspace. The western boundary of the Anchorage Oceanic FIR borders the Fukuoka FIR. Air Traffic Services (ATS) for the Fukuoka FIR are provided by Japan's Civil Aviation Bureau (JCAB) and Air Traffic Management Center (ATMC). The southern boundary of the Anchorage Oceanic FIR borders the Oakland FIR. The U.S. FAA provides air traffic services within the Oakland FIR. The northern boundary of the Anchorage Oceanic FIR borders airspace controlled by the Russian Federation.

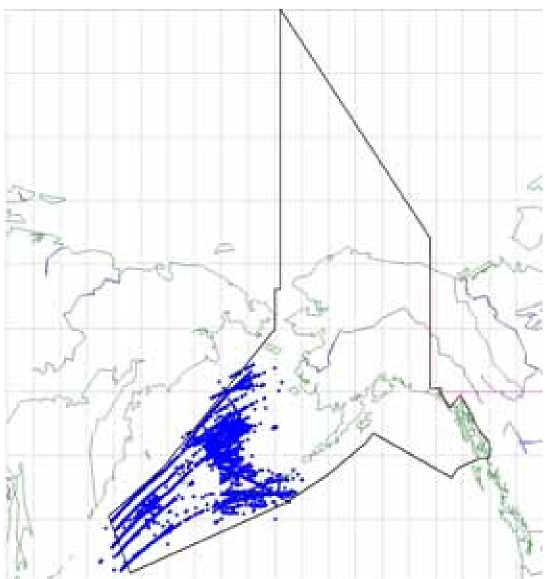

Figure 14: Aircraft/Pilot Reported Positions within Anchorage Airspace – December 2010

3.93 The planned implementation of the reduced horizontal separation standards will include eligible operations within the Anchorage oceanic FIR. In addition, the planned implementation will include eligible operations conducted within other areas of the Anchorage FIR where the Ocean21 automation system provides ATC with the necessary decision-support tools.

3.94 An estimated average of 440 flights per day operate within the Anchorage FIR. A majority of these flights are conducted within the domestic/continental portions of the FIR. An estimated average of 143 flights per day operates within the oceanic portion of the Anchorage FIR. An additional data source is needed and will be utilized to evaluate the differences in the aircraft operations within the Anchorage FIR.

3.95 Three of the five main airways in the NOPAC are one-way routes. Airway R220 and R580 are westbound routes. Airway A590 is an eastbound route. The remaining two routes, R591 and G344, allow for bi-directional traffic using flight level allocation rules. The westbound route R220 has the largest percent of ADS traffic in the Anchorage Oceanic FIR with 42.22 percent.

3.96 The top operator, Korean Air Lines Co Ltd. (KAL), accounts for approximately nine percent of the observed operations in the sample. The remaining 10 percent of the flights in the sample are attributed to thirty-five operators with operations ranging from 132 to one during the sample period, 107 military flights and 71 general aviation flights.

3.97 The top 13 aircraft types observed in the Anchorage oceanic FIR during calendar year 2010 are shown in Figure 15. The data presented in Figure 5 represents roughly 96 percent of all aircraft operations observed in the data sample. The B744 aircraft type accounts for roughly 43 percent of all operations conducted within the Anchorage oceanic FIR.

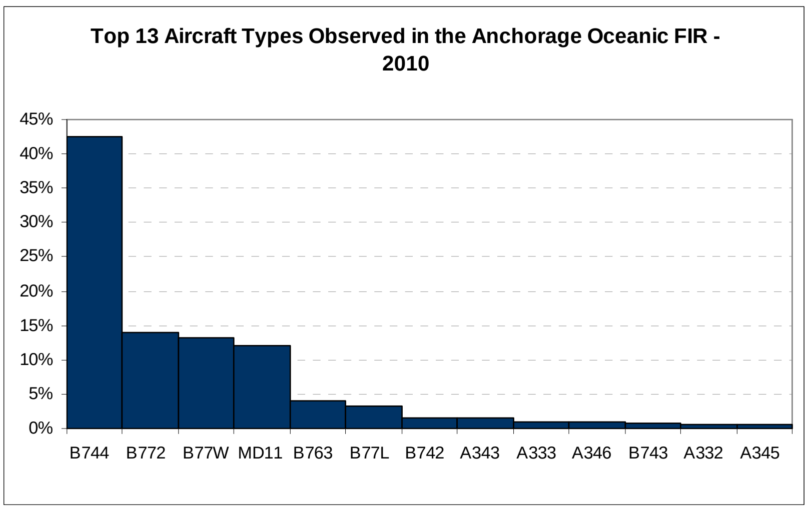

Figure 15: Top 13 Aircraft Types Observed within the Anchorage Oceanic FIR - 2010

3.98 **Table 13** contains the proportions of aircraft operations and filed RNP status. These data were obtained through the aircraft filed flight plans. In some cases, there was no RNP status filed or the filed flight plan was not located in the archived data. As shown in Table 1, most of the operations conducted within the Anchorage oceanic FIR are RNP10 certified. Roughly, 24 percent of operations conducted with the Anchorage oceanic FIR indicate RNP4 certified.

RNP Status	Count	Proportion
RNP 10	37543	71.95%
RNP 4	12532	24.02%
RNP 5	1175	2.25%
RNP 1	300	0.57%
Unknown or no RNP filed	629	1.21%
TOTAL	52179	

Table 13: Proportion of Operations by Filed RNP Status within the Anchorage Oceanic FIR - 2010

3.99 The observed proportions of operations that utilize ADS-C, CPDLC and are approved for RNP4 operations were examined. Based on these data, the estimated overall proportion of traffic eligible for the 30NM lateral and 30NM longitudinal separation standards in the Anchorage oceanic FIR is roughly 20 percent.

Safety Assessment Approach

3.100 The ICAO-endorsed collision risk methodology will be used to demonstrate that risk upon introduction 30NM lateral and longitudinal separation minima will satisfy TLS of 5×10^{-9} fatal accidents per flight hour due, separately, to the loss of 30NM lateral and 30NM longitudinal separation, following requirements formerly contained within ICAO Annex 11.

3.101 In Anchorage oceanic airspace, the controller decision support system is FAA's automated oceanic air traffic control system, Ocean21. The Ocean21 system is fully compliant with the requirements formerly contained within Annex 11 and ICAO Doc 4444 regarding automatic dependent surveillance (ADS-C) and controller-pilot data link communications (CPDLC) support of 30NM lateral and longitudinal separation standards, such as:

Establishing ADS-C contracts with 14-minute periodic update rate for suitably approved aircraft;

Lateral deviation event contract set to 5NM; and

Reversion to procedural separation if ADS-C message is overdue by 3 minutes and 6 minutes have elapsed since controller began attempting to establish communication.

3.102 The safety assessment for the implementation of the 30NM lateral and longitudinal separation standards will consider risk due to loss of lateral separation and longitudinal separation separately. This results in an estimate of risk for loss of each separation standard as if airspace were managed in a strictly strategic manner, without decision support aids of the Ocean21 system. If the resulting lateral and longitudinal collision risk estimates satisfy the TLS, then the 30NM lateral and longitudinal separation standards are considered "safe".

3.103 The aircraft characteristics of the B744 aircraft will be used for the appropriate lateral and longitudinal collision risk model parameters. The full safety assessment report will contain estimates of all collision risk model parameters.

3.104 Data link performance data obtained from operations conducted within the Anchorage oceanic FIR will be used in the estimation of risk. These empirical data will supply the necessary parameters for the controller-intervention buffer used in the risk model.

3.105 One challenge in this work is the mixture of procedural and non-procedural airspace within the Anchorage FIR. The traffic data will need to be examined to separate the aircraft operations within radar coverage. The Anchorage FIR has many radar locations which provide ATC with an independent source of aircraft position, thereby allowing for closer separations than in procedural airspace.

Agenda Item 4: Airspace Safety Monitoring Documentation and Regional Guidance Material

Amendments to the Guidance Material

4.1 New Zealand proposed amendments to the *Guidance Material for End-To-End Safety and Performance Monitoring of Air Traffic Service (ATS) Datalink Systems in the Asia/Pacific Region* which was prepared by the RASMAG and adopted by APANPIRG/16 in 2005. The current version of the document is Version 3, dated May 2008.

4.2 The main amendments are:

4.2.1 Clarification of the status and roles of FANS Interoperability Teams (FITs) and Central Reporting Agencies (CRAs), particularly regarding reporting of data link performance.

4.2.2 Revision of the details of data link monitoring parameters in Appendix D to the guidance material to reflect the adoption of the *Global Operational Data Link Document* (GOLD) by ICAO to replace the *FANS Operations Manual* (FOM).

4.3 The meeting recommended appropriate changes to the guidance material and adopted the amendments as in **Appendix H** to this report. The secretariat undertook to publish the proposed revised version of the guidance material as Version 4.

Use of the Regional MMR in LTHM for the Region

4.4 The 21st Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/21, September 2010) noted that RASMAG/13 (August 2010, Bangkok) was provided a brief overview of the outcomes of the fifth RMA Coordination Meeting (RMACG/5, May 2010) held in Atlantic City, USA and the main items of discussion were presented. With regard to the revised MMR agreed at RMACG/5, RASMAG/13 recalled that Conclusion 20/20 would remain in force until the Long-Term Height Monitoring (LTHM) requirements in Annex 6 – *Aircraft Operations* become effective in November 2010. RASMAG/13 was also informed that Annex 11 – *Air Traffic Services* provisions and those of the RVSM manual require system performance monitoring on a regional basis to provide evidence of stability of altimetry system error (ASE). Therefore, RASMAG decided that the revised MMR agreed by RMACG/5 would remain as the basis for the maintenance of LTHM requirements in the region after November 2010 as follows:

Decision RASMAG 13/1 – Use of the Revised MMR in LTHM for the Region

That, in order to ensure the continued safe use of RVSM airspace within Asia/Pacific region, the revised MMR endorsed by RMACG/5 be used as the regional basis for maintenance of LTHM requirements after November 2010.

4.5 The Regional Office issued a State letter Ref.: T3/10.0, T3/10.1.17 – AP158/10 (ATM) 15 October 2010 regarding the use of the revised Minimum Monitoring Requirement (MMR) in the regional guidance material of the *Asia/Pacific Regional Impact Statement – RVSM Global Long Term Height Monitoring* (LTHM) *Required Effective From November 2010*.

4.6 The Secretariat has updated the LTHM impact statement to incorporate the revised MMR and RMAs reviewed and updated the monitoring burden based on the revised MMR.

Update Estimate of RVSM Long Term Height Monitoring Burden for the Australia Airspace Monitoring Agency

4.7 The Long Term Height Monitoring Impact Statement developed by RASMAG was endorsed by APANPIRG/20 in September 2009. That statement included a determination by each of the Asia/Pacific Regional Monitoring Agencies (RMAs) of the anticipated monitoring burden for each State within the region. RASMAG/12 tasked the RMAs to review and update that data. The Australian Airspace Monitoring Agency (AAMA) provided anticipated monitoring burden data at RASMAG/13.

4.8 A review of the most recent RVSM approvals databases determined that the monitoring burden continues to vary, specifically in the case of Australian and Indonesian operators. The former has seen a decrease of 18 in the total number of airframes required to be monitored to a total of 124. The latter increased by 11 to a total of 72. Overall the revised monitoring burden for the AAMA is expected to be approximately 200 airframes over the two year period commencing November 2010. While the AAMA has responsibility for State airspace for both the Solomon Islands and Nauru, aircraft utilised by operators within those States are Australian registered aircraft and therefore included in the count for that State.

4.9 **Appendix I** to this report provides details of the monitoring burden based on the minimum monitoring requirements agreed at the recent RMACG/5 meeting in May 2010.

4.10 The meeting reviewed the information provided in Appendix I and used the information to update the current monitoring burden anticipated for the Asia/Pacific RMAs. The Secretariat undertook to update the LTHM statement.

4.11 The meeting also discussed the extent to which application of the LTHM monitoring requirement can best be standardised in an operational sense. PARMO commented that their intention was to use the most recent date of monitoring projected 2 years forward, noting it would be more focussed on US registered aircraft, but would possibly follow up with States if monitoring is falling behind. After some further discussion it was agreed that the best means for scheduling monitoring is to set November 2010 as the baseline, and anything monitored prior to 2008 will need to be monitored now and then stagger the remainder according to their last successful monitoring after November 2008.

Agenda Item 5: Airspace Safety Monitoring Activities/Requirements in the Asia/Pacific Region

RASMAG List of Competent Airspace Safety Monitoring Organizations

5.1 RASMAG is required by its terms of reference to recommend and facilitate the implementation of airspace safety monitoring and performance assessment services, and to review and recommend on the competency and compatibility of monitoring organizations. Accordingly, the meeting reviewed and updated the ‘RASMAG List of Competent Airspace Safety Monitoring Organizations’ shown at **Appendix J** to this report for use by States requiring airspace safety monitoring services.

Update of HMU Implementation in Japan

Setouchi HMU

5.2 Japan is preparing for the height monitoring service by the first HMU, which is officially named *SETOUCHI HMU* after the installation of antennas, situated within Fukuoka Flight Information Region (FIR). The accuracy of the altitude is calculated automatically when the aircraft flies within the measurable coverage of Setouchi HMU. .

Method of Measurement

5.3 The HMU consists of the height monitoring equipment (HME) and the total vertical error (TVE) monitoring unit (TMU). In case of Japan, the HME captures mode S signals of aircraft's SSR transponder replying to interrogations from radar stations. Geometrical three-dimensional position of airplane is measured by computing the time difference of arrival (TDOA) of a signal to more than four receivers (multilateration method). This information is transmitted to the TMU installed at Air Traffic Management Center in Fukuoka. Eventually, the monitoring process produces TVE, AAD (Assigned Altitude Deviation) and ASE readings for each aircraft measured. Height Monitoring results are automatically transmitted to the RVSM Analyzing and Evaluating System where the aircraft's performances are verified and recorded.

5.4 Japan informed the meeting that the Setouchi HMU has been already installed at the site. The flight validation by the flight inspection team of the Japan Civil Aviation Bureau (JCAB) will start in February 2011. JCAB will start a trial operation of height monitoring in April 2011. The purpose of the trial will be to collect enough samples of actual height keeping performance data and validate the accuracy of the readings. It is expected that a trial of at least five months will be needed. The official start of operations is planned in September 2011.

Monitoring Data

5.5 The results for each aircraft monitored will be published on the website (http://www.japan-rma-ema.com/), when measured values are appropriate. JCAB RMA will provide the value of monitoring result only when the operators request the value for their aircraft. The data will be updated once or twice a month.

Data Link Performance Monitoring Results

5.6 The meeting was informed that the CRA of the Informal South Pacific ATS Coordinating Group, the ISPACG CRA, has for some time published a collection of data-link monitoring data on its website at http://www.ispacg-cra.com/performance.asp.

5.7 De-identified information is presented by aircraft type and by operator, and provides a useful overview of data link performance in the South Pacific. The data refers to the Auckland Oceanic FIR and is presented on a monthly basis.

5.8 New Zealand stated that they had reworked some of the data to reflect performance trends rather than monthly performance.

5.9 **Figure 16** below shows the duration of monthly network outages and of the cumulative annual outage. The number in each bar shows the number of outages in each month. The GOLD requires an availability of 99.9% for safety, but adds the more stringent availability of 99.99% for traffic efficiency for ANSPs operating reduced separations in areas of high traffic density. In terms of outages, the safety target is a maximum of 520 min total outage in a 12 month period, and the efficiency target is a maximum of 52 min total outage with no more than 4 outages of greater than 10 min in a 12 month period.

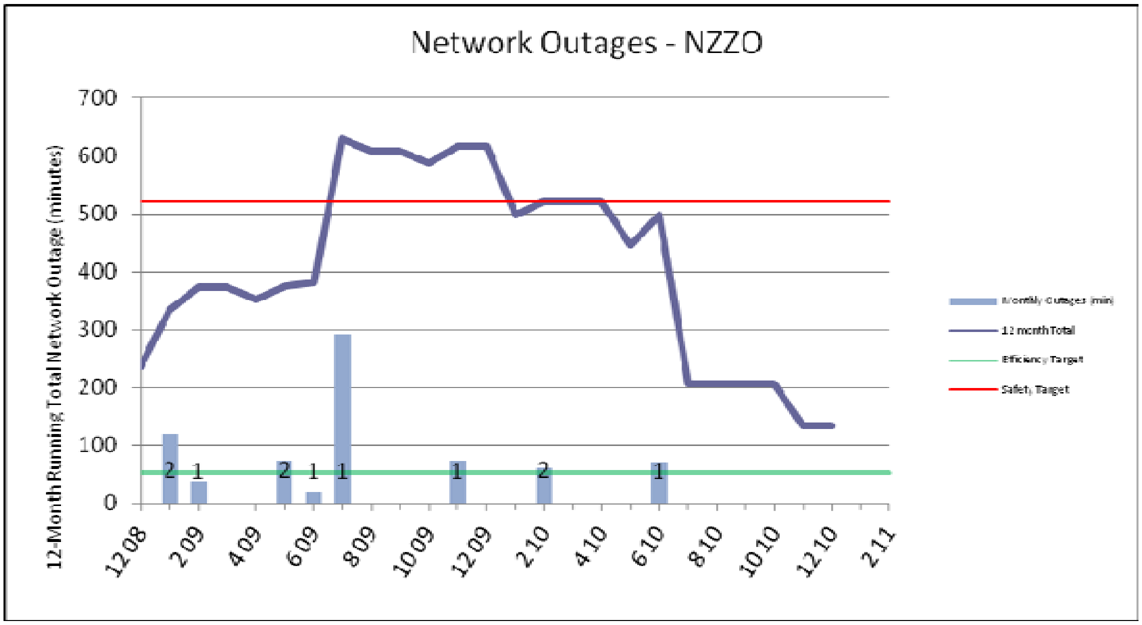

Figure 16: Network Outages

5.10 **Figure 17** compares the system availability from December 2008 as a running annual total with the safety target and the efficiency target.

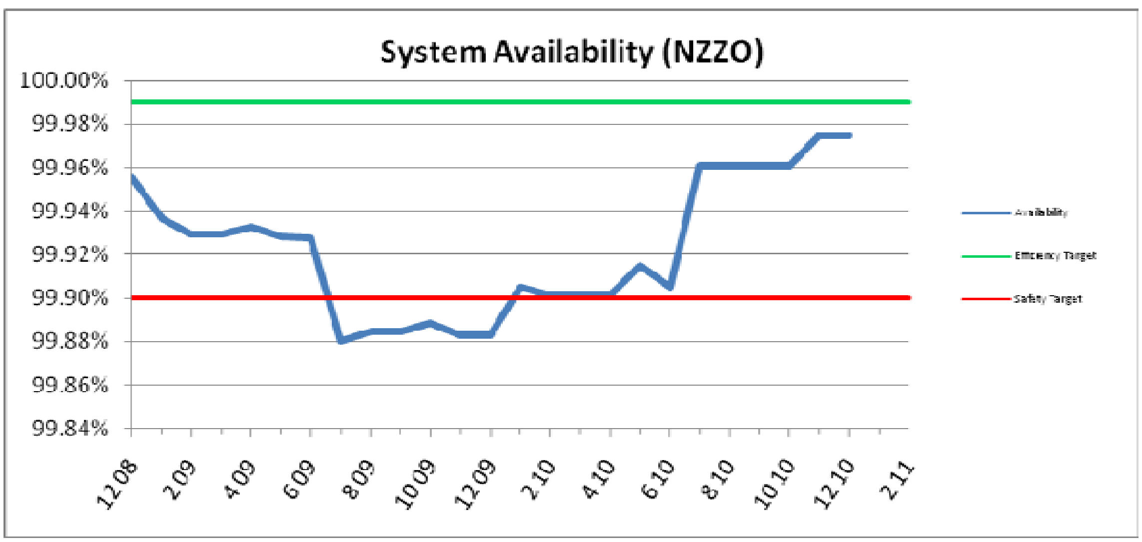

Figure 17: System Availability

5.11 **Figure 18** compares the CPDLC ACP with the continuity requirements for RCP 400 and RCP 240. Continuity is the required probability that an operational communication transaction can be completed within the communication transaction time, either expiration time (ET) or nominal time (TT 95%), given that the service was available at the start of the transaction. The 95% figure in each case represents the TT within which 95% of all transactions must be completed; the 99.9% figure is the ET, which is the maximum time for the completion of the operational communication transaction after which the initiator is required to revert to an alternative procedure.

5.12 It should be noted that the ACP includes the pilot operational response time for which 60s is allowed. **Figure 19** shows the same parameters for the actual technical communications performance (ATCP), which does not include the pilot response time. In practice, achievement of the 60s pilot response time is about 97%.

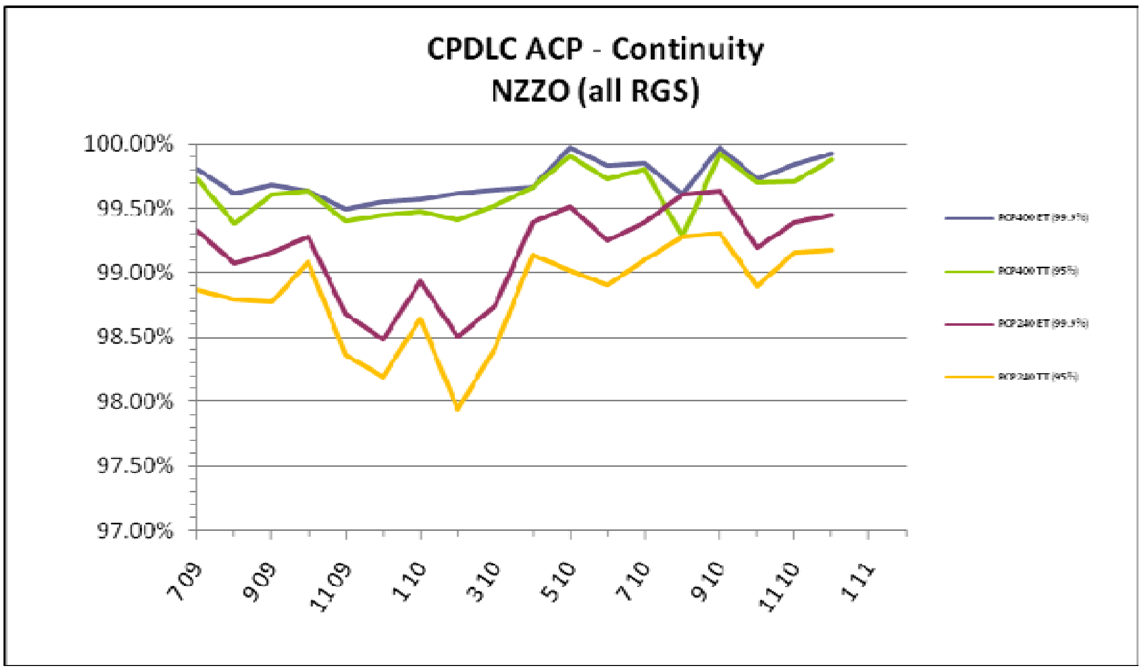

Figure 18: CPDLC Continuity Performance – ACP

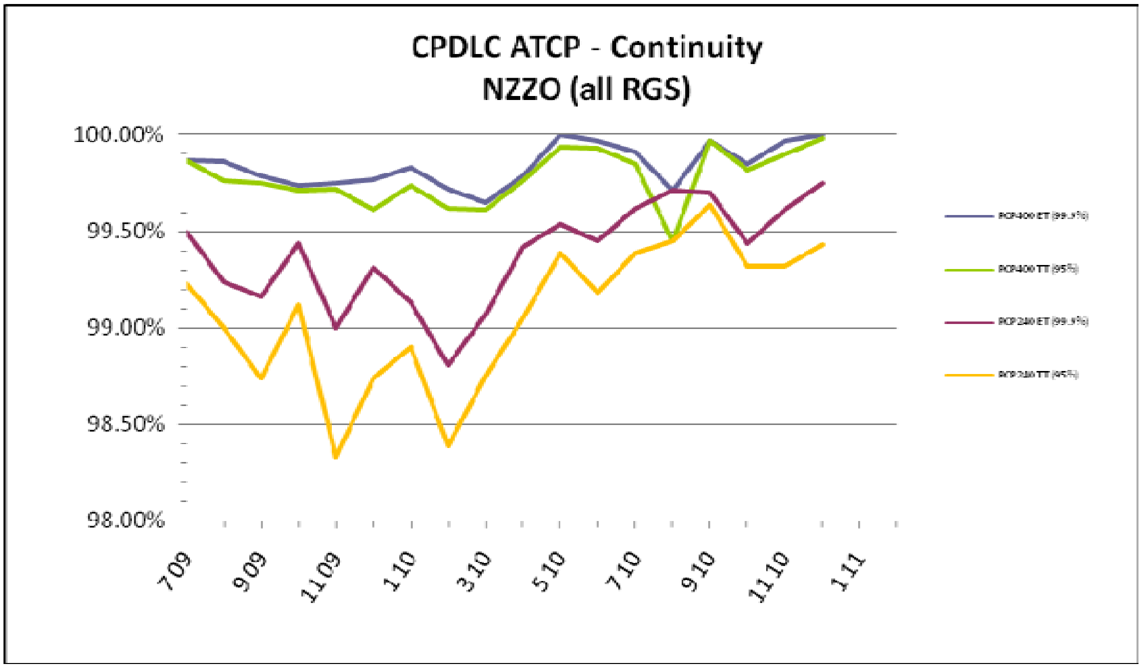

Figure 19: CPDLC Continuity Performance - ATCP

5.13 **Figure 20** compares the ADS-C downlink performance with the continuity standards for surveillance Types 400 and 180. Continuity is the required probability that surveillance data can be delivered within the surveillance delivery time parameter, either overdue time (OT) or delivery time 95% (DT), given that the service was available at the start of delivery.

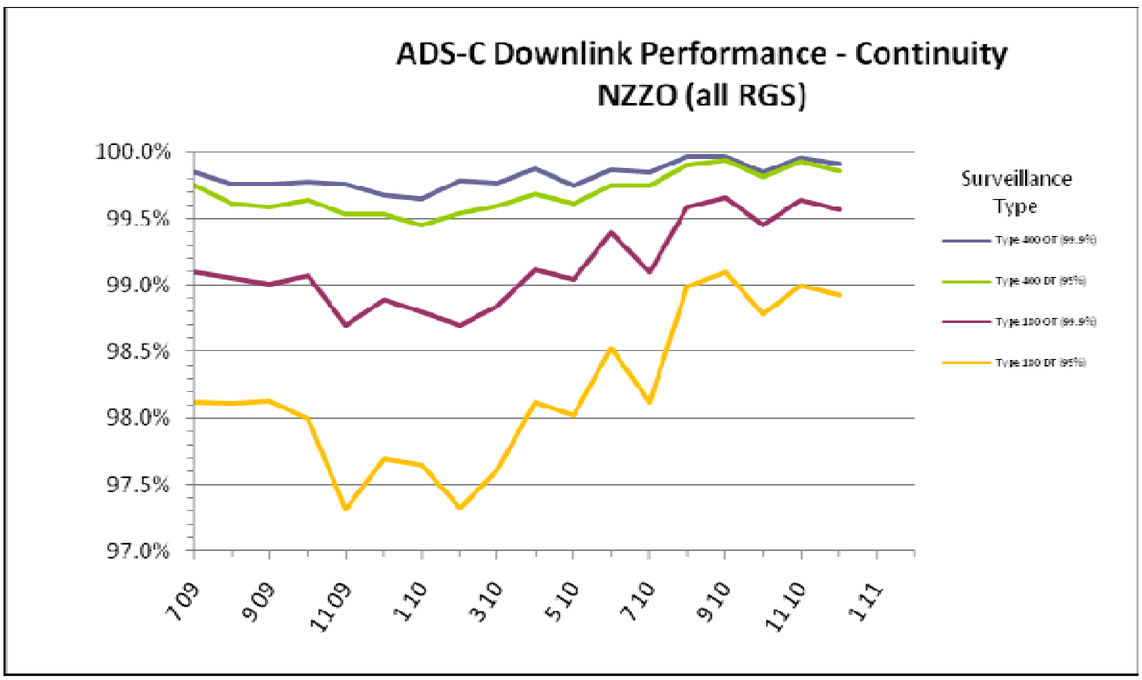

Figure 20: ADS-C Continuity Performance

5.14 As with CPDLC, the continuity easily meets the target for DT 95%, but does not achieve the target for OT. The data available do not enable the outages and service delays to be attributed to specific elements of the data-link path (i.e. ANSP, CSP, VHF/HF/satellite, aircraft system).

5.15 The meeting noted that the graphs above indicate that all aspects of data link performance are improving. While the safety targets for network availability are being achieved at present, it is clear that considerable improvement is necessary if the efficiency target is to be met. The efficiency target supports operational efficiency and orderly flow of air traffic. The nominal times for CPDLC and ADS-C continuity are being achieved, but some improvement is necessary to reach the target for expiration time.

5.16 The meeting discussed whether States understood that this type of performance monitoring was an on-going post-implementation requirement. The United States indicated that Appendix D of the GOLD document is based on post-implementation monitoring and corrective action. They noted that the FAA is doing some work to automate the charting of GOLD formatted data and will share that with States on request. Further discussion indicated that there was a need to take some action to encourage ANSPs to provide data link performance data to the CRAs. The Secretary advised that he had personally discussed such issues with those States that had not been providing data in an attempt to educate them to the requirements. New Zealand suggested that possibly the FITs should be asked to undertake such an education program. The meeting agreed to this suggestion and indicated that this may also occur at the SEACG meetings. The Secretary was tasked with conveying RASMAG's concern to relevant coordination groups and FITs.

ADS-C/CPDLC Data Link Performance Monitoring

5.17 New Zealand advised that the *Guidance Material for End-To-End Safety and Performance Monitoring of Air Traffic Service (ATS) Data Link Systems in the Asia/Pacific Region* indicates the information that should be collected by air navigation service providers (ANSPs) for analysis by the Central Monitoring Agencies (CRAs).

5.18 Monitoring of data link performance is a most important element of the provision of data link applications such as CPDLC, ADS-C and AIDC, especially where these applications are used as a basis for reduced separation minima. The efficiency benefits arising from reduced separation can only be achieved if specific data link performance criteria are met, and this can only be determined by regular monitoring of data link traffic and analysis of the resulting data.

5.19 The guidance material indicates that performance data is gathered by ANSPs and passed to the appropriate CRA for analysis. CRAs have specialist staff and equipment to undertake the detailed analysis that can identify the causes of performance problems. Once the causes are identified, solutions can be developed and implemented.

5.20 While the guidance material includes information on the performance data that ANSPs are expected to provide to the CRAs, to date the CRAs have received very little such data. Consequently, little is known of data link performance in much of the Region, with the inevitable corollary that poor performance may not be detected or corrected.

5.21 It is therefore most important that all ANSPs, whether state agencies or independent organisations, collect the required data link performance data and pass it to the appropriate CRA for analysis, investigation and initiation of any required corrective action.

5.22 The secretariat agreed with New Zealand's observation and informed the meeting that there had been no data provided from States to FIT-Bay of Bengal (FIT-BOB). This lack of data hinders FIT-BOB from examining the data link system performance data to allow for the reduced longitudinal separation to 50 NM, thus pending the implementation. In the South China Sea area, data are adequately provided to FIT-Southeast Asia (FIT-SEA).

5.23 The meeting discussed the information presented and recommended appropriate action to encourage ANSPs to provide data link performance data to the CRAs. Accordingly, the meeting proposed a recommendation as follows:

Recommendation RASMAG 14

Noting the pre- and post-implementation system performance monitoring required by Annex 11 – *Air Traffic Service* (Para 2.26.5), the *Global Operational Data Link Document* (GOLD) and the *Guidance Material for End-to-End Safety and Performance Monitoring of Air Traffic Service Data Link Systems in the Asia/Pacific Region*, States are invited to ensure that the appropriate data link performance monitoring is undertaken and reported to CRAs/FITs, as required, in a timely manner.

Proposal to Include the EMA in the Distribution List of December TSD

5.24 In 2005, APANPIRG/16 required that the TSD within the Asia/Pacific Region should be collected by all States for the month of December each year for the purpose of RVSM implementation and monitoring. During 2009, APANPIRG/20 expanded the usage of this data under certain conditions to support regional air traffic management implementations, including the reduced horizontal plane separation minima. The TSD is one of the essential sources of data used in the process of risk assessment for the vertical and horizontal plane reduced separation minima.

5.25 The data collection process is an important part of a monitoring agency's duties. In 2005, to minimize the impact on the States for the need to collect traffic sample data, RASMAG considered that efforts should be made to align the arrangements for the collection of horizontal traffic sample data information with the RVSM data collection, resulting in all required data being collected simultaneously during the December sampling.

5.26 For the implementation of the reduced horizontal separation minima, the TSD is used in various analyses. Currently, the TSD for the Western Pacific/South China Sea and Bay of Bengal are submitted directly to MAAR by the respective States and MAAR in turn, will forward the data to SEASMA which is the EMA for the South China Sea area.

5.27 It was appropriate for the EMA concerned to receive the TSD directly from relevant States for efficiency and expeditiousness. Also if there are any follow-up actions required, EMA can approach the States directly for further clarifications knowing that the data has previously been given to the EMA. Furthermore this will cut down the administrative process for the RMA in forwarding the data to the EMAs.

5.28 The meeting considered the provision of TSD by States directly to the EMA responsible for the airspace. The secretariat informed the meeting that the TSD was required by APANPIRG Conclusion 16/4 and the conclusion did not specifically limit the distribution to RMAs. The meeting recalled that the data should be sampled and recorded in accordance with the requirements of "regional safety monitoring agencies" which include both RMAs and EMAs. Accordingly, APANPIRG conclusion would not be required and the EMA was requested to coordinate with States for TSD to be directly submitted to the agency. The Secretariat will refer to this process in the State Letter in regard to the points of contact for RMAs and EMAs.

Use of ADS-B Data for Monitoring Aircraft ASE

5.29 RASMAG has strongly encouraged work to continue that would assess the viability of using ADS-B geometric height data as a means of estimating ASE. The FAA and Airservices Australia have continued work under a cooperative research agreement to further progress the use of aircraft geometric height data derived from ADS-B sources for estimating aircraft ASE.

5.30 At RASMAG/12, Australia and the United States informed the meeting that the FAA and Airservices Australia had presented WP/24 to SASP-WG/WHL/16 that provided details on progress with the investigation on the use of aircraft geometric height data derived from ADS-B sources for estimating aircraft ASE. The paper indicated that the research group had successfully processed ADS-B data using the FAA's AGHME processing software and provided initial results of the ASE estimates from various ADS-B ground stations in Australia.

5.31 The meeting was advised that research would continue to determine the exact cause or causes for noted differences in the results from different ground stations and would be revisiting the assumptions related to ground height and the WGS-84 spheroid model used in the ASE software.

5.32 During the period since RASMAG/12, the FAA and Airservices Australia have continued the research activity and presented WP/12 to SASP-WG/WHL/18 in November 2010. The paper, included as Attachment 1 to this paper, provided an update on the work of the research group and specifically regarding the ground station bias in terms of ASE differences, appears to be related to differences in the measurement of geometric height in different avionics.

5.33 The group now believes that they understand the cause of the observed ASE differences at different ADSB ground stations known as the lat-long effect, and are waiting for further feedback from avionics manufacturers in this regard. Additionally, work is proceeding to process large data sets of ADSB data to enable validation comparisons with aircraft group mean measurements from Eurocontrol and FAA monitoring systems.

5.34 The meeting endorsed the continued exploration of ADS-B derived geometric height as a data source for aircraft height-keeping performance monitoring.

Technical Transfer of Lateral Collision Risk Analysis to JCAB RMA

5.35 Japan informed the meeting that JCAB RMA plans to undertake the regular assessment of lateral and longitudinal separations to be approved as one of the APANPIRG EMAs. To establish a sustainable framework for the continuing activity as a future EMA, JCAB RMA requested the Electronic Navigation Research Institute (ENRI) for the transfer of technical knowledge on horizontal CRM. In the future, JCAB RMA is planning to evaluate longitudinal risk on the NOPAC routes.

5.36 The trial calculation of lateral technical collision risk was carried out on NOPAC ATS routes (i.e. R220, R580, A590, R591, and G344) by JCAB RMA with the technical advice by the ENRI.

Lateral Collision Risk Calculation Process

5.37 **Table 14** shows the estimates of lateral collision risk for NOPAC routes. The estimate of the total lateral technical collision risk is 4.13733 x 10-15 fatal accidents per flight hour, which satisfies the Asia/Pacific Region agreed TLS value of 2.5 x 10-9 fatal accidents per flight hour.

Source of Risk	Risk Estimation
N_{ay} (same)	9.25183×10^{-16}
N_{ay} (opposite)	3.21215×10^{-15}
N_{ay} (total)	**4.13733×10^{-15}**

Table 14: Lateral technical collision risk estimates for the NOPAC routes.

Clarification of Reporting Requirements by ANSPs for Category D and M Operational Errors

5.38 Australia proposed changes to the currently agreed LHD Cause taxonomy to clarify to States the type of incidents reportable as Category D (ATC loop errors) and Category M (Other). The proposal attempted to resolve the issue identified at RASMAG/10 in relation to possible State confusion as to operational error reporting to RMAs.

5.39 RASMAG/10 agreed that the current LHD taxonomy was possibly a source of confusion on the part of some States as to what types of incidents should be reported to RMAs in terms of being an LHD. Other RMAs indicated that their experience had been similar to that of the AAMA. As a result, RASMAG/10 generated a task (10/7) that sought to develop a taxonomy of RMA-related terms with objective of clarifying and standardising reporting of Large Height Deviations (LHDs) by States and limiting under reporting. The AAMA agreed to lead this work.

5.40 **Table 15** below is the currently agreed LHD Cause taxonomy contained in the RMA Manual. Additional wording has been suggested in highlight to better describe loop errors and provide clarity on the need to report loss of separation incidents.

Code	LHD Cause
	Operational Errors
A	Flight crew failing to climb/descend the aircraft as cleared
B	Flight crew climbing/descending without ATC Clearance
C	Incorrect operation or interpretation of airborne equipment (e.g. incorrect operation of fully functional FMS, incorrect transcription of ATC clearance or re-clearance, flight plan followed rather than ATC clearance, original clearance followed instead of re-clearance etc)
D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message. Includes situations where ATC delivery of operational information, including as the result of hear back and/or read back errors, is absent, delayed, incorrect or incomplete, and may result in a loss of separation.)
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)
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues

Aircraft Contingency Events	
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level
Deviation due to Meteorological Condition	
I	Deviation due to turbulence or other weather related cause
Deviation due to TCAS RA	
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory
Other	
L	An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)
M	Other – this includes situations where: i) there has been a failure to establish or maintain a separation standard between aircraft; or ii) flights are operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.

Table 15: Proposed revised taxonomy.

5.41 As an additional source of information for States, it was proposed that specific examples of incidents/reports for each LHD taxonomy category are provided. **Table 16** below provides suggested wording and examples for some of the categories for consideration.

Code	LHD Cause
Operational Errors	
A	Flight crew failing to climb/descend the aircraft as cleared
	Example: *Aircraft A was at F300 and assigned F360. A CLAM alert was seen as the aircraft passed F364. The Mode C level reached F365 before descending back to F360.*
B	Flight crew climbing/descending without ATC Clearance
	Example: *At 0648, Aircraft A reported leaving cruise level FL340. The last level clearance was coincident with STAR issue at 0623, when the flight was instructed to maintain FL340. ATC was applying vertical separation between Aircraft A and two other flights. The timing of the descent was such that Aircraft A had become clear of the first conflicting aircraft and there was sufficient time to apply positive separation with the other.*
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)
	Example: *The aircraft was maintaining a flight level below the assigned altitude. The altimeters had not been reset at transition. The FL assigned was 350.* *The aircraft was maintaining 346 for 4 min 46 s.*

D	ATC system loop error; (e.g. ATC issues incorrect clearance or flight crew misunderstands clearance message. Includes situations where ATC delivery of operational information, including as the result of hear back and/or read back errors, is absent, delayed, incorrect or incomplete, and may result in a loss of separation.)
	Example: *All communications between ATC and aircraft are by HF third party voice relay. Aircraft 1 was maintaining FL360 and requested FL380. A clearance to FL370 was issued, with an expectation for higher levels at a later point. A clearance was then issued to Aircraft 2 to climb to F390, this was correctly read back by the HF operator, but was issued to Aircraft 1. The error was detected when Aircraft 1 reported maintaining F390.*
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)
	Example 1: *Sector A coordinated Aircraft 1 to Sector B at FL380. The aircraft was actually at FL400.* Example 2: *The Sector A controller received coordination on Aircraft 1 for Waypoint X at F370 from Sector B. At 0504 Aircraft 1 was at Waypoint X at F350 requesting F370.*
F	Coordination errors in the ATC to ATC transfer or control responsibility as a result of equipment outage or technical issues
	Aircraft Contingency Events
G	Deviation due to aircraft contingency event leading to sudden inability to maintain assigned flight level (e.g. pressurization failure, engine failure)
H	Deviation due to airborne equipment failure leading to unintentional or undetected change of flight level
	Deviation due to Meteorological Condition
I	Deviation due to turbulence or other weather related cause
	Deviation due to TCAS RA
J	Deviation due to TCAS resolution advisory, flight crew correctly following the resolution advisory
K	Deviation due to TCAS resolution advisory, flight crew incorrectly following the resolution advisory
	Other
L	An aircraft being provided with RVSM separation is not RVSM approved (e.g. flight plan indicating RVSM approval but aircraft not approved, ATC misinterpretation of flight plan)
M	Other – this includes situations where: i) there has been a failure to establish or maintain a separation standard between aircraft; or ii) flights are operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS unit.

Table 16: Taxonomy with Examples

5.42 The meeting agreed with including specific report examples as in **Table 16** above to provide further clarity for States and considered how this might be disseminated to States. The Chairman informed the meeting that the table can be found in the RMA Manual and proposed that the amendment proposal be made at the next RMACG meeting. Further, the information would be disseminated by a State letter as the table is contained in the manual which is not readily available to States which do not have an RMA. Australia agreed to further develop the examples of reports in consultation with the other RMAs and States and for the RMAs to then make the examples available to States for which they are responsible.

Agenda Item 6: Review and Update RASMAG Task List

6.1 The meeting agreed that the updated task list included as **Appendix K** to this report accurately reflected the work programme of RASMAG.

Agenda Item 7: Any Other Business

Review and Update Conclusions and Decisions of APANPIRG

7.1 The meeting reviewed the Conclusions and Decisions of APANPIRG in the RASMAG field, and updated the RASMAG Task List as appropriate (Agenda Item 6 refers).

Agenda Item 8: Date and Venue of the Next RASMAG Meeting

8.1 With regards to the scheduling of the next meeting, it was tentatively agreed that RASMAG/15 would be held from 01 to 05 August 2011 at the Regional Office premises.

9. Closing of the meeting

9.1 The Chairman, Mr. Butcher, thanked the meeting participants for their significant work during a busy meeting program.

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LIST OF WORKING AND INFORMATION PAPERS

WORKING PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
WP/1	1	Provisional Agenda	Secretariat
WP/2	4	Amendments to the Guidance Material for End-To-End Safety and Performance Monitoring of Air Traffic Service (ATS) Datalink Systems in the Asia/Pacific Region	New Zealand
WP/3	5	Data Link Performance Monitoring Requirements	New Zealand
WP/4	3	The Coordination of Transition Arrangement of Regional Monitoring Agency Services for Sanya Oceanic Airspace	MAAR and China RMA
WP/5	3	Safety Monitoring Report from China Regional Monitoring Agency – Dec 2009 – Nov 2010	China RMA
WP/6	6	Review of RASMAG Task List	Secretariat
WP/7	3	Safety Assessment of RVSM within the Fukuoka Flight Information Region	Japan
WP/8	7	Review and Update Conclusions and Decisions of APANPIRG	Secretariat
WP/9	2	Outcome of the Seventh Meeting of the PBN Task Force (PBN/TF/7)	Secretariat
WP/10	5	Review of RASMAG List of Competent Airspace Safety Monitoring Organizations	Secretariat
WP/11	2	Outcome of APANPIRG/21	Secretariat
WP/12	4	Use of the Revised MMR in LTHM for the Region	Secretariat
WP/13	3	Report from the South East Asia Safety Monitoring Agency: December 2009 – November 2010	SEASMA
WP/14	3	Assessment of the Safety of continued use of 50-NM Lateral and the Implementation of 50-NM Longitudinal Separation Standards on ATS Routes P628 and L510, N571 and P762	SEASMA
WP/15	5	Propose to include the En-Route Monitoring Agency in the Distribution List of December Traffic Sample Data from the States	SEASMA
WP/16	3	Summary of the Airspace Safety Review for the RVSM Operation in Asia Region	MAAR
WP/17	3	Assessment of Non-RVSM-Approved Aircraft Operating in the Asia RVSM Airspace	MAAR
WP/18	3	Issues regarding the RVSM Implementation in the Kabul FIR	MAAR
WP/19	3	Airframes Continuously Conducted RVSM Flights with No Registration in RMA's Approval Database	Japan

NUMBER	AGENDA	TITLE	PRESENTED BY
WP/20	3	Vertical Safety Monitoring Report from the Pacific Approvals Registry and Monitoring Organization December 2009 – November 2010	PARMO
WP/21	5	Progress on the Research Conducted to Determine the Use of Automatic Dependent Surveillance-Broadcast Data for Monitoring Aircraft Altimetry System Error	United States Australia
WP/22	3	Safety Assessment of RVSM within the Flight Information Regions Monitored By the AAMA	Australia
WP/23	3	Horizontal Safety Monitoring Report from the Pacific Approvals Registry and Monitoring Organization December 2009 – November 2010	PARMO
WP/24	5	Analysis of ATC to ATC Coordination Errors between Australian and Indonesian Airspace	Australia
WP/25	5	Updated Estimate of RVSM Long Term Height Monitoring Burden for the Australian Airspace Monitoring Agency (AAMA)	Australia
WP/26	5	Clarification of Reporting Requirements by ANSPs for Category D and M Operational Errors	Australia
WP/27	3	Airspace Analysis of Bay of Bengal Arabian Sea Region and Safety Assessment of RNP 10 ATS Routes L510, N571, P628 & P762	India

INFORMATION PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
IP/1	-	List of Working Papers (WPs) and Information Papers (IPs)	Secretariat
IP/2	5	Datalink Performance Monitoring Results	New Zealand
IP/3	3	Transfer Errors between Incheon FIR and Fukuoka FIR before and after the AIDC Implementation	Japan
IP/4	5	Update of HMU Implementation in Japan	Japan
IP/5	5	Technical Transfer of Lateral Collision Risk Analysis to JCAB RMA	Japan
IP/6	3	Preliminary Safety Assessment Work to Support Use of the 30nm Lateral and 30nm Longitudinal Separation Standards in the Anchorage Flight Information Region	PARMO

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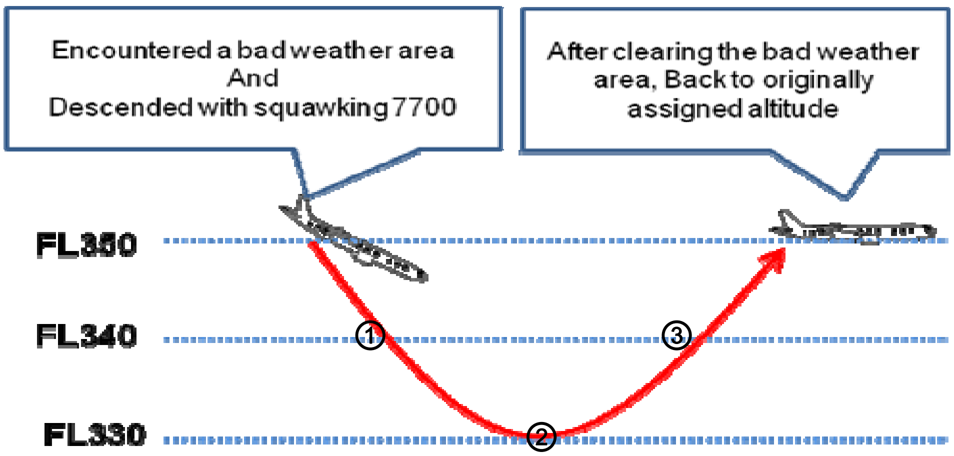
Adding Flight Levels Crossed to the assessment of Vertical Collision Risk

JCAB RMA attempted to add the risk of flight levels crossed of the two LHD reports to the RVSM risk estimation in accordance with WP/19 of RASMAG/13 as a trial.

1. Detail of the LHDs

CASE 1

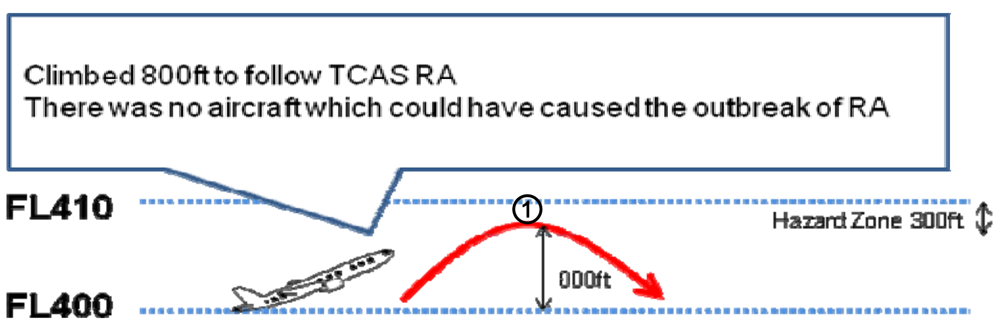
This aircraft was assigned and maintaining FL350.
The aircraft reported ATC to descend to FL310 because of a bad weather area, and squawked 7700.
Eventually, the aircraft could avoid the bad weather area by FL330.
After clearing the bad weather area, the aircraft climbed back to FL350.



This LHD was excluded from the operational risk calculation because the trigger was not considered as a human factor. This aircraft met contingency event which was impossible to keep their assigned altitude, and the ATC had followed the aircraft's altitude change by radar.

CASE 2

This aircraft was assigned and maintaining FL400.
There was no aircraft which could have caused the outbreak of RA around this aircraft.
But this aircraft climbed 800ft to follow TCAS RA.



This LHD seemed to be due to nuisance RA and was technical risk-bearing. The deviation of 800ft intruded a hazard zone of next flight level.

2. Risk Calculation

2.1 The relation between passing frequency and occupancy in RMA Manual is used.

$$N_x(same) = \frac{\lambda_x}{S_x} E_z(same) \frac{\overline{|\Delta V|}}{2\lambda_x}$$

and

$$N_x(opp) = \frac{\lambda_x}{S_x} E_z(opp) \frac{\overline{|V|}}{\lambda_x}$$

2.2 The equation (9) in the WP/19 of RASMAG/13 is permutated as follows

$$C_t = Py \frac{4\lambda_x \lambda_z}{\overline{|\dot{z}|}\overline{|\Delta V|}} N_x(same) \left(\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right) + Py \frac{4\lambda_x \lambda_z}{2\overline{|\dot{z}|}\overline{|V|}} N_x(opp) \left(\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right)$$

Where C_t = The risk in collisions per level crossed without clearance

2.3 N_{az} of Flight Levels Crossed was calculated as follow

$$N_{az} = 2\frac{C_t}{H}$$

Where H = Total flight hours in Japanese airspace (12 times of December 2009)

2.4 **Table E-1** shows the parameter values that was used to calculate Ct.

Parameter	Parameter Definition	Parameter Value	Source for Value
Py	Probability that two aircraft on the same track are in lateral overlap	0.0745	Using the data of secondary surveillance radar obtained by the Hachinohe Air Route Surveillance radar (domestic RNAV route, 2001-2002)
λx	Average aircraft length	0.0288 nm	FDPS data (December 2009)
λy	Average aircraft width	0.0263 nm	
λz	Average aircraft height	0.0083 nm	
$\overline{\lvert\Delta V\rvert}$	Average along track speed of aircraft pairs	28.9 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC, Apr. 1994)
$\overline{\lvert V\rvert}$	Individual-aircraft along track speed	480 kt	Value often used

$\overline{\lvert \dot{y} \rvert}$	Average cross track speed of aircraft pairs	11.6 kt	Kushiro Air Route Surveillance Radar data (R220 route, NOPAC, Apr. 1994)
$\overline{\lvert \dot{z} \rvert}$	Climb/Descent Rate	Descent Drift 10kt Descent Normal 15kt Descent Rapid 25kt Climb Minimum 5kt Climb Normal 7.5kt Climb Expedite 12.5kt	NAM SG agreed value (WP/19 of RASAMG/13)
Nx(same)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the same direction traffic	3.25×10^{-2}	FDPS data (December 2009)
Nx(opp)	The passing frequency of aircraft pair assigned to the adjacent flight levels under the opposite direction traffic	1.462×10^{-1}	FDPS data (December 2009)
H	Total flight hours of aircraft flying on the route segments within airspace under consideration	957711.25 flight hours	12 times of December 2009

Table E-1: Estimates of the Parameters in the CRM of Level Crossed

2.5 **Table E-2** shows Ct for Japanese RVSM airspace calculated by using the climb/descent rate reported in the WP/19 of RASMAG/13, which were the values agreed in the North American RVSM Scrutiny Group (NAM SG).

Climb/Descent Rate	Ct for Japanese RVSM Airspace
Descent Drift 10kt	2.96×10^{-5}
Descent Normal 15kt	2.13×10^{-5}
Descent Rapid 25kt	1.51×10^{-5}
Climb Minimum 5kt	5.40×10^{-5}
Climb Normal 7.5kt	3.76×10^{-5}
Climb Expedite 12.5kt	2.48×10^{-5}

Table E-2: Estimates of Ct

2.6 Two flight levels crossed at a rapid descent rate (25kt) and one flight level crossed at a normal climb rate (7.5kt) were used to calculate the case 1. One flight level crossed at an expedite climb rate (12.5kt) was used to calculate the case 2. The result of N_{az} of Flight Levels Crossed was 0.19×10^{-9}. Eventually, by adding the result of Flight Levels Crossed and the total risk of Fukuoka FIR reported in paragraph 4.4.1, the overall risk of Fukuoka FIR comes to be 9.61×10^{-9}.

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Airframes continuously conducted RVSM flights with no registration in RMAs' approval databases for twelve months

The list shows the seventy-seven (77) airframes identified by JCAB RMA, which were flying RVSM airspace of Fukuoka FIR with "W" on their flight plans but without the registration in RMAs' RVSM approval databases for twelve (12) months in a row between December 2009 and November 2010.

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<table>
<tr><th>Registration Number</th><th>Operator name</th><th>Aircraft Type</th><th>Airline</th><th>Country</th></tr>
<tr><td>CFRAM</td><td>ACA</td><td>B77W</td><td>Air Canada</td><td>Canada</td></tr>
<tr><td>HL7788</td><td>AAR</td><td>A320</td><td rowspan="4">Asiana Airlines</td><td rowspan="18">South Korea</td></tr>
<tr><td>HL7789</td><td>AAR</td><td>A321</td></tr>
<tr><td>HL7790</td><td>AAR</td><td>A321</td></tr>
<tr><td>HL7792</td><td>AAR</td><td>A333</td></tr>
<tr><td>HL8204</td><td>ESR</td><td>B737</td><td>Eastar Jet</td></tr>
<tr><td>HL7779</td><td>JJA</td><td>B738</td><td rowspan="4">Jeju Air</td></tr>
<tr><td>HL7780</td><td>JJA</td><td>B738</td></tr>
<tr><td>HL7796</td><td>JJA</td><td>B738</td></tr>
<tr><td>HL8206</td><td>JJA</td><td>B738</td></tr>
<tr><td>HL7798</td><td>JNA</td><td>B738</td><td>Jin Air</td></tr>
<tr><td>HL7400</td><td>KAL</td><td>B744</td><td rowspan="8">Korean Air</td></tr>
<tr><td>HL7473</td><td>KAL</td><td>B744</td></tr>
<tr><td>HL7530</td><td>KAL</td><td>B772</td></tr>
<tr><td>HL7531</td><td>KAL</td><td>B772</td></tr>
<tr><td>HL7733</td><td>KAL</td><td>B772</td></tr>
<tr><td>HL7783</td><td>KAL</td><td>B77W</td></tr>
<tr><td>HL7784</td><td>KAL</td><td>B77W</td></tr>
<tr><td>HL7786</td><td>KAL</td><td>B738</td></tr>
</table>

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Registration Number	Operator name	Aircraft Type	Airline	Country
HSTLD	THA	A345	Thai Airways International	Thailand
RP	CEB	A320	Cebu Pacific	Philippines
RPC3330	PAL	A333	Philippine Airlines	
RPC3331	PAL	A333		
RPC3332	PAL	A333		
RPC3333	PAL	A333		
RPC3335	PAL	A333		
RPC3336	PAL	A333		
RPC3337	PAL	A333		
RPC3340	PAL	A333		
RPC3430	PAL	A343		
RPC3431	PAL	A343		
RPC3432	PAL	A343		
RPC3434	PAL	A343		
RPC7471	PAL	B744		
RPC7472	PAL	B744		
RPC7473	PAL	B744		
RPC7475	PAL	B744		
RPC7777	PAL	B773		
RPC8604	PAL	A320		
RPC8605	PAL	A320		
RPC8606	PAL	A320		
RPC8609	PAL	A320		
RPC8610	PAL	A320		
RPC8611	PAL	A320		
RPC8612	PAL	A320		
RPC8613	PAL	A320		
RPC8614	PAL	A320		
RPC8615	PAL	A320		

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Registration Number	Operator name	Aircraft Type	Airline	Country
VN	HVN	A321	Vietnam Airlines	Vietnam
VNA147	HVN	B772		
VNA151	HVN	B772		
VNA309	HVN	A320		
VNA311	HVN	A320		
VNA350	HVN	A321		
VNA352	HVN	A321		
VNA353	HVN	A321		
VNA354	HVN	A321		
VNA356	HVN	A321		
VNA357	HVN	A321		
VNA359	HVN	A321		
VNA360	HVN	A321		
VNA361	HVN	A321		
VNA362	HVN	A321		
VNA369	HVN	A332		
VNA370	HVN	A332		
VNA371	HVN	A332		
VNA372	HVN	A332		
VNA374	HVN	A332		
VNA375	HVN	A332		
VPBDQ	RCF	MD11	Aeroflot-Cargo	Russia
VPBDR	RCF	MD11		
RA64045	VLK	T204	Vladivostok Air	
VPBFX	VLK	A320		
VPBFY	VLK	A320		
VPBUF	UZB	B763	Uzbekistan Airways	Uzbekistan
HL7799	HL7	GLF5		
HS	BCC	B762		

RVSM Sidebar Meeting

Attendees: Len Wicks, Kyotaro Harano (ICAO Regional Office), Purevjau Munkhjargal, Taivanbaatar Dulguun (CAA Mongolia), Shweta Mulcare, Prakash Subramanian (MITRE), Paisit Herabat, Rinthida Jorntes, Nuttakajorn Yanpirat (MAAR), Jon Townsend (AFCENT, by telephone).

AFCENT is currently serving as the proxy for the airspace control authority for Afghanistan and is responsible for coordinating all requirements for RVSM. MITRE is providing analytical support for the pre-implementation phases for RVSM implementation. The safety oversight of pre and post-implementation phases are to be conducted by MAAR since MAAR is the appropriate RMA. MAAR will assist the AFCENT team by providing oversight of the safety assessment for RVSM in Afghanistan and any associated data to the extent possible.

The meeting discussed the need for pre-implementation coordination between MAAR and MITRE to support the implementation of RVSM in terms of the quantitative safety assessment. No formal agreement was required between MITRE and MAAR for technical collaboration. MAAR will provide MITRE a training session on Thursday 24 February 2011 to go over the process that has been used in the past by MAAR to support go/no-go decisions. MITRE will share technical details of ongoing work with MAAR.

The meeting was reminded that the quantitative safety assessment was one component of the overall process, and that the State was responsible for the qualitative safety assessment. This was normally compiled by experts using a Hazard Identification and Risk Assessment (HIRA) process.

There are three key data elements required for the pre-implementation and post-implementation phases of the study – 1 month TSD data for peak month, LHD, aircraft approvals.

The actual assessment of RVSM readiness using the safety assessments submitted by the State would be done by the EURASIA RVSM Task Force Meeting. RASMAG's role was to oversee that the correct process had been used.

AIRSPACE ANALYSIS

1. INTRODUCTION

The present route network forms part of the EMARSSH project introduced in November 2002 and is mostly composed of nearly parallel North West – south east RNP10 routes catering to the traffic flow between Middle East and Southeast Asia. Another set of routes originate from the busy traffic hub of South East Asia and proceed northwards through Afghanistan to Europe and beyond. The existing non RNAV routes will be phased out shortly. There was no large lateral deviation of flights due navigational error since the implementation of this route structure. The safety assessment carried out by Singapore (SEASMA) with TSD of December 2009 and the results presented in their Working paper in BOB-RHS/TF/5 meeting by SEASMA strongly supports the continued use of safe operation of 50 NM lateral separation over Bay of Bengal and Arabian Sea. There are large weather deviations during the monsoon season over both Bay of Bengal and Arabian Sea.

2. AIRSPACE DESCRIPTION

The airspace analyzed is the Bay of Bengal Arabian sea region where RNP 10 and RVSM are implemented. The four Routes of N571, P628, P762 & L510 are analyzed. P628 is westbound unidirectional & L510 is eastbound unidirectional except during BOBCAT period and N571 is a bidirectional route crossing the entire breadth of the Bay of Bengal Arabian Sea region. P762 is a bidirectional crossing route from North east to South west and it is originating from South East Asia proceeding towards African countries via Colombo. This study is mainly focused on the introduction of Reduced Longitudinal separation of 50NM. Figure 1 shows the existing route network.

The Bay of Bengal Arabian Sea region spreads over twelve Flight Information Regions i.e., Chennai, Mumbai, Kolkata, Bangladesh, Yangon, Bangkok, Jakarta, Kuala Lumpur, Colombo, Male, Seychelles & Muscat

The four routes on which 50 NM reduced longitudinal separation is to be introduced in the first phase are N571, P628, and P762 & L510. Routes N571 & P762 are bidirectional and routes P628 & L510 are unidirectional. P628 is westbound and L510 eastbound unidirectional except when BOB-CAT level allocation takes place. All four routes follow the semicircular system of flight level allocation.

Route N877 is a converging/diverging route with N571 over common way point LAGOG. P761 is a crossing route with N571 over common way point IDASO. P762 is a crossing route with N571 over common way point BIKEN. Presently FL290 and FL320 have been allocated as No PDC level. P762 & P628 cross over common way point PPB.

The oceanic airspace of Bay of Bengal and Arabian Sea is Class E airspace and is subject to procedural control with pilot reporting waypoint either by voice or through data link. At present a longitudinal separation of 10 minutes based on MNT or 80NM is prescribed for routes N571 & P628. For routes L510 & P762 the only separation standard is 10minutes based on MNT. A Longitudinal separation of 15 minutes is prescribed for crossing routes.

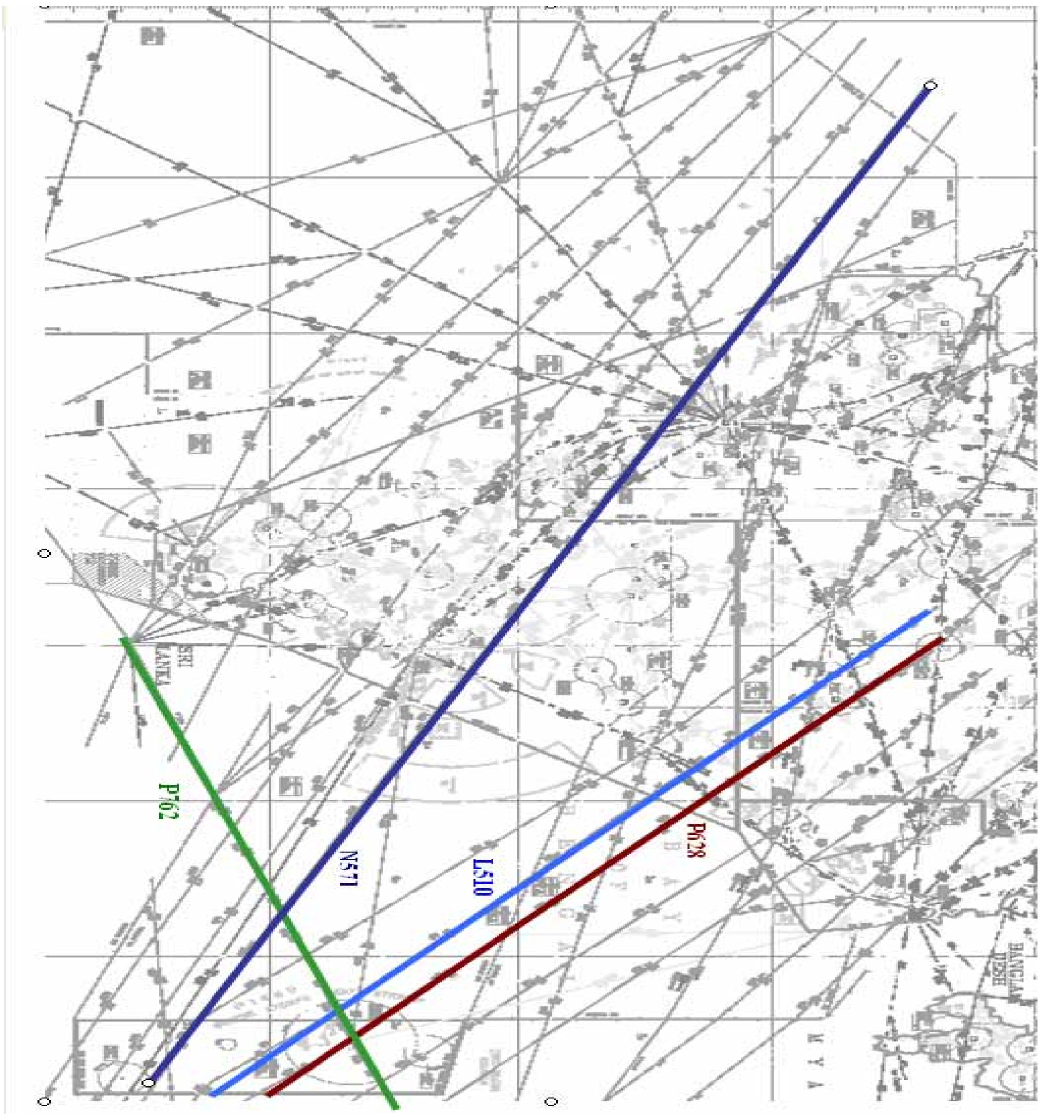

Figure 1

3. COMMUNICATION AND SURVEILLANCE.

The airspace being in the equatorial region, HF communications has inherent operational limitations due to ionospheric effects. CPDLC has proved to be an effective DCPC tool.

RCAG VHF is provided as primary backup frequency for CPDLC in Chennai, Mumbai & Kolkata FIRs and has been found to work satisfactorily. Figure2. Depicts the VHF-RCAG coverage in Indian FIRs. The VHF coverage of Yangon FIR extends up to LALIT on P762 and that of Kuala Lumpur is up to 30 NM short of IGREX, EMRAN & IGOGU. The VHF coverage of Colombo FIR is up to DUGOS on P762.

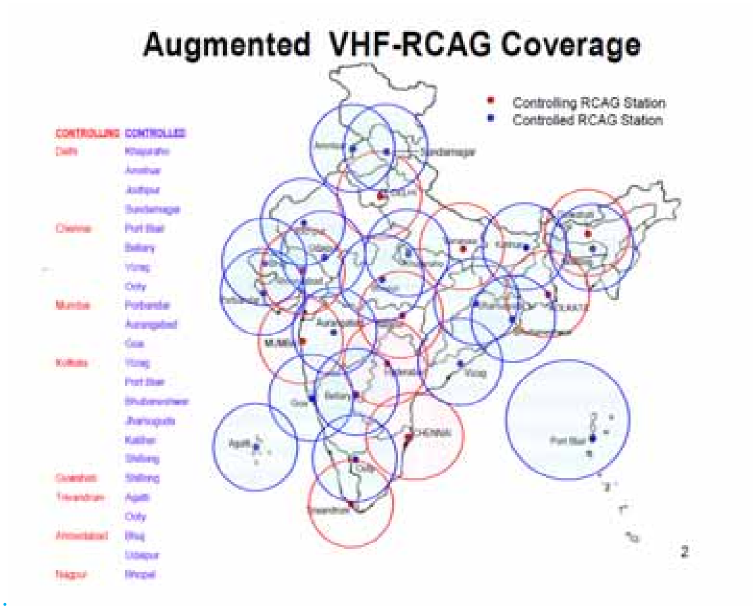

Figure 2. VHF – RCAG Coverage in Indian FIRs.

Radar surveillance is available over the continental airspace. The MSSR radars at Chennai, Mumbai & Kolkata extend up to approximately 200NM into oceanic airspace. These radars provide an opportunity to monitor the lateral deviations of aircraft and surveillance data collected from these radars were used for this study. The VHF and Radar coverage diagram are available in the states Aeronautical Information Publications (AIP).

ADS/CPDLC

Over oceanic airspace surveillance is via ADS/CPDLC. The number of airlines using ADS/CPDLC services within Indian FIRs is around 29. The percentage of aircraft using ADS/CPDLC in Mumbai FIR is 48% and in Chennai FIR is 51% and in Kolkata FIR is 60%. Malaysia has undertaken software upgrades of its ADS/CPDLC system which serve seven oceanic routes P628, L510, L645, L627, N571, B466 & P574 since May 2010 and commenced 24-hour operational trials from 11 October 2010. Maldives had implemented ADS-C/CPDLC services since 2009 and the equipment problem faced was expected to be fixed by March 2010. Myanmar has the ability to provide ADS/CPDLC services along P762. Myanmar has also started to integrate a new ADSC/CPDLC system into their ACC displays at the Yangon ACC. This will allow all of the Yangon FIR to operate in a data-link environment when necessary. Srilanka has taken steps to modernize the existing ATM systems with a fully integrated system (Radar, ADS-C/CPDLC, ADS-B etc).

The data link services are provided on 12 international routes over the Bay of Bengal within Chennai FIR i.e., N877, L510, P628, L759, N571, N563, P762, P574, L896, N564, P761 & L645.

Data link services are provided on 15 international routes over Arabian Sea and Indian Ocean i.e., routes M638, P518, L301, N571, P574, N563, M300, P570, R456, G465, A451, A474, A214, B459, G450 and G424

An analysis of aircraft equipage for RNAV routes N571 P628, P574, P762, P628 N563, L510 and N877 between 1st and 30th August, 2010 was done and the result is shown in Table 1 and Figure 3. The aircraft ADS equipage does not vary much from one FIR to another though it has been found that aircraft logging- in, in one FIR does not log on when in another FIR.

Route	Total no of acft	No of ADS Equipped Acft	No of acft logged on ADS	% of ADS equipped acft
N571	2790	1536	1514	55 %
P574	2025	799	330	40 %
P762	613	395	326	64 %
P628	474	418	358	88 %
N563	454	116	34	26 %
L510	366	324	248	89 %
N877	109	62	52	43%

Table 1. Aircraft ADS equipage.

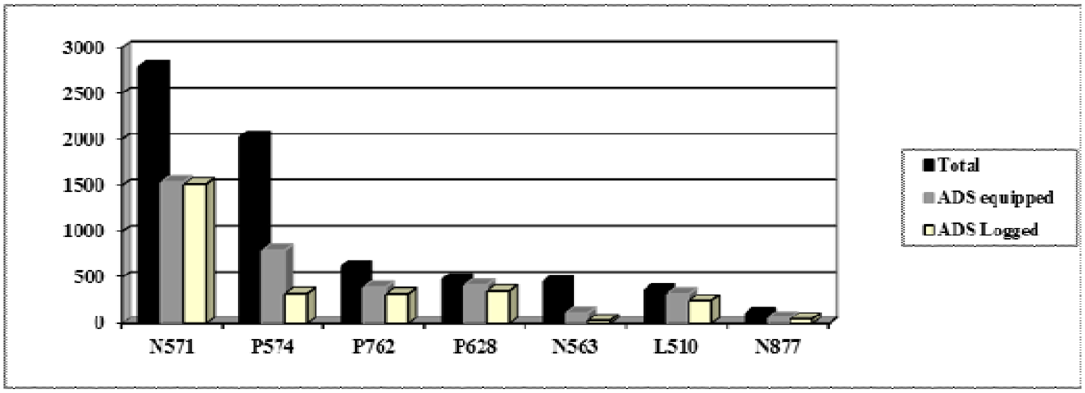

Figure3. Aircraft ADS equipage

TYPE	COUNT	PERCENTAGE	LENGTH	WINGSPAN	HEIGHT
A306	81	1.60	54.1	44.84	16.54
A319	137	2.70	33.84	34.1	11.76
A320	459	9.05	37.57	34.1	11.76
A321	154	3.04	37.57	34.1	11.76
A332	683	13.47	58.8	60.3	17.4
A333	488	9.62	63.6	60.3	16.85
A343	136	2.68	63.6	60.3	16.85
A345	30	0.59	67.9	63.45	17.1
A388	122	2.41	73	79.8	24.1
B722	13	0.26	46.69	32.91	10.36
B737	12	0.24	31.2	35.8	12.6
B738	400	7.89	39.5	35.8	12.5
B742	42	0.83	70.6	59.6	19.3
B743	25	0.49	70.6	59.6	19.3
B744	565	11.14	70.6	64.4	19.4
B74S	28	0.55	76.3	68.5	19.4
B762	14	0.28	48.5	47.6	15.8
B763	30	0.59	54.9	47.6	15.8
B772	751	14.81	63.7	60.9	18.5
B773	95	1.87	73.9	60.9	18.5
B77L	34	0.67	63.7	64.8	18.8
B77W	620	12.22	73.9	64.8	18.7
CL60	10	0.20	20.85	19.6	6.3
F900	13	0.26	20.2	19.3	7.6
GLF4	12	0.24	26.9	23.7	7.4
OTHERS	118	2.33	-	-	-

Table2: Aircraft Population and number of flights per type in Dec. 2010

4. **DATA COLLECTION.**

It was agreed in the first three meetings of the Bay Of Bengal Reduced Horizontal Separation Task Force that Traffic Sample Data (TSD) for the month of December 2010 and Gross Navigational Error data which is to be collected from 1st July 2010 are to be provided to the EMA by the states concerned.

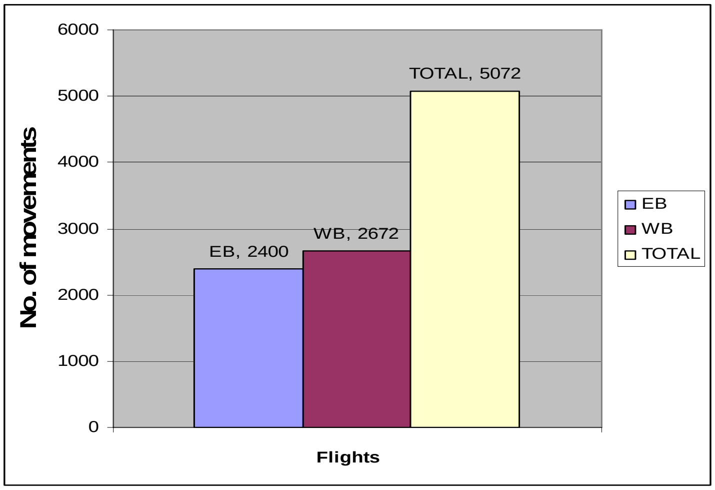

Figure 4. Record of Chennai TSD data collected for the month of December 2010

Route	**Segment**	**FIRs Involved**	**ACCs involved**#
L510	EMRAN & ELBAB	CHENNAI & KOLKATA	CHENNAI, KOLKATA
N571	IDASO & VAMPI	CHENNAI, KUALALUMPUR	CHENNAI
	SUGID & PARAR	MUMBAI, MUSCAT	MUMBAI
P628	LARIK & VATLA	CHENNAI, KOLKATA	CHENNAI, KOLKATA
P762	DUGOS & LULDA	CHENNAI	CHENNAI

Table 3. Monitored fixes in Bay of Bengal Arabian Sea

Month	Report received from							
	India			Colombo	Malaysia	Jakarta	Yangon	Bangkok
	Chennai	Mumbai	Kolkata					
July2010	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Aug2010	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Sep2010	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Oct2010	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Nov2010	Yes	Yes	Yes	No	Yes	No	Yes	Yes
Dec2010	Yes	Yes	Yes	No	Yes	No	Yes	Yes

Table 4. Record of GNE reports for the period July – Dec.2010

Monitoring Month	Cumulative Count of LLEs Reported Over Monitored Fixes Through Monitoring Month	Cumulative Count of LLDs Reported Over Monitored Fixes Through Monitoring Month
July2010	0	0
Aug2010	0	0
Sep2010	0	0
Oct2010	0	0
Nov2010	0	0
Dec2010	0	0

Table5: Monthly count of LLDs and LLEs reported on Bay of Bengal RNAV routes for the period July 2010 to December 2010

5. TRAFFIC ANALYSIS ON L510, N571, P628 & P762.

The latest available Traffic Sample Data of December 2010 from Chennai, Mumbai and Kolkata FIRs have been used to analyze the distribution of flights along the four routes. The analysis based on Type of aircraft, Name of Operator, Distribution of traffic over the days of the week and Flight level usage is displayed in Graphical form.

L510

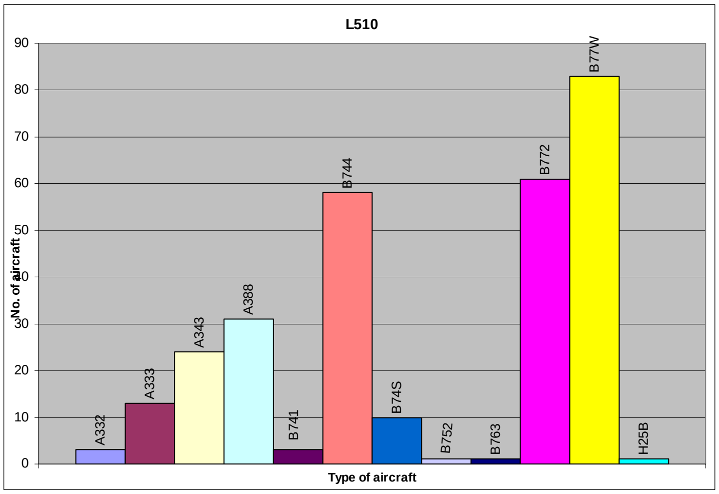

Figure 5 Aircraft Type wise distribution.

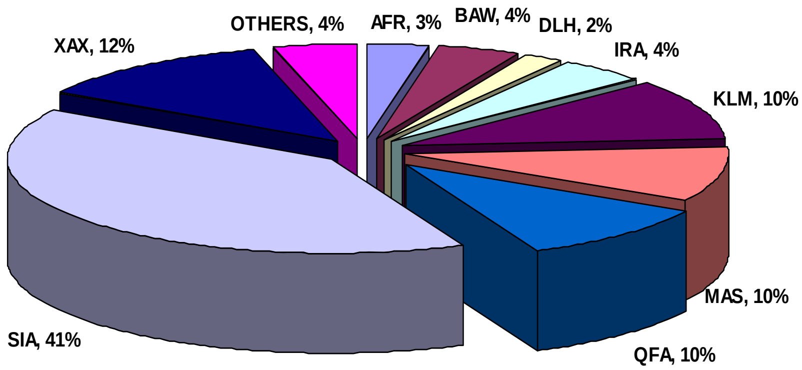

Figure 6 Operator-wise Aircraft Movements

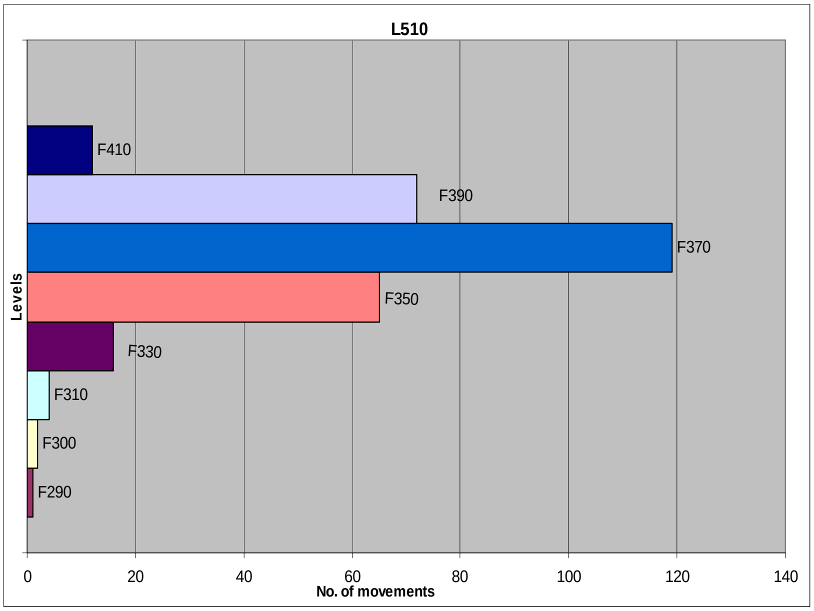

Figure 7 Flight Level usages by aircraft on L510

It can be seen that B77W , B772 & B744 are the three long range aircraft which account for more than 50% of the aircraft using this route. Singapore Airlines operates the maximum number of flights along this route and the next four major operators average about 35 to 40 movements each. The route being unidirectional the most preferred levels are FL370 & FL390 because most of the flights have destinations in Singapore and Malaysia and having already covered more than ¾ th of the flight distance prefer to maintain higher Flight Levels.

N571

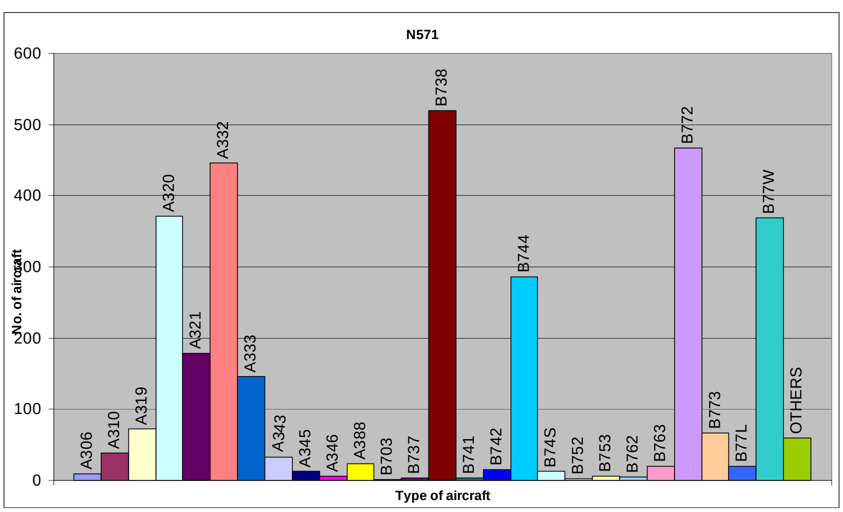

Figure 8 Aircraft Type wise distribution

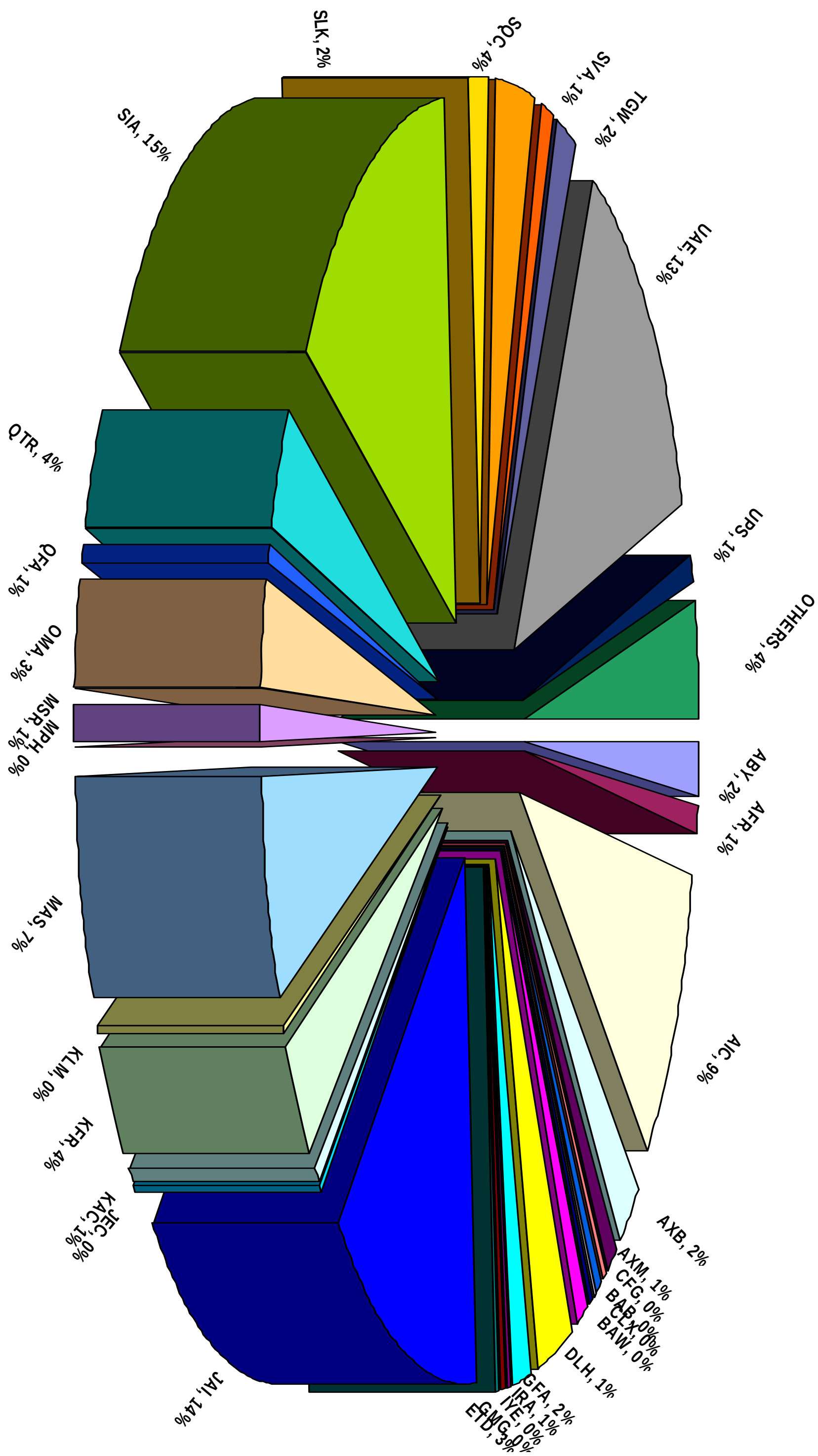

Figure 9 Operator-wise Aircraft Movements

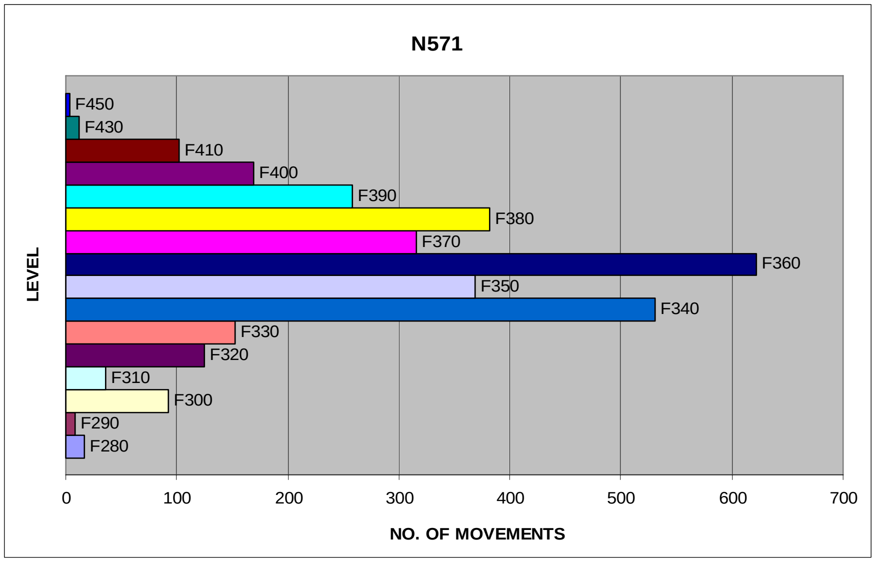

Figure 10 Flight Level usages by aircraft on N571

The maximum usage of this route is by B738. As Singapore Airlines and Emirates who along with Jet airways, are the top three airlines to operate on this route, it can be safely concluded that the maximum number of B738 is due to Jet Airways operating from India to destinations in the middle East and South East Asia and back. Since the Bay of Bengal Arabian Sea region lies midway between the two traffic hubs of Middle East and South East Asia the aircraft tend to maintain the most optimum levels of FL340 to FL380. During severe bad weather conditions in the monsoon season aircraft tend to deviate up to 40 – 50 NM resulting in controllers having to resort to frequent level changes to separate the traffic from those on the parallel route P574 in the Bay of Bengal and from traffic on routes P574 & L301 in the Arabian sea region.

<u>P628</u>

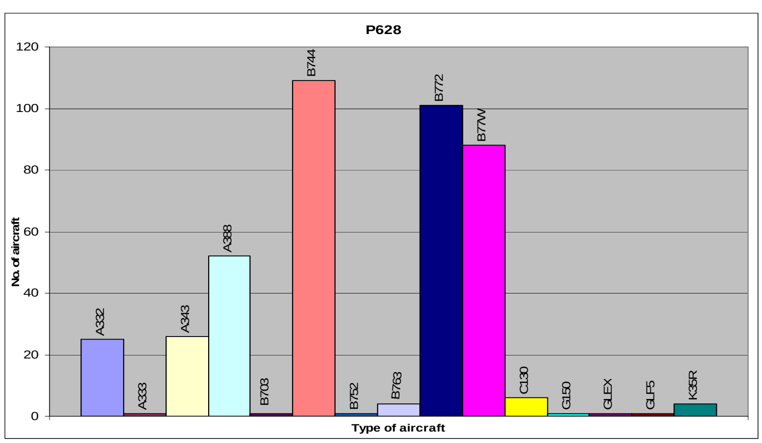

Figure 11 Aircraft Type wise distribution

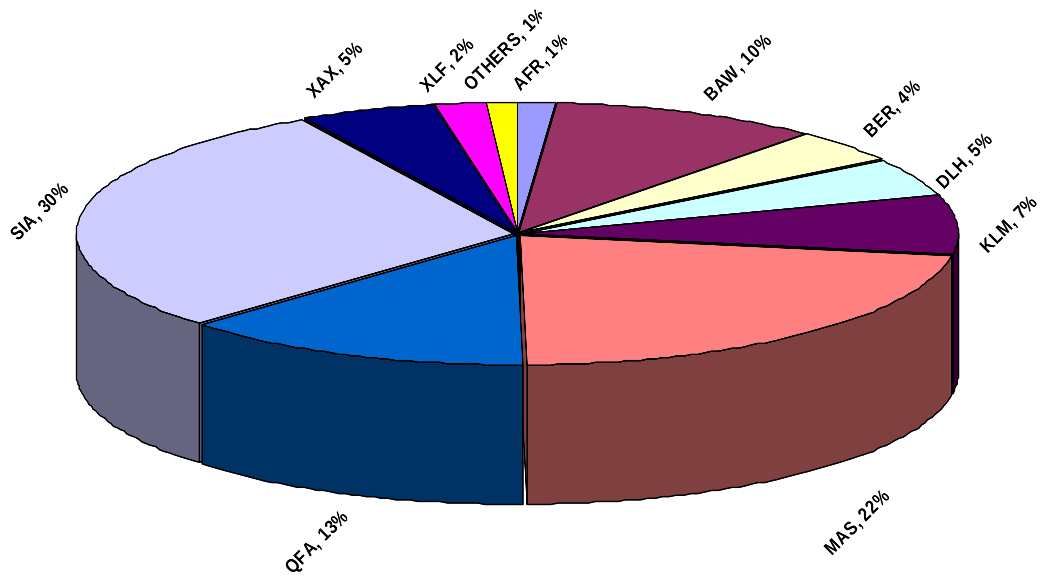

Figure 12 Operator-wise Aircraft Movements

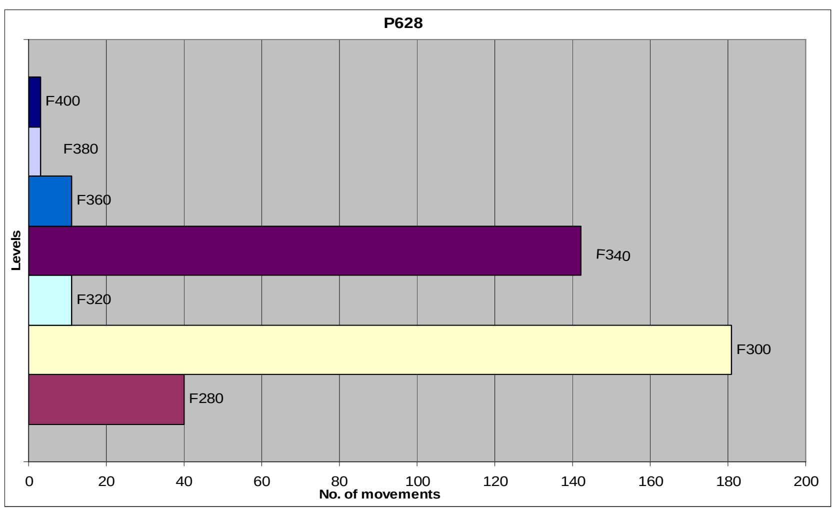

Figure 13 Flight Level usages by aircraft on P628.

It is seen that most of the flights operating on this route originate from either Malaysia or Singapore and mostly fly at FL 340 & below, FL300 being the most favored level. This may be because they are in the initial stage of their flight and may be too heavy to climb to much higher levels. The major aircraft types are B744, B772 & B77W.

P762

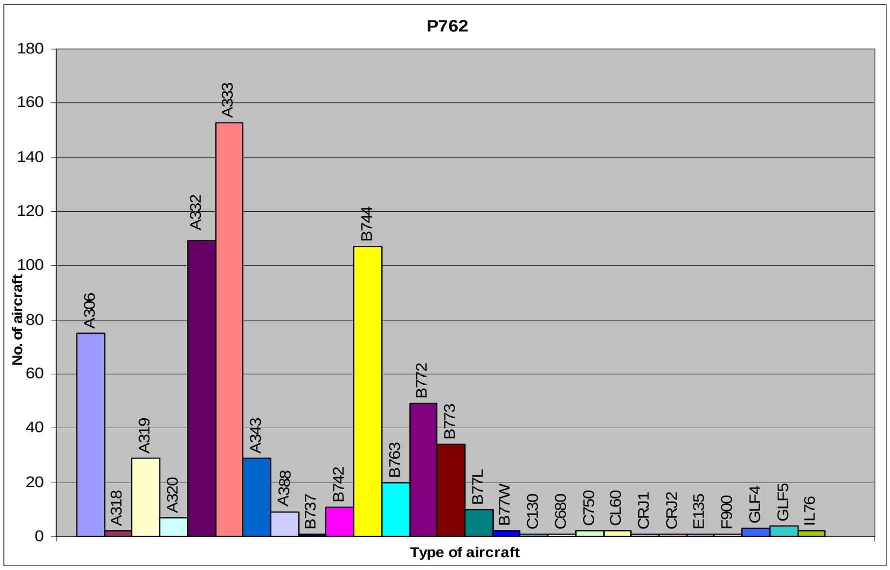

Figure 14 Aircraft Type wise distributions

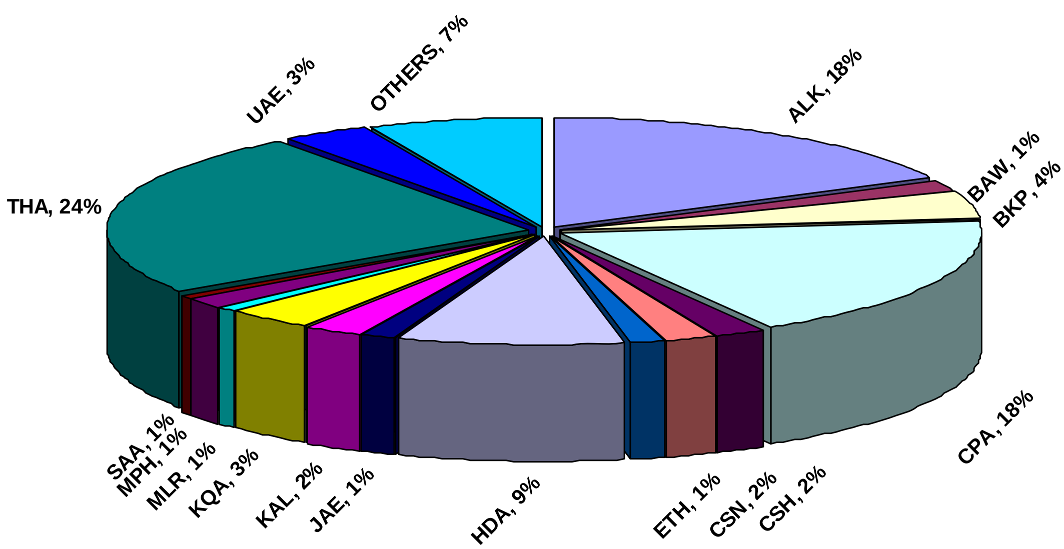

Figure 15 Operator-wise Aircraft Movements

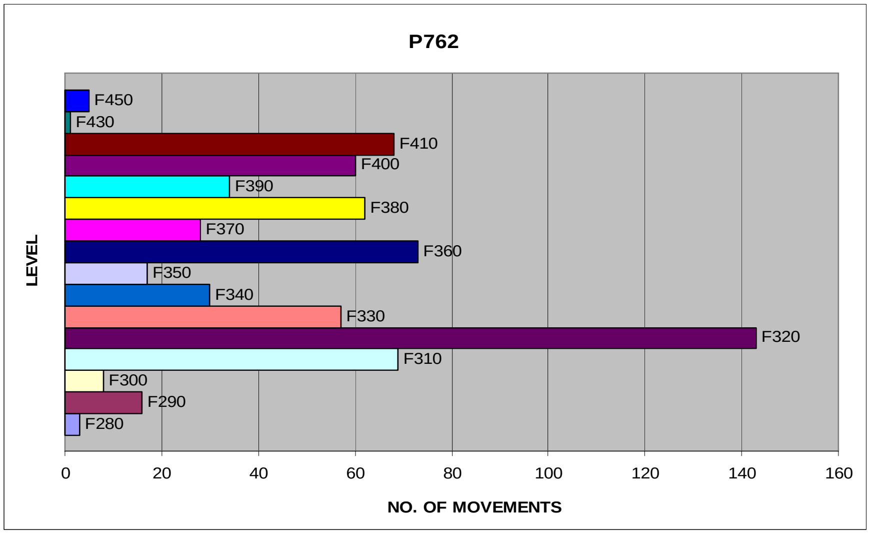

Figure 16 Flight Level usages by aircraft on P762.

P762 caters to the traffic between Bangkok and South Africa. The route cuts across major East – West routes in the Bay of Bengal region. FL320 is the pre-coordinated level between Yangon and Chennai and is also the most preferred westbound level. Thai airways and Cathay Pacific are the major airlines using this route.

Weekly Traffic flow

The weekly traffic flow on the four routes L510, N571, P628 & P762 were analyzed to find the peak traffic days on the different routes.

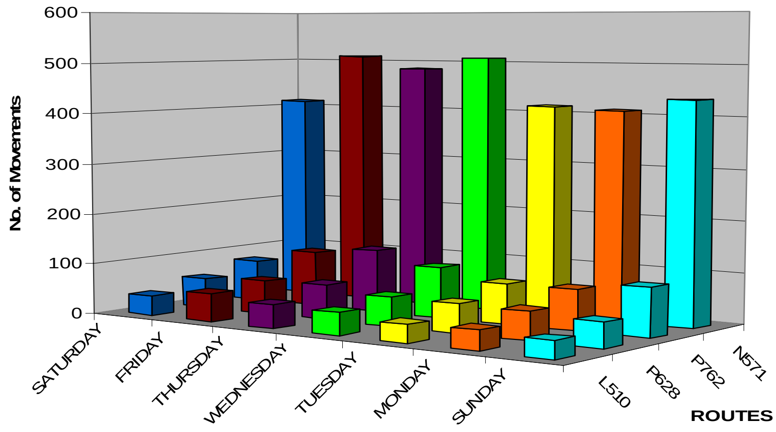

Figure 17 Weekly movements on four routes.

Traffic Density.

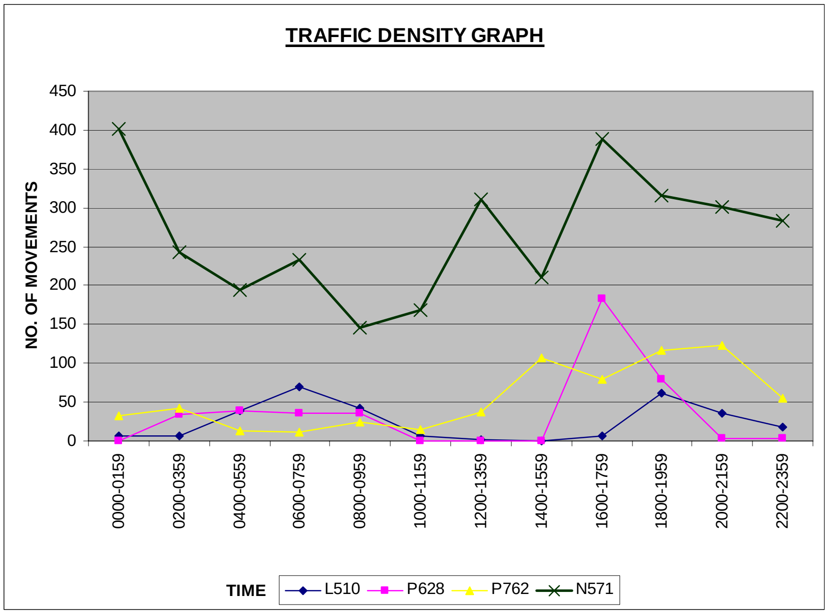

Figure 18 Traffic density pattern on the four routes.

6. WEATHER DEVIATION AND CONTINGENCY PROCEDURES

Between June to September the Arabian Sea region experiences south – West Monsoon climatic conditions and the Bay of Bengal region experiences north – East monsoon conditions between September to November. During this period aircraft are not able to maintain assigned flight level and track and need to deviate either left or right of track. Such deviations at times can be up to 70 to 80 NM.

A study was undertaken for the Bay of Bengal region using 20 days data from 28th October 2009 to 15th November 2009. Figure2 shows that the extent of deviation varied from 10NM to 60NM during this period. Number of aircraft deviations by more than 30NM from the intended track comes around 34, within a span of 15 days.

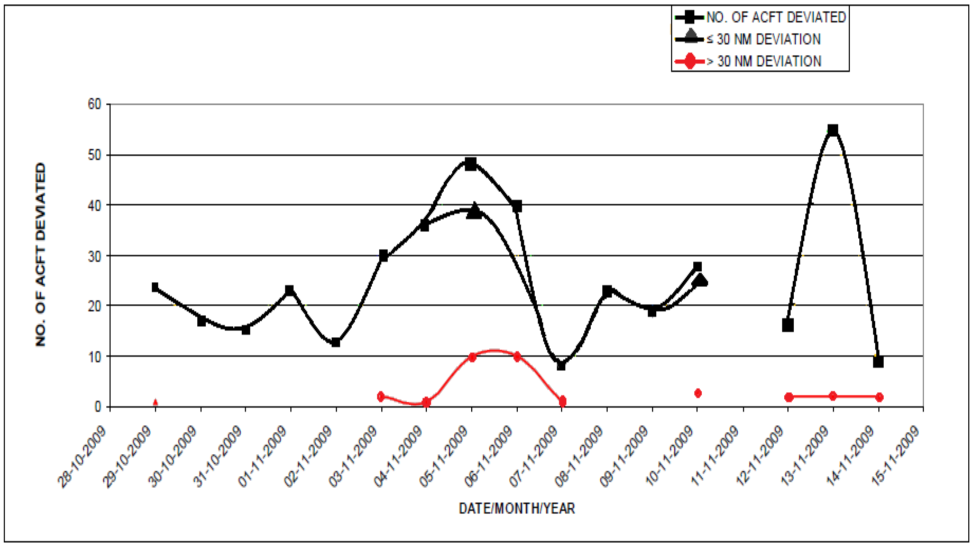

Figure 19. Weather Deviation over Bay of Bengal.

AIP India prescribes Weather deviation procedures for such contingencies. Aircraft are essentially required to either descend/climb by 300FT, depending on the direction of flight when unable to establish contact with ATC and the deviation is beyond 10NM. If deviation is to be less than 10NM aircraft shall maintain assigned level.

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7. BENEFITS OF REDUCED HORIZONTAL SEPARATION.

The introduction of Reduced Horizontal Separation is bound to enhance Safety, airspace capacity, increase fuel efficiency and reduce aircraft emissions.

Safety

Implementation of RHS will enhance safety in two ways.

(i) By increased surveillance using ADS/CPDLC as more and more aircraft are encouraged to have FANS1/A equipage.

(ii) Increased DCPC capability through enhanced VHF coverage and CPDLC.

8. AIRSPACE CAPACITY.

Table 6. shows the extent of capacity increase that can be achieved.

YEAR	ROUTE(S) & DISTANCE (NM)	SPACING BTN ACFT LAT/LONG (NM)	AIRSPACE / NO. OF VERTICAL LAYERS (FLIGHT LEVELS)	NO. OF AIRCRAFT
BEFORE 2002	SINGLE NON-RNP 2050	>200/120	CVSM(2000FT) / 9	153
2002	3 PARALLEL – RNP-10 2000 X 3	50/80	CVSM(2000FT) / 9	675
2003	3 PARALLEL – RNP-10 2000 X 3	50/80	RVSM(1000 FT) / 15	1125
2011	3 PARALLEL RNP-10 2000 X 3	50/50	RVSM(FANS) / 15	1800
2012*	4 PARALLEL RNP-4 2000X 4	30/30	RVSM(FANS) / 15	4000

Table 6.

9. FUEL EFFICIENCY

Fuel efficiency is one of the most import criteria in flight operations. It is estimated that for every 2000 ft difference from optimum flight level, the aircraft burns out approximately an additional 2% of fuel per hour. Hence for example, a heavy aircraft like Boeing 747, which burns 3.79 litres of fuel per second, flying at 2000 feet above or below its optimum level, from South East Asian countries to Middle East or to cross Middle East towards Europe, in its EET of 6 hr. 45 minutes, burns out an extra 1847 litres (2 %) during the flight.

10. ENVIRONMENTAL BENEFITS

Carbon dioxide (CO2), nitrogen oxides (NOX), sulfur oxides (SOX), and particulates (soot), are examples of aircraft emissions which may alter atmospheric processes. A scientific assessment published by the Intergovernmental Panel on Climate Change (IPCC) attributes 3.5% of the total harmful effects on environment resulting from human activities to aviation and suggests that the impact of aircraft emissions at altitude is potentially twice as severe with respect to climate change when compared to ground level emissions.

Amount of toxic gases emitted by burning of fuel, as estimated by US EPA (United States Environmental Protection Agency) is given below :

CO_2 (kg) = 2.56 x amount of fuel burned (lit);

SOx (kg) = 0.00065 x amount of fuel burned (lit)

NOx (kg)=0.0005 x amout of fuel burned (lit)

Hence wastage of 1847 litres of fuel, as per the existing traffic, adds 2.5 million kg of CO_2, and 634 Kg of SOx and a similar amount of NOx, to the atmosphere per month.

11. IMPACT ON ATS ROUTES LINKING INDIA WITH THE MIDDLE EAST VIA THE ARABIAN SEA

The routes transiting Bay of Bengal Arabian Sea regions also pass through the radar coverage area of Muscat FIR and beyond. When releasing eastbound traffic into Mumbai FIR Muscat FIR has to expand the separation between aircraft at the same level from 5 – 10 NM to 80NM. With the introduction of RHS Muscat FIR would have that much less workload.

12. KABUL FIR

The primary mission of the Kabul ACC and ATC services in Afghanistan was to support the coalition forces in Afghanistan and this affects handling of over-flight traffic to and from the south Asian sub-region. Kabul FIR still remains a procedural control facility and the standard longitudinal separation used is 80NM. The ATFM BOBCAT arrangement is mainly to support Kabul FIR in handling the traffic congestion on these routes. The introduction of 50NM longitudinal separation on routes leading from South East Asia to Europe and beyond may lead to even more traffic build up at the entry point into Kabul FIR. If Kabul also implements 50NM reduced longitudinal separation it would ease the traffic flow through Afghanistan airspace and it would also be possible to decrease the spacing presently used by the BOBCAT system.

13. CROSSING ROUTES

The primary traffic flow in the Bay of Bengal region is between South East Asia and India. The crossing routes serving traffic between Asia and Africa though not as heavily loaded, still affects the allocation of flight levels on the primary routes. These limitations can be overcome by establishing unidirectional routes (All levels available) for the crossing traffic, and aircraft on these routes could be allocated the same levels, which will effectively sustain the capacity on the primary routes.

14. SAFETY OVERSIGHT AND RECOMMENDATION

The lateral collision risk is estimated to be 6.01881 x 10^{-10} & the longitudinal collision risk 3.71804 x 10^{-10}, both of which are well below the TLS of 5 x $10^{-9.}$ Thus it can be concluded that the Safety Assessment supports the continued use of 50NM RNP10 lateral separation and also the implementation of RNP10 50NM longitudinal separation on L510, N571, P628 and P762.

References

1. EMA Handbook for Asia/Pacific Region Version-2 August 2010
2. Doc 9689, Manual on Airspace Planning Methodology for the Determination of separation Minima.
3. Annex 11 of the Convention on International Civil Aviation, Air Traffic Services.
4. Reports of Bay of Bengal Reduced Horizontal Separation Task Force Meeting.
5. Safety Assessment and Airspace Analysis of South China Sea
6. EUR/SAM: “Double Uni-directionality” Post-Implementation Risk Assessment
7. Aeronautical Information Publication (India).

LATERAL AND LONGITUDINAL COLLISION RISK ASSESSMENT OF BAY OF BENGAL

1. INTRODUCTION

In this article we investigate the collision risk between two aircraft flying over the Bay of Bengal. This safety assessment is undertaken by the Airports Authority of India (AAI). The goal of this study is to confirm that the Target Level of Safety (TLS) which is 5×10^{-9} collisions per flight hour is currently met. This analysis will also help the AAI to establish En-route Monitoring Agency (EMA) which is necessary for further lateral and longitudinal separation reductions. It is important to note that currently the separation standards are as follows

- for lateral separation it is at least 50 NM between all the parallel routes;
- for longitudinal it is at least 10 minutes leading to an average 80 NM between front and behind aircraft.

In this article we carry out the quantitative risk analysis based on two types of data sets collected by the AAI.

• Traffic Sample Data (TSD):

Traffic sample data from Chennai FIR for the month of December 2010 was used. The original sample contained 4986 records. The data contained several anomalies, which we tried to detect and remove. We also removed entries for routes that are not relevant for the current study. Briefly, the following initial filtering criteria were used:

- Records with Exit time less than Entry time were removed.
- Records with missing data on entry/exit points, entry/exit levels, entry/exit times were removed.
- Records with flight level less than F290 were removed.
- Records whose entry/exit routes were inconsistent were removed.
- Only records for routes L510, P628, N877, P574, N571, and P762 were retained.

2741 flights that were retained after filtering were considered for the subsequent statistical analysis and Figure 1 provides a more detailed graphical summary with additional break-up by flight level and direction.

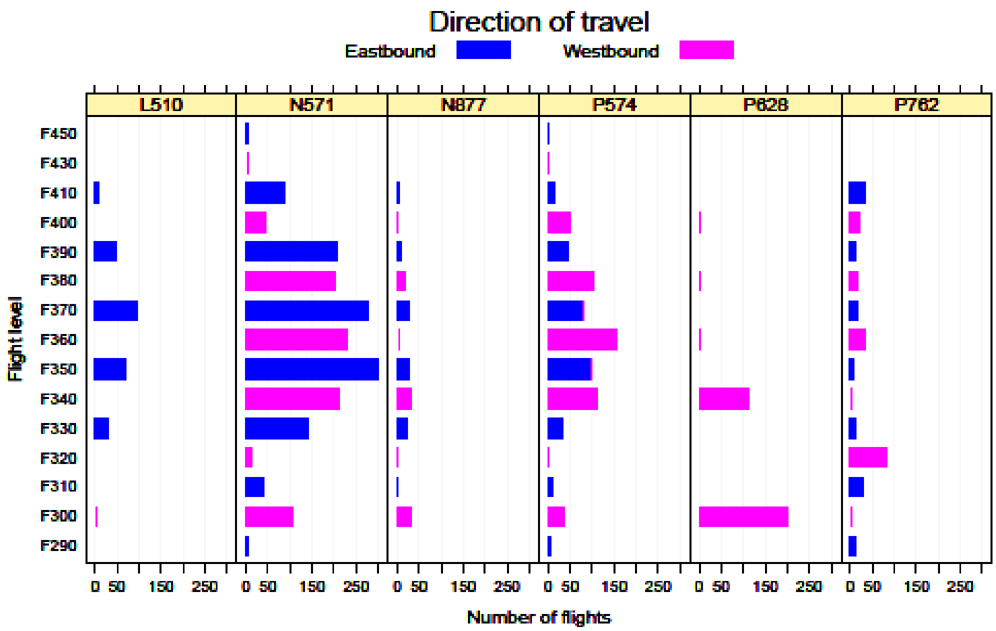

Figure 1: Number of flights per route and flight level entering Chennai FIR, based on December 2010 TSD.

Gross Navigational Error (GNE) Data:

Reports of Gross Navigational Errors were received from India (Chennai, Mumbai, and Kolkata FIRs) and Bangkok for the months of July to December 2010, as summarized in Table1. In Section 2 we discuss the risk assessment for the lateral direction and in Section 3 gives the same for the longitudinal direction.

Year	**Month**	**FIR**	**Flights**	**LLE**	**LLD**
2010	AUGUST	KOLKATA	443	0	0
2010	SEPTEMBER	KOLKATA	423	0	0
2010	OCTOBER	KOLKATA	432	0	0
2010	NOVEMBER	KOLKATA	427	0	0
2010	DECEMBER	KOLKATA	545	0	0
2010	JULY	CHENNAI	2679	0	0
2010	AUGUST	CHENNAI	5173	0	0
2010	SEPTEMBER	CHENNAI	5196	0	0
2010	OCTOBER	CHENNAI	5478	0	0
2010	NOVEMBER	CHENNAI	5258	0	0
2010	DECEMBER	CHENNAI	5432	0	0
2010	JULY	MUMBAI	1838	0	0
2010	AUGUST	MUMBAI	1812	0	0
2010	SEPTEMBER	MUMBAI	1792	0	0
2010	OCTOBER	MUMBAI	1884	0	0

2010	NOVEMBER	MUMBAI	1068	0	0
2010	DECEMBER	MUMBAI	1426	0	0
2010	JULY	BANGKOK	1865	0	0
2010	AUGUST	BANGKOK	2330	0	0
2010	SEPTEMBER	BANGKOK	2297	0	0
2010	OCTOBER	BANGKOK	2234	0	0
2010	NOVEMBER	BANGKOK	2108	0	0
2010	DECEMBER	BANGKOK	2061	0	0
2011	JANUARY	BANGKOK		0	0

Table1: Summary of reports of Gross Navigational Errors.

2 LATERAL COLLISION RISK ASSESSMENT

2.1 Lateral Collision Risk Model

In order to compute the *level of safety* for lateral deviations of operations on the Bay of Bengal we use the *Reich Lateral Collision Risk Model*. It models the lateral collision risk due to the loss of lateral separation between aircraft on adjacent parallel tracks flying at the same flight level. The model is as follows:

$$N_{ay} = P_y(S_y)\,P_z(0)\,\frac{\lambda_x}{S_x}\left\{E_y(\text{same})\left[\frac{|\Delta\bar{V}|}{2\lambda_x}+\frac{|\bar{\dot{y}}(S_y)|}{2\lambda_y}+\frac{|\bar{\dot{z}}|}{2\lambda_z}\right]+E_y(\text{opp})\left[\frac{|2\bar{V}|}{2\lambda_x}+\frac{|\bar{\dot{y}}(S_y)|}{2\lambda_y}+\frac{|\bar{\dot{z}}|}{2\lambda_z}\right]\right\}. \quad (1)$$

We would like to note that same model has been used for the safety assessment study of the South China Sea which was carried out by SEASMA and also in European safety assessment which was carried out for EUR/SAM corridor.

The parameters in the equation (1) are defined as follows:

- Nay := Expected number of accidents (two for every collision) per flight hour due to the loss of lateral separation between co-altitude aircraft flying on tracks with planned Sy NM lateral separation.
- Sy := Minimum planned lateral separation.
- λx := Average length of an aircraft flying on Bay of Bengal.
- λy := Average wingspan of an aircraft flying on Bay of Bengal.
- λz := Average height of an aircraft flying on Bay of Bengal.
- Py (Sy) := Probability that two aircraft assigned to two parallel routes with Sy NM lateral separation will lose all planned lateral separation.
- Pz (0):= Probability that two aircraft assigned to same flight level are at same geometric height.
- Sx := Length of half the interval in NM used to count proximate aircraft at adjacent routes.
- Ey (same):= Same direction lateral occupancy at same assigned flight level.
- Ey (opp):= Opposite direction lateral occupancy at same assigned flight level.

- $\left|\Delta\,\overline{V}\right|$ = Average relative speed of two aircraft flying on parallel routes in same direction.
- $\left|\overline{V}\right|$ = Average ground speed on an aircraft.
- $\left|\overline{\dot{y}}(S_y)\right|$ = Average relative lateral speed of aircraft pair at loss of planned lateral separation of S_y.
- $\left|\overline{\dot{z}}\right|$ = Average relative vertical speed of a co-altitude aircraft pair assigned to the same route.

A collision and consequently two accidents can only occur if there is overlap between two aircraft in all three dimensions simultaneously. Equation 1 gathers the product of the probabilities of losing separation in each one of the three dimensions.

As it has already been said, $P_z(0)$ is the probability of vertical overlap; $P_y(S_y)$ is the probability of lateral overlap and the combinations of $\frac{\lambda_x}{S_x}E_y$ (same) and $\frac{\lambda_x}{S_x}E_y$ (opp) relate to the probability of longitudinal overlap of aircraft on adjacent parallel tracks and at the same flight level. All the probabilities can be interpreted as proportions of flight time in the airspace during which overlap in the pertinent dimension occurs. As the collision risk is expressed as the expected number of accidents per flight hour, the joint overlap probability must be converted into number of events involving joint overlap in the three dimensions, relating overlap probability with passing frequency. Here we note that passing frequency between two adjacent routes is the average number of events, per flight hour, in which two aircraft are in longitudinal overlap when travelling in the opposite or same direction at the same flight level. This is achieved by means of the expressions within square brackets in Equation 1. Each of the terms within square brackets represents the reciprocal of the average duration of an overlap in one of the dimensions. For example, $\frac{\left|\Delta\overline{V}\right|}{2\lambda_x}$ is the reciprocal of the average duration of an overlap in the longitudinal direction for same direction traffic. In the case of longitudinal direction too, but for opposite direction, the average relative speed is $2\overline{V}$ and the average overlap time is $\frac{\left|\Delta\overline{V}\right|}{2\lambda_x}$.

The model is based on the following hypothesis:

- All routes are parallel. (In the Bay of Bengal sea area there are cross route, such as, P762. We are excluding these routes from the current study)
- All collisions normally occur between aircraft on adjacent routes, although, if the Probability of overlap is significantly large, they may also occur on non-adjacent routes.
- The entry times into the track system are statistically independent.
- The lateral deviations of aircraft on adjacent tracks are statistically independent.

- The vertical, longitudinal and lateral deviations of an aircraft are statistically independent.
- The aircraft are replaced by rectangular boxes.
- There is no corrective action by pilots or ATC when two aircraft are about to collide.

The model also assumes that the nature of the events making up the lateral collision risk is completely random. This implies that any location within the system can be used to collect a representative data sample on the performance of the system.

2.2 Estimated Values of the Parameters and Estimated Lateral Collision Risk

The following table gives the values of the parameters of the right-hand side of the equation (1) Which are obtained from our analysis.

Parameter	Estimated Values	Source of the Estimate
Sy	50 NM	Current minimum lateral separation
λx	0.0326051NM	Estimated from the TSD of December, 2010 (see Section 2.3).
λy	0.02983705 NM	Estimated from the TSD of December 2010 (see Section 2.3).
λz	0.009069301 NM	Estimated from the TSD of December 2010 (see Section 2.3).
P_y (50)	4.31577×10^{-8}	Estimated using a mixture model (see Section2.4).
P_z (0)	0.3617939	Estimated using a Double Exponential model (see Section 2.5).
S_x	80 NM	Equivalent to ±10-minutes of longitudinal separation.
E_y(same)	0.04880429	Estimated from the TSD of December 2010 (see Section 2.6).
E_y (opp)	0	No opposite directional lateral occupancy at same assigned flight level.
$\left\|\Delta\overline{V}\right\|$	36 knots	Value obtained from TSD (see Section 2.8).
$\left\|\dot{\bar{y}}(50)\right\|$	75 knots	Conservative value taken from EMA Handbook (see Section 2.9).
$\left\|\dot{\bar{z}}\right\|$	1.5 knots	Conservative value as per EMA Handbook(see Section 2.10).

Finally this leads to the following estimate for the lateral collision risk Nay .

$$N_{ay} = 6.01881 \times 10^{-10}$$

2.3 Estimating Average Aircraft Dimensions

We computed the average aircraft dimensions using the dimensions of each aircraft type weighted by their relative proportions

2.4 Estimating Probability of Lateral Overlap: $P_y (S_y)$

The probability of lateral overlap of aircraft nominally flying on adjacent flight paths, separated by S_y, is denoted by $P_y (S_y)$ and is defined as

$P_y (S_y) := P (|S_y + Y_1 - Y_2| \leq \lambda y)$, (2) where Y_1 and Y_2 are assumed to be the lateral deviations of two aircraft which are nominally separated by S_y. We assume that Y_1 and Y_2 are identically distributed but statistically independent with a distribution F_y.

We model F_y as mixture distribution having a core distribution Gy and a non-core distribution H_y.

- The core distribution Gy, represents errors that derive from standard navigation system deviations. These errors are always present, as navigation systems are not perfect and they have a certain precision.
- The non-core distribution H_y, represents Gross Navigation Errors (GNE), that corresponds to what may be viewed as non-nominal performance.

We assume that a standard navigation system error represented by the core distribution may take large values but the non-core distribution representing gross navigation errors can only take large values. But in most cases it is impossible to determine with certainty if a given observed lateral error arose from the core or from the tail term of the distribution. Therefore, the overall lateral deviation distribution is modeled as:

$$F_y (y) = (1 - \alpha) G_y (y) + \alpha H_y (y) . \qquad (3)$$

The mixing parameter α is the probability of a *gross navigational error.*

The core lateral deviation distribution Gy is modeled by a Double Exponential distribution with a parameter $\beta y > 0$ as the rate, that is, if $Y1 \sim Gy$ then

$$P (|Y1| > y) = e^{-\beta_y y}$$

In other words we assume that the core distribution has a density of the form

$$g_y(y) = \frac{\beta_y}{2} e^{-\beta_y y}$$

Finally the non-core distribution H_y is modeled by a *"Separated Double Exponential "* distribution with parameters $\mu_y > 0$, representing the "separation and $\gamma_y > 0$ the rate parameter, that is, if $Y2 \sim Hy$ then

$$P (Y2 > \mu_y + y) = \frac{1}{2} e^{-\gamma_y y} \text{ and}$$

$$P (Y2 < -\mu_y - y) = \frac{1}{2} e^{\gamma_y y}$$

This really means that the non-core distribution H_y gives no mass in $[-\mu_y, \mu_y]$ and outside it decays as a Double Exponential distribution with rate parameter γ_y. The density of this distribution is given by

$$h_y(y) = \begin{cases} \frac{\gamma_y}{2} e^{\gamma_y (y+\mu_y)} & \text{if} \quad x < -\mu_y \\ 0 & \text{if} \quad -\mu_y \le x \le \mu_y \\ \frac{\gamma_y}{2} e^{\gamma_y (y-\mu_y)} & \text{if} \quad x > \mu_y \end{cases} .$$

This modeling is similar but more realistic than what has been used by FAA and also in EUR/SAM. The parameter α is estimated by taking the 95% upper confidence limit from the July December 2010 GNE data as provided by AAI. The formula comes out to be

$$\widehat{\alpha} = 1 - (0.05)^{1/N} = 5.526927 \times 10^{-5} ,$$

where N = 54201 is the number of flights observed and no gross navigational errors were detected. More GNE data with no detected gross navigational error will increase the value of N and hence decrease the value of α which will lead to decrease in the risk.

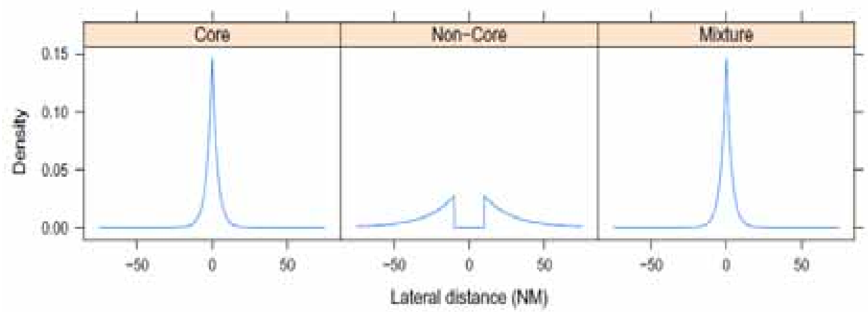

Figure 2: Modeling of lateral deviation.

The parameter β_y is estimated under the RNP10 assumption of ±10 NM deviation with 95% confidence, this leads to the estimate

$$\widehat{\beta_y} = -\frac{\log 0.05}{10} = 0.299573227 .$$

The parameter μ_y is taken to be 10 based on RNP10 consideration and γ_y is then estimated by maximizing the wingspan overlap probability with S_y = 50 NM initial separation. This is a conservative method similar to what has been used by FAA and also in EUR/SAM. The estimated value of γ_y is 0.05489709 leading to the estimated value of P_y (50) as 4.31577×10^{-8}.

2.5 Estimating Probability of Vertical Overlap: P_z (0)

The probability of vertical overlap of aircraft nominally flying at the same flight level on laterally adjacent flight paths is denoted by P_z (0). It is defined by

$$P_z(0) = \mathbf{P}(|Z_1 - Z_2| \le \lambda_z),$$

where Z_1 and Z_2 are the height deviations of two aircraft nominally flying at the same flight levels on laterally adjacent flight paths.

We assume that Z_1 and Z_2 are statistically independent with distribution F_z . Unlike in the computation of P_y (S_y) where we assume the lateral deviations follow a mixture distribution here we only assume that F_z is a Double Exponential distribution with parameter $\beta_z > 0$, that is, with density function

$$f_z(z) = \frac{\beta_z}{2} e^{-\beta_z |z|} .$$

We estimate $\beta_z > 0$ by

$$\widehat{\beta_z} = -\frac{\log 0.05}{0.032915} = 91.014196371 .$$

This is under assumption that a typical aircraft stays within ±200 ft = ±0.032915 NM of its assigned flight level 95% of the time.

2.6 Estimating the Lateral Occupancy Parameters: Ey (same) and Ey (opp)

In equation 1 there are two occupancy terms, one for same direction occupancy Ey (same) and another one for opposite direction occupancy Ey (opp). Same direction occupancy is defined as the average number of aircraft that are, in relation to a typical aircraft

Count By	**Routes**	**Waypoints**	**Total**	**Proximate**
Entry	(N877, L510)	(ORARA, BIDEX)	316	2
Entry	(N877, P628)	(IGOGU, IGREX)	389	40
Entry	(P574, N571)	(NOPEK, IGOGU)	1188	80
Entry	(P574, N571)	(GIRNA, IDASO)	1254	38
Exit	(N877, P628)	(ORARA, VATLA)	389	20
Exit	(N877, L510)	(IGOGU, EMRAN)	81	0
Exit	(P574, N571)	(NOPEK, IGOGU)	1276	82
Exit	(P574, N571)	(GIRNA, IDASO)	1254	38

Table2: Number of laterally proximate flights per route pair,
based on Chennai FIR December 2010 TSD.

- flying in the same direction as it;
- nominally flying on tracks one lateral separation standard away;
- nominally at the same flight level as it; and
- within a longitudinal segment centered on it.

The length of the longitudinal segment, $2S_x$, is usually considered to be the length equivalent to 20 minutes of flight resulting to a value of 160 NM. It has been verified that the relationship between S_x and the occupancy is quite linear.

A similar set of criteria can be used to define opposite direction occupancy, just replacing “flying in the same direction” by “flying in the opposite direction”. Occupancy, in general, relates to the longitudinal overlap probability and can be obtained by the equation

$$E_y = \frac{2T_y}{H},$$

where T_y represents the total proximity time generated in the system and H is the total flight hours generated in the system during the considered period of time. We estimate this quantity by direct estimation from time at waypoint passing using the TSD. For this we compute the number of proximate pairs by comparing the time at which an aircraft on one route passes a waypoint with the time at which another aircraft on a parallel route passes the homologous waypoint. When the difference between passing times is less than certain value, 10 minutes in this case, it is considered that there is a proximate pair in that pair of routes. Occupancy is then calculated using the following expression:

$$E_y = \frac{2n_y}{n},$$

where the numerator ny is the number of proximate pairs and the denominator, n, is the the total number of aircraft. The observed number of proximate pairs and the total number of flights per route pair are summarized in Table 2.

2.7 Estimate of Average Ground Speed

As directly measured speed data were not provided, speeds and relative velocities have been estimated by comparing waypoint report times. To do this, we divide the distance separating the entry and exit waypoints on a route by the time taken to travel the route. The result of this operation is the speed of each aircraft.

2.8 Estimate of Average Relative Longitudinal Speed: $\left|\Delta\overline{V}\right|$

$\left|\Delta\overline{V}\right|$ is the average relative longitudinal speed between aircraft flying in the same direction. We estimate it from the TSD by taking the differences between the speeds of all the pairs of aircraft that constitute a lateral proximate pair in the same direction (see Figure 4). $\left|\Delta\overline{V}\right|$ is estimated as the mean absolute value of all the calculated differences, which turns out to be 35.13632. We use the conservative value 36. Here we note that the lateral proximate pairs are already determined while estimating the parameter E_y (same).

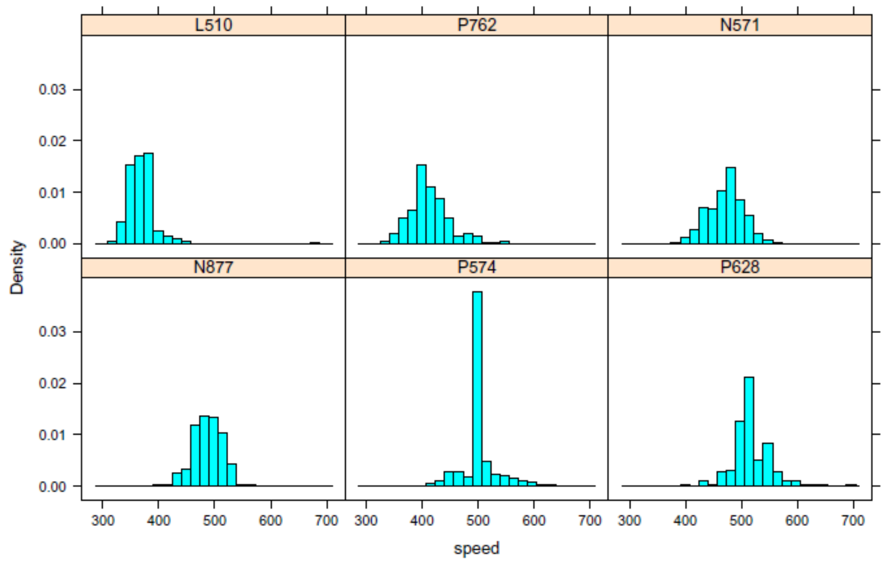

Figure 3: Distribution of estimated average speed by route.

2.9 Estimate of Average Relative Lateral Speed: $\left|\bar{\dot{y}}(S_y)\right|$

$\left|\bar{\dot{y}}(S_y)\right|$ is the average relative lateral cross-track speed between aircraft, flying on adjacent routes separated by S_y NM at the same flight level, that have lost their lateral separation. The estimation of this parameter generally involves the extrapolation of radar data, speeds and lateral deviations, but such radar data were not available for this study. So we take a conservative value 75 knots as per the EMA Handbook.

2.10 Estimate of Average Relative Vertical Speed: $\left|\bar{\dot{z}}\right|$

$\left|\bar{\dot{z}}\right|$ denotes the average modulus of the relative vertical speed between a pair of aircraft on the same flight level of adjacent tracks that has lost lateral separation. It is generally assumed that $\left|\bar{\dot{z}}\right|$ is independent of the size of the lateral separation between the aircraft and, for aircraft in level flight, it can also be considered that there is no dependency of $\left|\bar{\dot{z}}\right|$ with the vertical separation between the aircraft. As noted by various agencies data on $\left|\bar{\dot{z}}\right|$ are relatively scarce but typically taken as 1.5 knots which is considered to be conservative (see EMA Handbook).

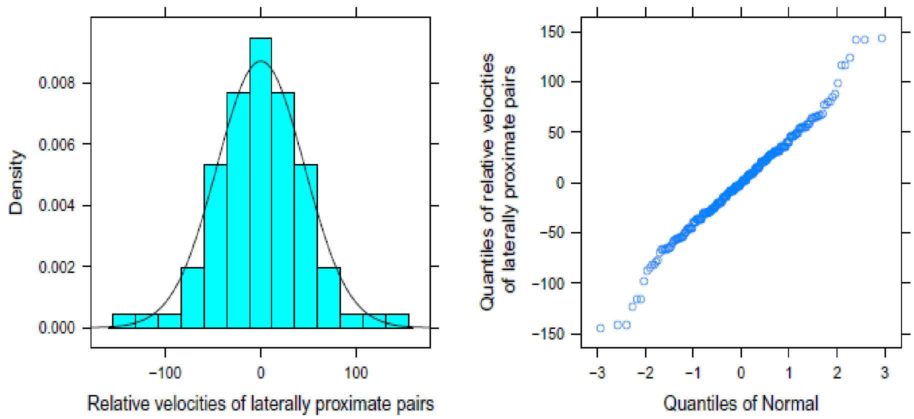

Figure 4: Distribution of relative velocities of laterally proximate pairs. The Normal distribution with sample standard deviation looks like a reasonable fit.

3. LONGITUDINAL COLLISION RISK ASSESSMENT

In order to compute the *level of safety* for longitudinal deviations of operations on the Bay of Bengal we use the *Longitudinal Collision Risk Model*. It models the longitudinal collision risk due to the loss of longitudinal separation between aircraft on adjacent flying on the same route at the same flight level. The model is as follows:

$$N_{ax} = P_y(0)\, P_z(0)\, \frac{2\lambda_x}{|\dot{x}|} \left(\frac{|\bar{\dot{x}}|}{2\lambda_x} + \frac{|\bar{\dot{y}}(0)|}{2\lambda_y} + \frac{|\bar{\dot{z}}|}{2\lambda_z} \right) \times \left[\sum_{k=m}^{M} Q(k)\, \mathbf{P}(K > k) \right]. \qquad (4)$$

We would like to note that the same model has been used for the safety assessment study of the South China Sea which was carried out by SEASMA.

The parameters in the equation (4) are defined as follows:

- N_{ax} :=Expected number of accidents (two for every collision) per flight hour due to the loss of longitudinal separation between co-altitude aircraft flying on the same track with planned minimum m NM longitudinal separation.
- m := Minimum longitudinal separation in NM.
- M := Maximum initial longitudinal separation between aircraft pair which will be monitored by ATC in order to prevent loss of longitudinal separation standard.
- λ_x := Average length of an aircraft flying on Bay of Bengal.
- λ_y := Average wingspan of an aircraft flying on Bay of Bengal.

- λ_z := Average height of an aircraft flying on Bay of Bengal.
- $P_y(0)$:= Probability that two aircraft assigned at the same route will be at same across-track position.
- $P_z(0)$:= Probability that two aircraft assigned to same flight level are at same geometric height.
- $\left|\bar{\dot{x}}\right|$:= Minimum relative along-track speed necessary for following aircraft in a pair separated by m NM at a reporting point to overtake lead aircraft at the next reporting point.
- $\left|\bar{\dot{y}}(0)\right|$:= Relative across-track speed of same route aircraft pair.
- $\left|\bar{\dot{z}}\right|$:=Average relative vertical speed of a co-altitude aircraft pair assigned to the same route.
- Q (k) := Proportion of aircraft pairs with initial longitudinal separation k.
- P (K > k) := Probability that a pair of same route co-altitude aircraft with initial longitudinal separation k will lose at least as much as k longitudinal separation before correction by ATC.

Once again, a collision, and consequently two accidents, can only occur if there is overlap between two aircraft in all three dimensions simultaneously. Equation 4 gathers the product of the probabilities of losing separation in each one of the three dimensions.

The equation is derived under similar assumption as done in the case of lateral collision risk assessment.

We should note here that the first part of the right-hand side of the equation (4) gives the probability of a collision given an event of overtake of a front aircraft by a behind aircraft when both are nominally flying at the same route at the same flight level, and the second part which is inside the square bracket is the probability of an overtake event.

3.1 Estimated Values of the Parameters and Estimated Longitudinal Collision Risk

The following table gives the values of the parameters of the right-hand side of the equation (4) which are obtained from our analysis.

Parameter	Estimated Values	Source of the Estimate
m	80 NM	Current minimum longitudinal separation.
M	160 NM	Conservative value corresponding to 20 minutes separation.
λ_x	0.0326051 NM	Estimated from TSD
λ_y	0.02983705 NM	Estimated from TSD
λ_z	0.009069301 NM	Estimated from TSD
$P_y(0)$	0.2	Conservative estimate (see Section 3.2).
$P_z(0)$	0.3617939	Estimated using a mixture model (see Section 2.5).

$\lvert \bar{\dot{x}} \rvert$	90 knots	Conservative estimate using speed and distance between way points (see Section 3.3)
$\lvert \bar{\dot{y}}(0) \rvert$	1 knot	RASMAG/9 safety assessment (see Section 3.4).
$\lvert \bar{\dot{z}} \rvert$	1.5	Conservative value as per EMA Handbook (see Section 2.10)
Q (k)	See Table 5	Obtained from TSD (see Section 3.5).
P (K > k)	See Table 5	Computed using normal model on speed(see Section 3.6).

Finally this leads to the following estimate for the longitudinal collision risk N_{ax}.

$$N_{ax} = 3.71804 \times 10^{-10}$$

k (mins)	k (NM)	Q(k)	P (K > k)
10	80	0.002235469	1.83061×10^{-6}
11	88	0.003353204	1.88145×10^{-7}
12	96	0.003725782	1.6016×10^{-8}
13	104	0.008196721	1.16613×10^{-9}
14	112	0.006706408	8.16394×10^{-11}
15	120	0.002608048	7.35331×10^{-12}
16	128	0.008941878	1.04974×10^{-12}
17	136	0.006333830	1.95268×10^{-13}
18	144	0.007451565	3.89188×10^{-14}
19	152	0.004843517	7.84075×10^{-15}
20	160	0.005961252	1.58302×10^{-15}

Table 3: Estimated values of Q (k) and P (K > k)

3.2 Estimating Probability of Lateral Overlap: Py (0)

P_y (0) is defined as the probability of lateral overlap of aircraft nominally flying at adjacent flight levels on same route. We can now use the same mixture model of Section 2.4 to compute this parameter by substituting $S_y = 0$ in the equation 2. This leads to an estimate of P_y (0) as 0.004527846.
However as noted earlier in the EUR/SAM report, this factor P_y (0,) has a significant effect on the risk estimate. Therefore, it should not be underestimated. P_y (0) will increase as the lateral navigational performance of typical aircraft improves, causing a corresponding increase in the collision risk estimate. As reported in the EUR/SAN report, the RGCSP was aware of this problem and attempted to account for improvements in navigation systems when defining the RVSM global system performance specification. Based on the performance of highly accurate area navigation systems observed in

European airspace, which demonstrated lateral path-keeping errors with a standard deviation of 0.3 NM, the RGCSP adopted a value of 0.059 as the value of $P_y(0)$ for the global system performance.
We further note that in the EMA Handbook the value has been taken conservatively as 0.2. We take this rather conservative value for our analysis as well.

3.3 Estimation of the Parameter $|\bar{\dot{x}}|$

$|\bar{\dot{x}}|$ is defined as the minimum relative along-track speed necessary for following aircraft in a pair separated by m NM at a reporting point to overtake lead aircraft at the next reporting point. Thus if d is the distance between the two way points and v_0 is the speed of the front aircraft then $|\bar{\dot{x}}|$ can be computed by the equation

$$\frac{d-m}{v_0} = \frac{d}{v_0 + |\dot{x}|},$$

Leading to

$$|\bar{\dot{x}}| = \frac{mv_0}{d-m}.$$

We conservatively estimate it by taking v_0 as the minimum speed observed in TSD which is 315 NM per hour and the maximum distance between two waypoints on the routes which we study which is d = 338 NM. With m = 80 NM the final estimate turns out to be $|\bar{\dot{x}}|$ = 97.67442 knots. We use a conservative value of 90 knots.

3.4 Estimation of parameter $|\bar{\dot{y}}(0)|$

$|\bar{\dot{y}}(0)|$ is defined as the relative cross-track speed of same route aircraft pair. No data is available for estimation of this parameter so we take a conservative value of 1 knot as given in the EMA Handbook.

3.5 Estimation of the Parameter Q (k)

Q (k) is defined as the proportion of aircraft pairs with initial longitudinal separation k. We estimate its value from the December 2010 TSD (Chennai FIR). Flights entering the FIR on different routes and assigned different flight levels were considered separately (see Figure 5), and the waiting times between successive arrivals were tabulated in minutes. We assume an average speed of 8 NM per minute, and compute the proportion Q(k) as

$$Q(k) = \frac{\text{number of flight pairs with inter-arrival distance } 8k}{\text{total number of flight pairs with at least 80 NM separation}}.$$

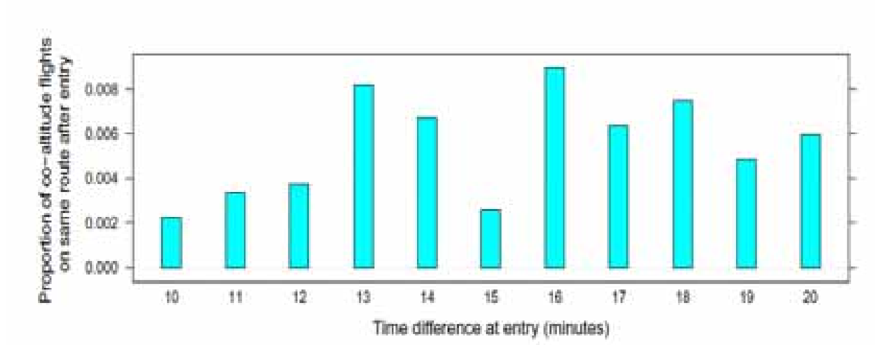

Figure 5: Values of Q(k) estimated from December 2010 Chennai FIR TSD.

For co-altitude flights on the same route (after entry / before exit), the proportion of flights that entered k minutes after the preceding flight is plotted for k = 10, 11, 12, . . . , 20 minutes. Note that the routes N877 and N571 have a (short) common segment, and flights entering or exiting at IGOGU do not follow the previous flight throughout their route. However, we have included these flights as well in order to be conservative. The final estimated value of Q (k) for k ranging between 10 and 20 minutes is given in the Table 3.

3.6 Estimation of the Parameter P (K > k)

To estimate P (K > k) we consider two aircraft flying on same route at same flight levels at the same direction. Let V and V' be their ground speeds of the front and behind aircraft respectively. We assume these speeds to be statistically independent but identically distributed. Let T_0 be the maximum duration of time before ATC intervenes. Then

$$\mathbf{P}\left(K > k\right) = \mathbf{P}\left(0 < \frac{k}{V' - V} < T_0\right) = \mathbf{P}\left(V' - V > \frac{k}{T_0}\right).$$

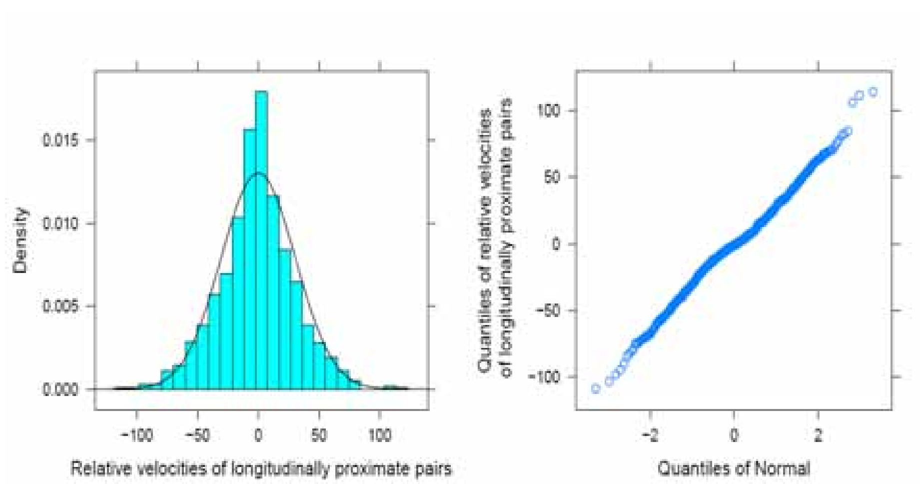

Figure 6: Distribution of relative velocities of longitudinally proximate pairs. The Normal distribution does not necessarily seem to be a reasonable fit.

We note here that the value of T_0 is conservatively taken to be 0.5 hours. Now we finally estimate these probabilities using the TSD. For that we consider the difference in velocity of two aircraft nominally flying on the same route at the same flight level. We conservatively consider velocity differences of all flight pairs which are separated by 2 hours time at entry. It is to be noted that we observed from the TSD data that two hours is more than the maximum time taken by any aircraft to travel between its entry and exit points. We observe that these differences in velocity are symmetrically distributed around zero but from the histogram and the quantile- quantile plot (see Figure 6) it is not clear that these differences necessarily Normally distributed. To be conservative, we postulate the following mixture model for the density of these velocity differences.

$$f_v(v) = p\frac{\beta_v}{2}e^{-\beta_v|v|} + (1-p)\frac{1}{\sqrt{2\pi}\sigma_v}e^{-\frac{v^2}{2\sigma_v^2}},$$

which is a mixture of Double Exponential and Normal densities with mixing proportion p. We then estimate the parameters of this mixture model by their *maximum likelihood estimates (MLEs)*

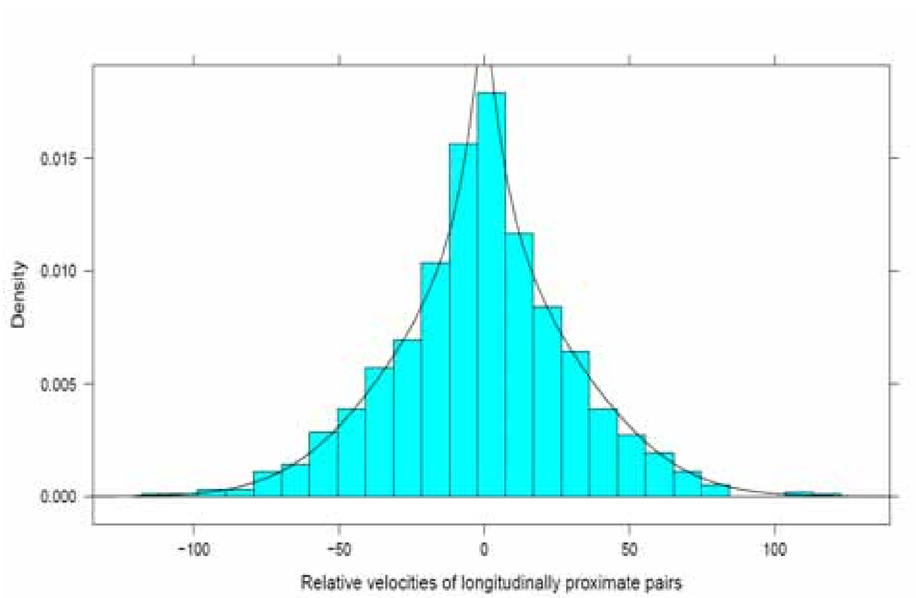

Figure 7: Distribution of relative velocities of laterally proximate pairs along with estimated mixture density (estimated using the EM algorithm).

Since this is a mixture model so we use the Expectation-Maximization (EM) algorithm to find the MLEs. The algorithm converged rapidly to give the following estimates:

$$\widehat{p} = 0.2066880,\ \widehat{\beta}_v = 0.1433969,\ \text{ and } \widehat{\sigma}_v = 34.4067437\,.$$

It is well known in Statistics literature that even though the EM algorithm increases the value of the likelihood it may get trapped in a local maximum. To avoid this problem we tried several starting values and observed that the algorithm always converges to the same estimated values given above.

So it is statistically reasonable to accept the mixing density with these values of the parameters as a good estimate of the true density of the velocity differences. A graphical representation of the fit is given in Figure 7.

It is to be noted here that the final estimate of P (K > k) values will be more conservative if we increase the values of p and σ and decrease the value of β_v. Thus conservatively we take the estimated values as

$$\widehat{p} = 0.25, \widehat{\beta}_v = 0.1 \text{ and } \widehat{\sigma}_v = 35\,.$$

With these we estimate the values of P (K > k) for k ranging between 10 and 20. These are presented in the Table 3.

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INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA AND PACIFIC OFFICE

GUIDANCE MATERIAL FOR

END-TO-END SAFETY AND PERFORMANCE MONITORING OF

AIR TRAFFIC SERVICE (ATS) DATA LINK SYSTEMS

IN THE ASIA/PACIFIC REGION

Version 3.0 – May 2008

Issued by the ICAO Asia and Pacific Office, Bangkok

TABLE OF CONTENTS

1. Background

1.1 The Asia Pacific Airspace Safety Monitoring (APASM) Task Force established by the Asia Pacific Air Navigation Planning Implementation Regional Group (APANPIRG) during 2001 noted that requirements for monitoring aircraft height-keeping performance and the safety of reduced vertical separation minimum (RVSM) operations had been more comprehensively developed than for other Air Traffic Management (ATM) services, such as reduced horizontal separation based on required navigation performance (RNP) and the monitoring of ATS data link systems.

1.2 For example, to assist RVSM operations a handbook with detailed guidance on the requirements for establishing and operating Regional Monitoring Agencies (RMA) was developed by the ICAO Separation and Airspace Safety Panel (SASP). There was no comparable document under development by ICAO for ATS data link applications and so the APASM Task Force developed draft guidance material covering safety and performance monitoring for ATS data link applications.

1.3 The experience gained by the Informal Pacific ATC Coordinating Group (IPACG) and the Informal South Pacific ATS Coordinating Group (ISPACG) FANS Interoperability Teams (FITs) and the supporting Central Reporting Agencies (CRAs) to monitor automatic dependent surveillance - contract (ADS-C) and controller pilot data link communication (CPDLC) performance for both aircraft and ground systems was used as a resource from which to develop monitoring guidance material.

1.4 From 2004, the APASM Task Force was succeeded by the Regional Airspace Safety Monitoring Advisory Group (RASMAG) of APANPIRG, which decided to adopt and extend the APASM material to become the standard guidance material for end-to-end safety and performance monitoring of ATS data link systems in the Asia/Pacific region. Following significant development of the material, APANPIRG/16 (2005) adopted the *Guidance Material for the End-to-End Monitoring of ATS Data Link Systems in the Asia/Pacific Region* under the terms of Conclusion 16/20.

1.5 Within the remainder of the Asia/Pacific Region, the Bay of Bengal and South East Asia ATS Coordination Groups are following the lead of IPACG and ISPACG and have created FANS-1/A implementation teams and data link CRAs to accomplish this activity. These implementation teams also perform the interoperability activities which will continue after the implementation of CPDLC and ADS-C is complete. This guidance material focuses on interoperability issues, both prior to and following implementation of a data link system

1.6 During 2008, agreement was reached between Asia/Pacific and North Atlantic data link interoperability/implementation groups that the global harmonization of data link monitoring activities was desirable. Accordingly, the APANPIRG, NAT SPG and ICAO Secretariat would coordinate to the extent possible in order to develop proposals to implement required monitoring infrastructure and arrangements that would be global and cost effective.

2. Requirements for Safety and Performance Monitoring

2.1 Annex 11, at paragraph 2.27.5, states:

"Any significant safety-related change to the ATC system, including the implementation of a reduced separation minimum or a new procedure, shall only be effected after a safety assessment has demonstrated that an acceptable level of safety will be met and users have been consulted. When appropriate, the responsible authority shall ensure that adequate provision is made for post-implementation monitoring to verify that the defined level of safety continues to be met."

2.2 The *Manual of Air Traffic Services Data Link Applications* (Doc 9694) describes ATS data link applications as including DLIS, ADS, CPDLC, DFIS, AIDC and ADS-B. ATS data link applications, such as ADS-C, CPDLC and ATS interfacility data communication (AIDC), are increasingly being used in support reduced horizontal separation minima. It is therefore necessary to apply the safety monitoring requirements of Annex 11 to these data link services.

Note: *For the purposes of this guidance material, 'data link systems' (or applications) generally refer to CPDLC, ADS-C and/or AIDC.*

2.3 Data link applications comprise both a technical and an operational element. The guidelines in this document - which apply only to the technical element - propose a structure and methodology for monitoring the technical end-to-end safety performance of air-ground and ground-air data link services. The operational aspects of data link monitoring – such as reviewing the correct use of CPDLC message elements - are carried out by the appropriate safety monitoring agency.

2.4 Ground-ground data link systems supporting applications such as AIDC are essentially simpler and more direct than air-ground systems, and monitoring can be achieved directly between the concerned ATSUs. However, it should be noted that States have a responsibility to ensure that monitoring of ground-ground data link systems is carried out in support of the implementation of reduced separation minima. Monitoring of ground-ground AIDC performance is outlined in **Appendix A.**

2.5 The requirement for on-going monitoring after implementation of a data link system is based on several factors, including:

a) degradation of performance with time,

b) increasing traffic levels, and

c) changes to equipment and/or procedures which may occur from time to time,

2.6 On-going monitoring also permits the detection of errors that may have been introduced by a third party (e.g. a communications service provider).

2.7 The use of ADS-B to support separation and the introduction of the Aeronautical Telecommunication Network (ATN) will bring significant changes to operational systems that will also require the establishment of monitoring programmes.

3. Purpose of Guidance Material

3.1 The purpose of this guidance material is to:

a) Provide a set of working principles common to all Asia/Pacific States implementing ATS data link systems;

b) Provide detailed guidance on the requirements for establishing and operating a FANS-1/A implementation/interoperability team (FIT);

c) Provide detailed guidance on the requirements for establishing and operating a Central Reporting Agency (CRA);

d) Promote a standardized approach for implementation and monitoring within the Asia/Pacific Region; and

e) Promote interchange of information among different Regions to support common operational monitoring procedures.

4. Establishment and Operation of an Implementation/Interoperability Team and CRA

4.1 Recognizing the safety oversight responsibilities necessary to support the implementation and continued safe use of ATS data link systems, the following standards apply to any organization intending to fill the role of an implementation/interoperability team:

a) The organization must receive authority to act as an implementation/ interoperability team as the result of a decision by a State, a group of States or a regional planning group, or by regional agreement.

b) States should appoint a CRA that has the required tools and personnel with the technical skills and experience to carry out the CRA functions.

c) States should ensure that the CRA is adequately funded to carry out its required functions.

5. Interoperability Teams

5.1 ATS data link functionality exists in several different domains (e.g. aircraft, satellite, ground network, air traffic service units and human factors) and these elements must be successfully integrated across all domains. Airborne and ground equipment from many different vendors, as well as the sub-systems of several different communication networks, must inter-operate successfully to provide the required end-to-end system performance. In addition, standardised procedures must be coordinated among many different airlines and States to provide the desired operational performance. Technical and operational elements must then combine to allow the various applications to demonstrate mature and stable performance. It is only when this has been achieved that benefits can start being realized.

5.2 A team approach to interoperability is essential to the success of any ATS data link implementation, an important lesson learned by ISPACG, whose members were the first to implement CNS/ATM applications using FANS-1/A systems. Stakeholders had worked closely together during the initial development and subsequent certification of FANS-1/A. However, even though a problem-reporting system was in place when FANS-1/A operations commenced, many problems went unresolved. Consequently it was not possible in the short term to adopt the new operational procedures that would provide the expected benefits of higher traffic capacity and more economic routes.

5.3 An interoperability team (the 'FIT') was formed and tasked to address both technical and operational issues and to assist in ensuring that benefits would result. Because daily attention and occasional significant research would be required, ISPACG realized that a traditional industry team approach would not be effective. To address these concerns, the FIT created a dedicated sub-team, the CRA, to perform the daily monitoring, coordination, testing and investigation of the problem reports submitted by the team. This approach aligns with that taken for RVSM implementations where specialist supporting groups provide height keeping monitoring services.

5.4 Although the monitoring process described above was developed for FANS-1/A based CPDLC and ADS-C applications, it applies equally to AIDC and to ATN-based ATS applications. The latter was validated during the Preliminary EUROCONTROL Test of Air/ground data Link (PETAL) implementation of ATN-based ATS data link services in Maastricht ACC.

Role of the Interoperability Team

5.5 The role of the interoperability team is to address technical and operational problems affecting the transit of data link aircraft through international airspace. To do this, the interoperability team must oversee the end-to-end monitoring process to ensure the data link system meets, and continues to meet, its performance, safety and interoperability requirements and that operations and procedures are working as specified.

5.6 The specific tasks of an interoperability team are to:

a) Initiate and oversee problem reporting and problem resolution processes;

b) Establish a CRA to undertake performance monitoring on its behalf;

c) Initiate and oversee end-to-end system performance monitoring processes;

d) Oversee the implementation of new procedures;

e) Report to the appropriate State regulatory authorities and to the appropriate ATS coordinating group; and

f) Provide reports to the RASMAG.

The section on CRAs below shows that a CRA requires considerable technical resources and skills. It is likely to be more efficient to employ one of the existing CRAs than to set up a new CRA; this would also improve the standardisation of methods and results across the Region.

5.7 Terms of reference for an interoperability team are shown at **Appendix B.**

Interoperability Team Members

5.8 The principal members of an interoperability team are the major stakeholders of the sub-systems that must interoperate to achieve the desired system performance and end-to-end operation. In the case of ATS data link systems, the major stakeholders are aircraft operators, air navigation services providers (ANSPs) and communication services providers (CSPs). Other stakeholders such as international organizations, and airframe and avionics manufacturers also play an important role and should be invited by the major stakeholders to contribute their expertise.

6. Central Reporting Agencies

6.1 Work must be conducted on a daily basis for an interoperability team to achieve its important goals of problem resolution, system performance assurance, and planning and testing of operations that will enable benefits. A dedicated sub-team, the CRA, is required to do the daily monitoring, coordination, testing and problem research tasks for the interoperability team. **Appendix C** shows a table of CRA tasks and the associated resource requirements.

6.2 A CRA should be established in order to determine the safety performance of the ADS-C and CPDLC data link systems before the implementation of reduced separation minima in a particular area, and it should remain active throughout the early stages of implementation. However, as the performance of the systems stabilises to a satisfactory level, it should be possible to reduce the number of CRAs in the region by combining responsibility for different areas.

6.3 The functions of a CRA are:

a) To develop and administer problem report processes;

b) To maintain a database of problem reports;

c) To receive and process monthly end-to-end system performance reports from air navigation service providers;

d) To coordinate and test the implementation of new procedures resulting from ATS data link systems for a given region;

e) To administer and monitor an informal end-to-end configuration process;

f) To manage data confidentiality agreements as required;

g) To identify trends; and

h) To provide regular reports to the interoperability team.

CRA Resource Requirements

6.4 To be effective, the CRA must have dedicated staff and adequate tools. Staffing requirements will depend on the complexity of the region being monitored. There are several factors that affect regional complexity from an ATS monitoring standpoint such as dimensions of the airspace, variety in operating procedures, number of airlines, number of airborne equipment variants, number of ANSPs, number of ground equipment variants and number of CSPs.

6.5 The CRA must be able to simulate an ATS ground station operational capability to the extent of exercising all combinations and ranges of CPDLC uplinks and ADS-C reports. The CRA must also have access to airborne equipment: a test bench is adequate, though engineering simulators that can be connected to either the ARINC or SITA communication network can offer additional capability for problem solving. In support of the data link audit analysis task, the CRA must have software that can decode CSP audit data and produce usable reports. Without these tools it is virtually impossible for a CRA to resolve problems or monitor system performance.

6.6 Coordination is an important component of the CRA's function. In the pursuit of problem resolution, action item resolution, monitoring and testing, many issues arise that require coordination among the various stakeholders. The CRA has a primary responsibility to provide this coordination function as delegated by the interoperability team. Coordination between CRAs is also important, particularly to expand the information database on problems and trends; there may be a need for CRA coordination within the region and with CRAs in other regions. An incident may appear to be an isolated case, but the collation of similar reports by a number of CRAs might indicate an area that needs more detailed examination.

7. Working Principles for Central Reporting Agencies

7.1 The working principles in this guidance material result from the combined experience of the North Atlantic FANS Implementation Group (NATFIG), ISPACG FANS Interoperability Team, IPACG FANS Interoperability Team, and the ATN implementation in Maastricht ACC.

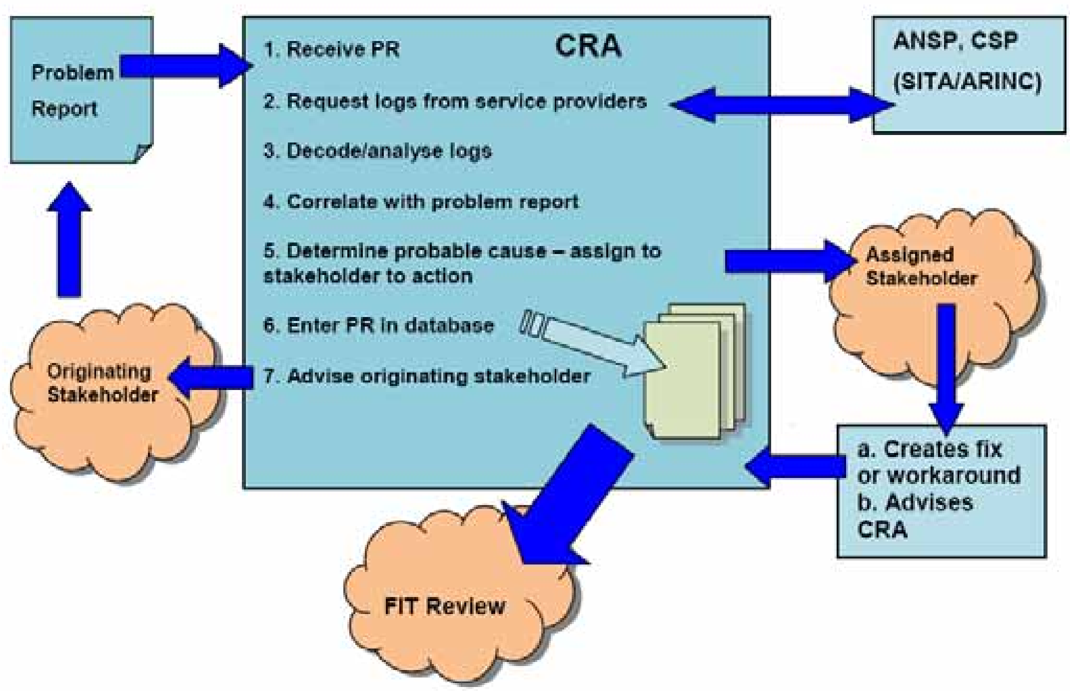
Confidentiality Agreements

7.2 Confidentiality of information is an established principle for problem reporting, and so reports must be de-identified before being made accessible to other agencies. However, it is necessary for the CRA to retain the identity of the original reports so that problem resolution and follow-up action can be taken.

7.3 The CRA must initiate and maintain confidentiality agreements with each entity providing problem reports.

Problem Identification and Resolution

7.4 The problem identification and resolution process, as it applies to an individual problem, consists of a data collection phase, followed by problem analysis and coordination with affected parties to secure a resolution, and recommendation of interim procedures to mitigate the problem in some instances. This is shown in the diagram below.



7.5 The problem identification task begins with receipt of a report from a stakeholder, usually an operator, ANSP or CSP. If the person reporting the problem has used the problem reporting form provided in the appropriate regional manual, then data collection can begin. If not, additional data may have to be requested from the reporter.

7.6 The data collection phase consists of obtaining message logs from the appropriate parties, which will depend on which service providers were being used and the operator service contracts in place at the time. Today, this usually means obtaining logs for the appropriate period from the CSPs involved. In the future, with ATN development, additional providers will become involved and airborne recordings as per EUROCAE ED-112 should become available. Usually, a log for a few hours before and after the event that was reported will suffice but, once the analysis has begun, it is sometimes necessary to request additional data, perhaps for several days prior to the event if the problem appears to be an on-going one.

7.7 Additionally, some airplane-specific recordings may be available that may assist in the data analysis task. These are not always requested initially as doing so would be an unacceptable imposition on the operators, but may occur when the nature of the problem has been clarified enough to indicate the line of investigation that needs to be pursued. These additional records include:

- Aircraft maintenance system logs, and
- Built-In Test Equipment data dumps for some airplane systems, and
- SATCOM activity logs.

7.8 Logs and printouts from the flight crew and recordings/logs from the ATSUs involved in the problem may also be necessary. It is important that the organization collecting data for the analysis task requests all this data in a timely manner, as much of it is subject to limited retention.

7.9 Once the data has been collected, the analysis can begin. For this, it is necessary to be able to decode all the messages involved, and a tool that can decode every ATS data link message type used in the region is essential. These messages include:

- AFN (ARINC 622), ADS-C and CPDLC (RTCA DO-258A/EUROCAE ED-100A) in a region operating FANS-1/A;
- Context Management, ADS-C and CPDLC applications (ICAO Doc 9705 and RTCA DO-280/ED-110) in a region using ATN; and
- FIS or ARINC 623 messages used in the region.

7.10 The analysis of the decoded messages requires a thorough understanding of the complete message traffic, including:

- Media management messages;
- Relationship of ground-ground and air-ground traffic; and
- Message envelope schemes used by the particular data link technology (ACARS, ATN, etc).

7.11 The analyst must also have a good understanding of how the aircraft systems operate and interact to provide the ATS data link functions, as many reported problems are airplane system problems.

7.12 This information will enable the analyst to determine a probable cause by working back from the area where the problem was noticed to where it began. In some cases, this may entail manual decoding of parts of messages based on the appropriate standard to identify particular encoding errors. It may also require laboratory testing using the airborne equipment (and sometimes the ground networks) to reliably assign the problem to a particular cause.

7.13 Once the problem has been identified, the task of coordination with affected parties begins. The stakeholder who is assigned responsibility for fixing the problem must be contacted and a corrective action plan agreed.

7.14 This information (the problem description, the results of the analysis and the plan for corrective action) is then entered into a database covering data link problems, both in a complete form to allow continued analysis and monitoring of the corrective action and in a de-identified form for the information of other stakeholders. These de-identified summaries are reported at the appropriate regional management forum.

Mitigating Procedures

7.15 The CRA's responsibility does not end with determining the cause of the problem and identifying a fix. Procedural methods to mitigate the problem may have to be developed because a considerable period may elapse while a solution is being developed and implemented, particularly if software updates are to be applied to all aircraft in a fleet. The CRA should identify the need for such procedures and develop recommendations for implementation by the service providers and operators involved.

Routine Data Link Performance Reporting

7.16 An important part of data link safety performance is the measurement of the end-to-end performance. This should be carried out prior to implementation of new separation minima, but should continue regularly to provide assurance that the safety requirements continue to be met. Data link performance assessment is based on round-trip time, availability, integrity, reliability and continuity, and ANSPs should provide the CRA with regular measurements of these parameters.

7.17 The CRA will use the information supplied by ANSPs to produce a performance assessment against the established data link requirements for the region. The implementation of Required Communication Performance (RCP) in a region will assist the CRA by providing a statement of the performance requirements for operational communication in support of specific ATS functions. These requirements are set according to the separation minima being applied, and so may differ within different areas according to usage.

7.18 The CRA performance assessment should be made available to the RVSM RMA and horizontal plane En-route Monitoring Agency (EMA) for their calculation of system performance against the minimum values defined in the Oceanic SPR Standard (RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace). The system performance criteria are included in **Appendix D**.

7.19 ADS-C round-trip times are normally measured as the time between sending a contract request and receiving the associated Acknowledgement (ACK) or Message Assurance (MAS) message. CPDLC round-trip times are normally determined from the ATSU end-system time stamps for transmission of the uplink message and reception of the associated MAS.

7.20 ADS-C and CPDLC downlink one-way times are defined by the difference between the aircraft time stamp and the ASTU end-system reception time stamp.

7.21 ADS-C and CPDLC success rates are only available for uplink messages. The success rate is expressed as the percentage of messages that receive a successful ACK or MAS within a specified time.

7.22 CPDLC Actual Communications Performance (ACP) used for monitoring the RCP TRN (transaction) is the difference between the time stamp on the CPDLC uplink from the ATSU requiring a WILCO/UNABLE response to reception of the associated downlink from the aircraft.

> ***Note 1.*** *TRN is the overall transaction time, and denotes that part of the operational communication used to define start and end points for monitoring; it <u>does not include uplink message composition or reviewing of the downlink message response by the Controller</u>.*

> ***Note 2.*** *When monitoring RCP only those transactions requiring a WILCO/UNABLE response are assessed in order to provide the best modeling of the performance of a CPDLC message used for intervention in a reduced separation scenario.*

7.23 CPDLC Actual Communications Technical Performance (ACTP) used for monitoring RCTP is the sum of the following two time intervals:

1. The difference between the time stamp on the CPDLC uplink and the ATSU end-system reception time stamp of the corresponding MAS divided by two; and
2. The associated CPDLC downlink transit time (calculated by determining the difference between the aircraft time stamp and the ATSU end-system reception time stamp).

7.24 CPDLC Crew Performance (sometimes referred to as Pilot Operational Response Time - PORT) is the difference between ACP and ACTP for the same transaction.

7.25 Communication transaction time - The maximum time for the completion of the operational communication transaction after which the initiator should revert to an alternative procedure.

7.26 Position report delivery time – The maximum time for the delivery of a position report from the aircraft to the ATSU.

7.27 Monitored operational performance (TRN) - The portion of the operational communication transaction (used for intervention) that does not include message composition or recognition of the operational response.

7.28 Required Communication Technical Performance (RCTP) – The technical portion of the operational communication transaction (used for intervention) that does not include message composition, operational response, and recognition of the operational response times.

7.29 Continuity - The probability that an operational communication transaction or position report delivery can be completed within the communication transaction time.

- The proportion of intervention messages and responses that can be delivered within the specified TRN for Intervention.
- The proportion of intervention messages and responses that can be delivered within the specified RCTP for Intervention.

7.30 AIDC round trip times may be obtained from the difference between message transmission and reception of the associated application response (Logical Acknowledgement Message (LAM), or Logical Rejection Message (LRM)). The success rate is expressed as the percentage of messages that are delivered to the destination ATSU.

7.31 The integrity of AIDC messaging is not normally monitored, although an analysis of operational data over a long period could reveal undetected errors and their effects. It may also reveal interoperability issues between ground systems in adjoining ATSUs.

Time Standards

7.32 It is critical to the successful measurement and analysis of the data link performance that all elements of the system use a common time system and that the system time is maintained within the required tolerance. In accordance with Annexes 2 and 11, all times used in data link communications must be accurate to within 1 second of UTC.

7.33 It is important to note that, at the time of publishing this guidance material, GPS time is more than 10 seconds ahead of UTC; where GPS time is used as the source, the system time must be corrected to UTC.

Configuration Monitoring

7.34 A variety of technical systems are involved in the data link process and changes, particularly to software and/or software parameters, are not infrequent. Any system change may have an impact on the overall performance of the data link, and it is therefore important that the CRA is kept informed of each change of configuration to each system. With this information it is often possible to identify changes that result it improvements or deteriorations in data link performance or that may be associated with particular problems.

7.35 All ANSPs, CSPs, aircraft operators and avionics suppliers should therefore report all system configuration changes to the CRA. The CRA will then maintain a database of configuration changes for each system or sub-system. It is not necessary for the CRA to know the details of changes, but where a change is expected to affect performance, information on the likely effect should be provided.

New Procedures and Improved Performance Requirements

7.36 The CRA may recommend new end-to-end data link system performance requirements, either to accommodate new operational procedures or to take account of recognised problems.

7.37 The CRA may recommend the testing and implementation of new procedures.

APPENDIX A METHODOLOGY FOR MONITORING AIDC

1 Introduction

1.1 AIDC plays an important role in ATC coordination, and may become a significant element of ATC in the support of reduced separation minima. The performance of AIDC operations should therefore be monitored as part of the required monitoring process prior to the implementation of reduced separation minima.

1.2 AIDC operates essentially over fixed networks and generally has only two or three involved parties, generally comprising the ATSUs at either end of the network and the network provider. It is therefore generally unnecessary to develop a FIT-type approach to safety monitoring; instead such monitoring and problem identification and resolution can be carried out directly by the concerned parties.

1.3 Because fixed networks are used for AIDC, continuous performance monitoring after the implementation of reduced separation minima is not generally necessary, though annual performance and availability checks are recommended. Monitoring should also take place after any changes to the network or the end-user equipment. This will be particularly important during the implementation of the ATN.

2 AIDC Technical Performance

2.1 Two major criteria for monitoring AIDC technical performance are the achievement of acceptable delivery times and the reliability of message delivery. Delivery times can best be measured in terms of the end-to-end round trip time. Reliability is measured as the AIDC message delivery success rate.

3 End-to-End Round-Trip Time

3.1 The end-to-end round trip message time may be measured as the time difference between the transmission of an AIDC message and the reception of the corresponding Logical Acknowledgement Message (LAM) or Logical Rejection Message (LRM). If the originating AIDC system receives neither a LAM nor an LRM from the receiving system within a specified time limit (a variable system parameter, typically between 1 and 3 minutes), it will declare a time-out, and the time-out parameter must be used as the round-trip time.

3.2 All AIDC message requiring a LAM response may be used; measuring results from a variety of message types should give a more representative overall result.

3.3 Because of variations in circuits used for AIDC, separate measurements should be made and reported for each ATSU with which AIDC messages are exchanged.

3.4 A large number of measurements of round-trip times should be averaged for performance reporting.

Note: *If it is not practical to measure end-to-end times, one-way trip times may be measured by comparing the time stamps of the outgoing AIDC message and the received LAM or LRM. The reverse path may be measured from the time stamps of the received AIDC message and the corresponding LAM or LRM.*

4 Message Delivery Success Rate

4.1 The Message Delivery Success Rate is expressed as the percentage of messages successfully delivered to the destination ATSU.

4.2 Unsuccessful delivery is indicated by a time-out due to non-reception of either a LAM or LRM within a specified time.

Note: *For the purpose of this measurement, even if an AIDC message is responded to with an LRM, it is considered to have been "successfully delivered".*

4.3 The time-out indicates non-delivery of the message (and initiates various actions within the AIDC system).

$$\text{Message Delivery Success Rate} = 1 - \frac{TO}{TOT}$$

Where:

TO = number of Time Outs

TOT = total number of messages

4.4 A large number of measurements of delivery success rates should be averaged for performance reporting. Non-typical extensive transit times should also be investigated.

5 ~~Reporting~~Results

5.1 An ANSP~~s~~ should ~~report~~ share the results of AIDC performance monitoring ~~to~~ with ~~the RASMAG~~relevant ANSPs. This will enable problems to be identified and remedial actions agreed upon.

6 Caution

6.1 It is known that there are incompatibilities between some ATS end-systems leading to a situation in which a satisfactorily received message may not be able to be properly processed. In at least one case, the receiving system has been programmed to send neither LAM nor LRM in response to such messages.

6.2 This will result in a distortion of the average round-trip time and success rate for the originating end-system.

6.3 It is recommended that ANSPs ensure that all involved parties are aware of such situations so that affected messages may be excluded from the performance measurement data.

APPENDIX B <u>MODEL TERMS OF REFERENCE FOR AN INTEROPERABILITY TEAM</u>

<u>Reporting and problem resolution processes</u>

- To establish a problem reporting system;
- To review de-identified problem reports and determine appropriate resolution;
- To identify trends;
- To develop interim operational procedures to mitigate the effects of problems until such time as they are resolved;
- To monitor the progress of problem resolution; and
- To prepare summaries of problems encountered and their operational implications.

<u>System performance and monitoring processes</u>

- To determine and validate system performance requirements;
- To establish a performance monitoring system;
- To assess system performance based on information from the CRA;
- To authorise and coordinate system testing;
- To identify accountability for each element of the end-to-end system;
- To develop, document and implement a quality assurance plan that will provide a path to a more stable system; and
- To identify configurations of the end-to-end system that provide acceptable data link performance, and to ensure that such configurations are maintained by all stakeholders.

<u>New procedures</u>

- To coordinate testing in support of implementation of enhanced operational procedures

<u>Reporting</u>

- To report safety-related issues to the appropriate State or regulatory authorities for action;
- To provide reports to each meeting of the implementation team or ATS coordinating group, as appropriate; and
- To provide reports to RASMAG.

APPENDIX C CRA TASKS AND RESOURCE REQUIREMENTS

CRA Task	Resource Requirement
Manage data confidentiality agreements as required.	Legal services Technical expertise
Develop and administer problem report process: • de-identify all reports, • enter de-identified reports into a database, • keep the identified reports for processing, • request audit data from communication service providers, • assign responsibility for problem resolution where possible, • analyse the data, and • identify trends.	Problem reporting data base, ATS audit decode capability and Airborne test bench as a minimum, simulator highly recommended as well as ATS simulation capability (CPDLC and ADS-C)
Coordinate and test the implementation of new procedures	Airborne test bench as a minimum, simulator capability highly recommended ATS simulation capability (CPDLC and ADS-C) ATS audit decode and report capability Technical expertise Operational expertise
Administer and monitor an informal end-to-end configuration process.	Technical expertise
Report to the interoperability team.	Technical expertise

APPENDIX D SYSTEM PERFORMANCE CRITERIA

The Global Operational Datalink Document (GOLD), which is published as Regional Guidance Material, contains the detailed safety and performance requirements for data link services that need to be met and verified. These requirements are derived from *RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace* (Oceanic SPR Standard). This does not prevent ATS service providers from negotiating more constraining contractual requirements with their communication service providers if necessary.

The tables below summarise the requirements in Appendices B and C of the GOLD.

D.1 Required Communication Performance Specifications

The rationale for the criteria provided in these specifications can be found in ICAO Annex 11, ICAO Doc 4444, ICAO Doc 9689 and RTCA DO-306/ED-122.

RCP specification	
Term	**Description**
RCP expiration time (ET)	The maximum time for the completion of the operational communication transaction after which the initiator is required to revert to an alternative procedure.
RCP nominal time (TT 95%)	The maximum nominal time within which 95% of operational communication transactions is required to be completed.
RCP continuity (C)	The required probability that an operational communication transaction can be completed within the communication transaction time, either ET or TT 95%, given that the service was available at the start of the transaction.
RCP availability (A)	The required probability that an operational communication transaction can be initiated when needed.
RCP integrity (I)	The required probability that an operational communication transaction is completed with no undetected errors. Note *Whilst RCP integrity is defined in terms of the "goodness" of the communication capability, it is specified in terms of the likelihood of occurrence of malfunction on a per flight hour basis, e.g.* 10^{-5}*, consistent with RNAV/RNP specifications.*
/D transaction time	
Term	**Description**
Monitored operational performance (TRN)	The portion of the transaction time (used for intervention) that does not include the times for message composition or recognition of the operational response.
Required communication technical performance (RCTP)	The portion of the (intervention) transaction time that does not include the human times for message composition, operational response, and recognition of the operational response.
Responder performance criteria	The operational portion of the transaction time to prepare the operational response, and includes the recognition of the instruction, and message composition, e.g. flight crew/HMI for intervention transactions.
$RCTP_{ATSU}$	The summed critical transit times for an ATC intervention message and a response message, allocated to the ATSU system.

RCP specification	
Term	**Description**
$RCTP_{CSP}$	The summed critical transit times for an ATC intervention message and a response message, allocated to the CSP system.
$RCTP_{AIR}$	The summed critical transit times for an ATC intervention message and a response message, allocated to the aircraft system.

D.1.1 RCP 240

RCP communication transaction time and continuity criteria		
Specification: RCP 240/D	**Application: CPDLC**	
Transaction Time Parameter	**ET (sec)** **C = 99.9%**	**TT (sec)** **C = 95%**
Transaction Time Value	240	210
RCP Time Allocations		
Initiator	30	30
TRN	210	180
TRN Time Allocations		
Responder	60	60
RCTP	150	120
RCTP Time Allocation		
$RCTP_{ATSU}$	15	10
$RCTP_{CSP}$	120	100
$RCTP_{AIR}$	15	10

RCP availability criteria		
Specification: RCP 240/D	**Application: CPDLC**	
Availability parameter	**Efficiency**	**Safety**
Service availability (A_{CSP})	0.9999	0.999
Unplanned outage duration limit (min)	10	10
Maximum number of unplanned outages	4	48
Maximum accumulated unplanned outage time (min/yr)	52	520
Unplanned outage notification delay (min)	5	5
<u>Note 1</u>— DO 306/ED 122 specifies an availability value based on safety assessment of the operational effects of the loss of the service. The more stringent (efficiency) value is based on an additional need to maintain orderly and efficient operations. *<u>Note 2</u>— DO 306/ED 122 specifies a requirement to indicate loss of the service. Unplanned outage notification delay is an additional time value associated with the requirement to indicate the loss to the ATS provider.*		

RCP integrity criteria	
Specification: RCP 240/D	**Application: CPDLC**
Integrity (I)	Malfunction = 10^{-5} per flight hour

D.1.2 RCP 400

RCP communication transaction time and continuity criteria		
Specification: RCP 400/D	**Application: CPDLC**	
Transaction Time Parameter	**ET (sec)** **C = 99.9%**	**TT (sec)** **C = 95%**
Transaction Time Value	400	350
RCP Time Allocations		
Initiator	30	30
TRN	370	320
TRN Time Allocations		
Responder	60	60
RCTP	310	260
RCTP Time Allocation		
$RCTP_{ATSU}$	15	10
$RCTP_{CSP}$	280	240
$RCTP_{AIR}$	15	10

RCP availability and integrity criteria	
Specification: RCP 400/D	**Application: CPDLC**
Availability (A) 0.999	**Integrity (I)** Malfunction= 10^{-5} per flight hour

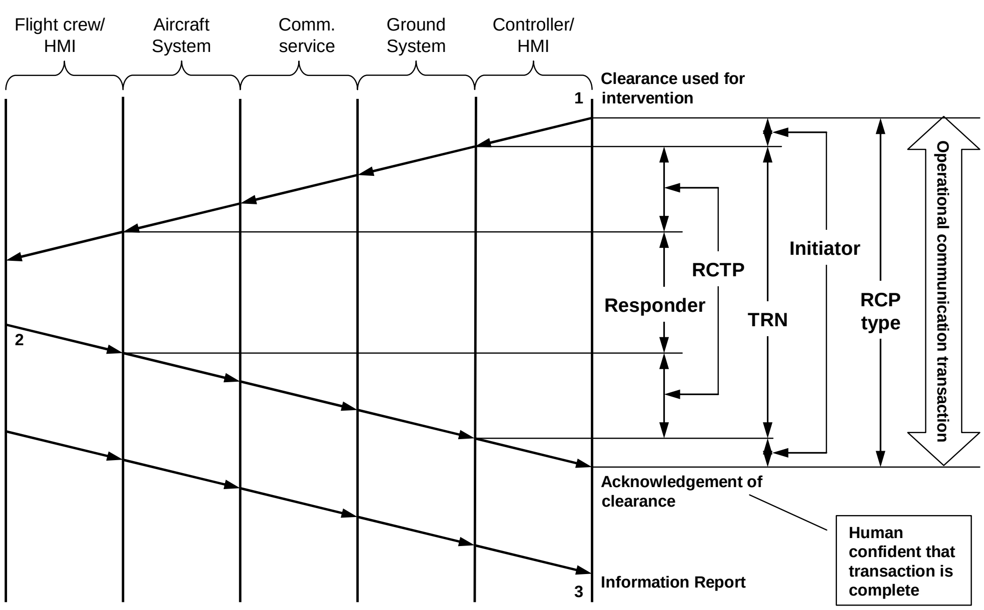


Figure 1: *RCP allocations for intervention capability (DO-306/ED-122, Figure 5-3)*

D.2 Surveillance Performance Specifications

The rationale for the criteria provided in these specifications can be found in ICAO Annex 11, ICAO Doc 4444, ICAO Doc 9689, and RTCA DO-306/ED-122.

Surveillance performance specification and related terms	
Term	**Description**
Surveillance overdue delivery time (OT)	The maximum time for the successful delivery of surveillance data after which the initiator is required to revert to an alternative procedure.
Surveillance nominal delivery time (DT 95%)	The maximum nominal time within which 95% of surveillance data is required to be successfully delivered.
Surveillance continuity (C)	The required probability that surveillance data can be delivered within the surveillance delivery time parameter, either OT or DT 95%, given that the service was available at the start of delivery.
Surveillance availability (A)	The required probability that surveillance data can be provided when needed.
Surveillance integrity (I)	The required probability that the surveillance data is delivered with no undetected error. *Note Surveillance integrity includes such factors as the accuracy of time, correlating the time at aircraft position, reporting interval, data latency, extrapolation and/or estimation of the data.*
Surveillance data transit time criteria	
Term	**Description**
$RSTP_{ATSU}$	The overdue (OD) or nominal (DT) transit time for surveillance data from the CSP interface to the ATSU's flight data processing system.
$RSTP_{AIR}$	The overdue (OD) or nominal (DT) transit time for surveillance data from the aircraft's avionics to the antenna.
$RSTP_{CSP}$	The overdue (OD) or nominal (DT) transit time for surveillance data allocated to the CSP.

D.2.1 Surveillance performance type 180 specification

<table>
<tr><td colspan="3">Surveillance data transit time and continuity criteria</td></tr>
<tr><td>Specification: Type 180/D</td><td colspan="2">Application: ADS-C, FMC WPR</td></tr>
<tr><td>Data Latency Parameter</td><td>OT (sec)
C = 99.9%</td><td>DT 95%(sec)
C = 95%</td></tr>
<tr><td>Delivery Time Value</td><td>180</td><td>90</td></tr>
<tr><td>RSTP Time Allocation</td><td></td><td></td></tr>
<tr><td>$RSTP_{ATSU}$</td><td>5</td><td>3</td></tr>
<tr><td>$RSTP_{CSP}$</td><td>170</td><td>84</td></tr>
<tr><td>$RSTP_{AIR}$</td><td>5</td><td>3</td></tr>
<tr><td colspan="3">Surveillance availability and integrity criteria</td></tr>
<tr><td>Availability (A)</td><td colspan="2">Integrity (I)</td></tr>
<tr><td rowspan="3">0.999
0.9999 (efficiency)
<u>Note</u>.— The surveillance availability criteria for type 180/D are the same as the for RCP 240/D. See D.1.1 above.</td><td>Navigation FOM</td><td>The navigation figure of merit (FOM) is specified based on the navigation criteria associated with this spec. For example, if RNP 4 is prescribed, then for ADS-C surveillance service, the FOM level would need to be 4 or higher.</td></tr>
<tr><td>Time at position accuracy</td><td>+/- 1 sec (UTC)</td></tr>
<tr><td>Data integrity</td><td>Malfunction = 10^{-5} per flight hour</td></tr>
</table>

D.2.2 Surveillance performance type 400 specification

Surveillance data transit time and continuity criteria		
Specification: Type 180/D	**Application: ADS-C, FMC WPR**	
Data Latency Parameter	**OT (sec)** **C = 99.9%**	**DT 95%(sec)** **C = 95%**
Delivery Time Value	400	300
RSTP Time Allocation		
$RSTP_{ATSU}$	30	15
$RSTP_{CSP}$	340	270
$RSTP_{AIR}$	30	15
Surveillance availability and integrity criteria		
Availability (A)	**Integrity (I)**	
0.999	**Navigation FOM**	*The navigation figure of merit (FOM) is specified based on the navigation criteria associated with this spec. For example, if RNP 10 is prescribed, then for ADS-C surveillance service, the FOM level would need to be 3 or higher.*
	Time at position accuracy	+/- 1 sec (UTC)
	Data integrity	Malfunction = 10^{-5} per flight hour

Estimated RVSM Monitoring Burden for Asia/Pacific Region as a result of Long Term Height Monitoring Requirements of Annex 6 - Period from Nov 2010 to Nov 2012

(Data estimated by Asia/Pacific RVSM Regional Monitoring Agencies)

AAMA Monitoring Burden (compiled October 2010)

AUSTRALIA:

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
AGC	STRATEGIC AIRLINES PTY. LTD.	A320	1	2	2	0
	STRATEGIC AIRLINES PTY. LTD.	A330	1	1	1	1
IGA	SKYTRADERS PTY LTD	A320	1	1	1	0
	STRATEGIC AIRLINES PTY. LTD.		1	1	1	0
	NATIONAL JET SYSTEMS PTY. LTD.	B712	1	1	1	0
	CELIJET AVIATION SOLUTIONS PTY LTD	C525	1	2	2	0
	DICK SMITH ADVENTURE PTY LTD		1	1	1	0
	EDWARDS COACHES PTY. LIMITED		1	1	1	0
	GOJET PTY. LTD.		1	1	1	0
	PROFESSIONAL JET AVIATION PTY LTD		1	1	1	0
	SOUTHERN AIR SERVICES PTY LTD		1	1	1	0
	STRATEGIC AIR CHARTER PTY LTD		1	1	1	0
	Flight Options (Australia)	C560	1	1	1	0
	HEATHGATE RESOURCES PTY LTD		1	1	1	0
	JET CITY PTY. LTD.		1	1	1	0
	MAXEM AVIATION PTY LTD		1	1	1	0
	Business Aviation Solutions	C650	1	1	1	0
	INGHAMS ENTERPRISES PTY LIMITED		1	1	1	0
	LYNDEN AVIATION PTY LIMITED		1	1	1	0
	PROFESSIONAL JET AVIATION PTY LTD		1	1	1	0

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
IGA	EXECUTIVE AIRLINES PTY. LTD.	C680	1	2	2	0
	TWENTIETH SUPER PACE NOMINEES PTY. LTD.		1	1	1	0
	BALMORAL AIR PTY. LTD.	C750	1	1	1	0
	Business Aviation Solutions		1	1	1	0
	JET CITY PTY. LTD.		1	1	1	0
	AIR NATIONAL AUSTRALIA PTY. LTD.	CL600	1	1	1	0
	AVWEST PTY LTD		1	1	1	0
	MAXEM AVIATION PTY LTD		1	1	1	0
	REVESCO AVIATION PTY LTD		1	1	1	0
	MARCPLAN CHARTER PTY. LTD.	E135-E145	1	1	1	0
	CAPITEQ LIMITED	E170-190	1	3	2	0
	NETWORK AVIATION PTY LTD	F100	1	2	2	0
	LLOYD AVIATION JET CHARTER PTY. LTD.	F900	1	1	1	0
	TINKLER AVIATION PTY LTD		1	1	1	0
	EXECUJET AUSTRALIA PTY LIMITED	GLEX	1	1	1	0
	GANDEL INVESTMENTS PTY. LTD.		1	1	1	0
	PRATT AVIATION PTY LTD		1	1	1	0
	WALKER AIR PTY LIMITED		1	1	1	0
	CROWN MELBOURNE LIMITED	GLF4	1	1	1	0
	EXECUJET AUSTRALIA PTY LIMITED		1	1	1	0
	GARUDA AVIATION PTY LTD		1	1	1	0
	MARCPLAN CHARTER PTY. LTD.		1	1	1	0
	CROWN MELBOURNE LIMITED	GLF5	1	1	1	0
	LITTLE AVIATION PTY. LIMITED		1	1	1	0
	AVWEST PTY LTD	H25B-800	1	1	1	0
	GOJET PTY. LTD.		1	1	1	0
	MARCPLAN CHARTER PTY. LTD.		1	2	2	0

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
IGA	NANTAY PTY LTD		1	2	2	0
	PROFESSIONAL JET AVIATION PTY LTD		1	1	1	1
	RAMSAY AIRCHARTER PTY LIMITED		1	1	1	0
	Remorex Pty Ltd		1	1	1	0
	STATE OF QUEENSLAND		1	1	1	0
	TATARY PTY. LTD.		1	1	1	0
	CAREFLIGHT (QLD) LIMITED	LJ45	1	1	1	0
	EXECUJET AUSTRALIA PTY LIMITED		1	1	1	0
	PACIFIC FLIGHT SERVICES PTY LTD		1	1	1	0
	SINGAPORE FLYING COLLEGE PTE LTD		1	4	2	0
	EXECUJET AUSTRALIA PTY LIMITED	LJ60	1	2	2	0
	GOJET PTY. LTD.	PRM1	1	1	1	0
	SYDNEY JET CHARTER PTY LIMITED		1	1	1	0
	AIR NATIONAL AUSTRALIA PTY. LTD.	BD700	2	1	1	0
	EXECUJET AUSTRALIA PTY LIMITED		2	1	1	0
	TATARY PTY. LTD.		2	1	1	0
	STATE OF QUEENSLAND	BE30	2	1	1	0
	BUSINESS AVIATION SOLUTIONS PTY LTD	BE40	2	3	2	0
	PROFESSIONAL JET AVIATION PTY LTD		2	1	1	0
	Morgan & Co	C25A	2	1	1	0
	CCJ PTY LTD	C510	2	1	1	0
	ERCEG, Ivan		2	1	1	0
	FLIGHT OPTIONS (AUSTRALIA) PTY LTD		2	1	1	0
IGA	SINGAPORE FLYING COLLEGE PTE LTD		2	1	1	0

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
	SKYPAC AVIATION PTY LTD		2	1	1	0
	CHINA SOUTHERN WEST AUSTRALIAN FLYING COLLEGE PTY LTD	C550-552	2	1	1	0
	MAXEM AVIATION PTY LTD		2	1	1	0
	PROFESSIONAL JET AVIATION PTY LTD		2	3	2	0
	EXECUTIVE AIRLINES PTY. LTD.	C550-B	2	1	1	0
	PROFESSIONAL JET AVIATION PTY LTD		2	1	1	0
	BALMORAL AIR PTY. LTD.	F2TH	2	1	1	0
	SYDNEY JET CHARTER PTY LIMITED		2	1	1	0
	BOSTON L.H.F. PTY LTD	H25C	2	1	1	0
	AIR NATIONAL AUSTRALIA PTY. LTD.	LJ35-36	2	1	1	0
	CAREFLIGHT (QLD) LIMITED		2	1	1	0
	JET CITY PTY. LTD.		2	2	1	0
	JV AVIATION MANAGEMENT SERVICES PTY LTD		2	1	1	0
	PACIFIC FLIGHT SERVICES PTY LTD		2	1	1	0
JST	JETSTAR AIRWAYS PTY LIMITED	A320	1	48	2	42
	JETSTAR AIRWAYS PTY LIMITED	A330	1	7	2	7
NJS	NATIONAL JET SYSTEMS PTY. LTD.	B712	1	10	2	0
OZW	SKYWEST AIRLINES (AUSTRALIA) PTY LTD	F100	1	9	2	0
QFA	QANTAS AIRWAYS LIMITED	A330	1	17	2	17
	QANTAS AIRWAYS LIMITED	B737CL	1	21	2	0
	QANTAS AIRWAYS LIMITED	B737NX	1	41	2	25
QFA	QANTAS AIRWAYS LIMITED	B744-10	1	14	2	14
	QANTAS AIRWAYS LIMITED	B744-5	1	16	2	16
	QANTAS AIRWAYS LIMITED	B747CL	1	3	2	0

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
	QANTAS AIRWAYS LIMITED	B767	1	21	2	0
	QANTAS AIRWAYS LIMITED	A380	2	7	4	7
RON	NAURU AIR CORPORATION	B737CL	1	2	2	0
TGW	TIGER AIRWAYS AUSTRALIA PTY LIMITED	A320	1	9	2	8
UTY	ALLIANCE AIRLINES PTY LTD	F100	1	11	2	0
VAU	VIRGIN BLUE INTERNATIONAL AIRLINES PTY LTD	B773	1	4	2	0
VOZ	VIRGIN BLUE AIRLINES PTY LIMITED	B737NX	1	57	2	26
	VIRGIN BLUE AIRLINES PTY LIMITED	E170-190	1	21	2	0
GRAND TOTALS:				**420**	**125**	**164**

***Monitoring burden of aircraft not ADS-B approved**: 103

INDONESIA:

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
AFE	AIRFAST INDONESIA	B732	2	1	1	0
		E135-145	1	1	1	0
		MD80	1	2	2	0
AWQ	INDONESIA AIRASIA	A320	1	11	2	0
AWQ		B737CL	1	11	2	0
BTV	BATAVIA AIR	A320	1	6	2	0
		A330	1	1	1	0
BTV		B737CL	1	24	2	0
CGR	CARDIG AIR CARGO	B737CL	1	2	2	0
GIA	GARUDA INDONESIA	A330	1	10	2	4
		B737CL	1	41	2	0
		B737NX	1	40	2	39

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
		B744-5	1	3	2	3
JLB	UNKNOWN	BE30	2	1	1	0
		H25B-800	1	1	1	0
KAE	KARTIKA AIRLINES	MD80	1	1	1	0
LNI	LION AIRLINES	B737CL	1	11	2	0
		B737NX	1	40	2	0
		B744-5	1	2	2	0
		MD80	1	2	2	0
		MD90	1	4	2	0
MDL	MANDALA AIRLINES	A320	1	11	2	0
		B737CL	1	1	1	0
MNA	MERPATI NUSANTARA AIRLINES	B732	2	6	4	0
		B737CL	1	13	2	0
PAS	PELITA AIR SERVICES	F100	1	2	2	0
SJY	SRIWIJAYA AIRLINES	B732	2	13	8	0
		B737CL	1	11	2	0
		B737NX	1	2	2	0
TGN	TRIGANA AIR	B732	2	1	1	0
TMG	TRI-MG AIRLINES	B727	1	1	1	0
TRV	TRAVIRA AIR	B737CL	1	1	1	0
		C56X	1	1	1	0
		H25B-800	1	1	1	0
UNKNOWN	"PREMAIR"	C650	1	1	1	0
		E135-145	1	1	1	0
		F100	1	1	1	0
	TRANSWISATA PRIMA AVIATION	F100	1	1	1	0
		PRM1	1	1	1	0
WON	WINGS AIR	MD80	1	5	2	0
XAR	EXPRESS AIR	B732	2	2	1	0

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
		B737CL	1	2	2	0
	EXPRESS AIR *Delivered to Air Libya in 2008, still flying under same registration	F100	1	1	1	0
GRAND TOTALS:				**294**	**72**	**46**

Monitoring burden of aircraft not ADS-B approved: 66

PAPUA NEW GUINEA:

Operator	Operator Name	Aircraft Monitoring Group (e.g. [A342, A343])	MMR Category (1, 2 or 3)	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Aircraft ADS-B Approved
ANG	Air Niugini	B752	1	1	1	1
		B767	1	2	1	0
		F900	1	1	1	0
GRAND TOTALS:				**4**	**3**	**1**

Monitoring burden of aircraft not ADS-B approved: 2

AAMA GRAND TOTAL *(Australia + Indonesia + Papua New Guinea)*	Total # Airframes under Monitoring Unit	Resultant Monitoring Burden (# Airframes)	Total # of Airframes ADS-B Approved
	718	**200**	**211**

Total monitoring burden of aircraft non ADS-B approved: 171

APANPIRG Asia/Pacific Airspace Safety Monitoring

RASMAG LIST OF COMPETENT AIRSPACE SAFETY MONITORING ORGANIZATIONS

The Regional Airspace Safety Monitoring Advisory Group of APANPIRG (RASMAG) is required by its terms of reference to recommend and facilitate the implementation of airspace safety monitoring and performance assessment services and to review and recommend on the competency and compatibility of airspace monitoring organizations. In order to assist in addressing these requirements, RASMAG updates and distributes the following list of competent airspace safety monitoring organizations for use by States requiring airspace safety monitoring services. In the context of the list, abbreviations have meanings as follows:

- RMA – Regional Monitoring Agency – safety assessment and monitoring in the vertical plane (i.e. RVSM);
- EMA – En-route Monitoring Agency – safety assessment and monitoring in the horizontal plane (i.e. RVSM, RNAV10, RNP4);
- CRA – Central Reporting Agency – technical performance of data link systems (i.e. ADS/CPDLC); and
- FIT – FANS 1/A Interoperability/Implementation Team – parent body to a CRA.

(Last updated 23 February 2011)

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed (FIRs)
Australian Airspace Monitoring Agency (AAMA) - Airservices Australia http://www.airservicesaustralia.com/organisations/aama/default.asp Mr. Robert Butcher, Operational Analysis Manager, Safety and Assurance Group email: robert.butcher@airservicesaustralia.com or aama@airservicesaustralia.com	Australia	APANPIRG RMA	Current	Brisbane, Honiara, Jakarta, Melbourne, Nauru, Port Moresby and Ujung Pandang (including Timor-Leste) FIRs
		EMA	Current	Brisbane, Melbourne FIRs.

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed (FIRs)
China RMA - **Air Traffic Management Bureau, (ATMB) of Civil Aviation Administration of China (CAAC)** http://www.chinarma.cn (secure site) Mr. Tang Jinxiang, Engineer of Safety and Monitoring Technical Group, ATMB email: tangjx@adcc.com.cn	China	APANPIRG RMA	Current	Beijing, Guangzhou, Kunming, Lanzhou, Shanghai, Shenyang, Urumqi Wuhan Sanya and Pyongyang FIR.
JCAB RMA - **Japan Civil Aviation Bureau** Mr. Noritoshi Suzuki, Special Assistant to the Director, Flight Procedures and Airspace Program Office, email: suzuki-n248@mlit.go.jp	Japan	APANPIRG RMA	Current	Fukuoka FIR
		EMA	Available fourth quarter – 2011	Fukuoka FIR
Monitoring Agency for the Asia Region (MAAR) – **Aeronautical Radio of Thailand LTD** http://www.aerothai.co.th/maar Mr. Nuttakajorn Yanpirat, Executive Officer, Systems Engineering,Aeronautical Radio of Thailand Ltd. email: nuttakajorn.ya@aerothai.co.th or maar@aerothail.co.th	Thailand	APANPIRG RMA	Current	Bangkok, Kolkatta, Chennai, Colombo, Delhi, Dhaka, Hanoi, Ho Chi Minh, Hong Kong, Karachi, Kathmandu, Kota Kinabalu, Kuala Lumpur, Lahore, Male, Manila, Mumbai, Phnom Penh, Singapore, Taibei, Ulaan Bataar, Vientiane, Yangon FIRs

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed (FIRs)
Pacific Approvals Registry and Monitoring Organization (PARMO) – Federal Aviation Administration (US FAA) http://www.faa.gov/air_traffic/separation_standards/parmo/ Mr. Dale Livingston, Manager, Separation Standards Analysis Team, FAA, email: dale.livingston@faa.gov or aparmo@faa.gov	USA	APANPIRG RMA	Current	Anchorage Oceanic, Auckland Oceanic, Incheon, Nadi, Oakland Oceanic, Tahiti FIRs
		EMA	Current	Anchorage Oceanic, Oakland Oceanic
South East Asia Safety Monitoring Agency (SEASMA) - Civil Aviation Authority of Singapore (CAAS) Mr. Kuah Kong Beng, Chief Air Traffic Control Officer, email: KUAH_Kong_Beng@caas.gov.sg	Singapore	EMA for South China Sea	Current	Hong Kong, Ho Chi Minh, Kota Kinabalu, Kuala Lumpur, Manila, Sanya and Singapore FIRs
FIT - SEA (ICAO Regional Office email icao_apac@bangkok.icao.int & **CRA Japan** Mr. Mitsuo Hayasaka, Deputy Director, Air Traffic Control Association Japan, email:hayasaka@atcaj.or.jp	ICAO Regional Office & CRA Japan	FIT & CRA	Current	South China Sea FIRs

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed (FIRs)
IPACG/FIT Mr. Takahiro Morishima, JCAB Co-Chair email: morishima-t2zg@mlit.go.jp & Mr. Reed Sladen, FAA Co-Chair, email: reed.b.sladen@faa.gov	Japan & USA	FIT & CRA	Current	North & Central Pacific (Oceanic airspace within Fukuoka FIR, and Anchorage & Oakland FIRs)
CRA Japan Mr. Mitsuo Hayasaka, Deputy Director, Air Traffic Control Association Japan, email: hayasaka@atcaj.or.jp	Japan	CRA	Current	Fukuoka FIR for IPACG/FIT Ho Chi Minh, Manila, Singapore FIRs for FIT-SEA
FIT - BOB ICAO Regional Office email icao_apac@bangkok.icao.int & Mr. Bradley Cornell, Boeing Engineering email: Bradley.D.Cornell@Boeing.Com	ICAO Regional Office & Boeing USA	FIT & CRA	Current	Bay of Bengal FIRs, Ujung Pandang and Jakarta FIRs, provides assistance to the members of the Arabian Sea/Indian Ocean ATS Coordination Group (ASIOACG)
ISPACG/FIT Mr. Bradley Cornell, Boeing Engineering email: Bradley.D.Cornell@Boeing.Com	Boeing USA	FIT & CRA	Current	South Pacific FIRs and members of the Informal South Pacific ATS Coordination Group (ISPACG)

RASMAG — TASK LIST

(last updated 10 August 2010)

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
8/6	Take action to implement Long-Term Height Monitoring (LTHM) Actions 1, 5 and 6 as described in RASMAG/8 report. In particular, ensure arrangements for regional cooperation between regional monitoring agencies (RMAs).	RASMAG/14	Asia/Pacific RMAs	Closed	Tasks completed and impact statement finished.
10/2	Undertake studies to quantify the magnitude of the problem of RVSM non-approved flights operating in RVSM airspace. Identify solutions.	Ongoing	Asia/Pacific RMAs	Open	Lead RMA is PARMO. RMAs to work by correspondence, present adequate information to RASMAG/11 to compile briefing for APANPIRG PARMO provided update report to RASMAG/11, further development required before reporting to APANPIRG RMAs will provide RASMAG/13 with activity reports on solutions. RMAs to coordinate with States involved and then to send the list of non-approved operators to Regional Office for follow up
10/7	Prepare Taxonomy of RMA-related terms with objective of clarifying and standardising reporting of Large Height Deviations (LHDs) by States and limiting under reporting. Consider inclusion of taxonomy as appendix to Regional Monitoring Impact Statement	RASMAG/14	Asia/Pacific RMAs	Closed	Amended taxonomy developed at RASMAG/14 to be provided to RMACG/6 for inclusion in RMA Manual.
12/4	Provide analysis of AIDC implementation and the effect of those implementations of the level of Category E LHD reports.	Ongoing	Asia/Pacific RMAs	Open	Japan captured and analysed data in relation to implementation of AIDC. RMAs will attempt to show Category E LHD performance before and after implementation of AIDC.

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
12/9	Continue joint research activity to explore ADS-B derived geometric height as a data source for aircraft height-keeping performance monitoring	RASMAG/15	Australia and United States	Open	Further data analysis to be provided by Australia to SASP WG/WHL19
13/1	Coordinate the additional wording at Para 2.3 of the RASMAG/13 report to the SASP at its next meeting in November 2010, for inclusion in the RVSM manual (Doc 9574)	November 2010	Chairman	Closed	
13/2	Amend the EMA Handbook to include the adopted proposed changes in Appendix D to RASMAG/13 report	RASMAG/14	Secretary	Closed	
13/3	RMAs review and amend their F2/F3 forms to align with Appendix F to RASMAG/13 Report	RASMAG/15	All RMAs	Open	
13/4	The Secretariat to convey the concerns and views expressed by RASMAG at Para 2.23 of RASMAG/13 Report to ATM/AIS/SAR/SG and FIT-SEA.	RASMAG/14	Secretary	Closed	
13/5	The Secretariat to update the LTHM impact statement to incorporate the revised MMR agreed at RMACG/5 and endorsed by RASMAG.	APANPIRG/21	Secretary	Closed	
13/6	The Secretary write State letter advising the decision by RASMAG to use the MMR agreed by RMACG/5 as the basis for all long term height monitoring for Asia/Pac.	Oct 2010	Secretary	Closed	
13/7	RMAs review the monitoring burden based on the revised MMR by 30 August 2010.	30 Aug 2010	All RMAs	Closed	