INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE NINTH MEETING OF THE REGIONAL AIRSPACE SAFETY MONITORING ADVISORY GROUP (RASMAG/9)

BANGKOK, THAILAND, 26 – 30 MAY 2008

The views expressed in this Report should be taken as those of the RASMAG and not of the Organization.

Adopted by the RASMAG
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HISTORY OF THE MEETING

1. Introduction

1.1 The Ninth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/9) was held in Bangkok, Thailand from 26 to 30 May 2008 at the Kotaite Wing of the ICAO Asia/Pacific Office.

2. Attendance

2.1 The meeting was attended by 29 participants from Australia, China, India, Japan, New Zealand, Singapore, Thailand, United States, IATA and IFALPA. A list of participants is at **Appendix A** to this report.

3. Officers & Regional Office

3.1. Mr. Robert Butcher, Manager Human Factors & Analysis, Safety Management Group, Airservices Australia, chaired the meeting.

3.2. Mr. Andrew Tiede, Regional Officer ATM, was the Secretary for the meeting.

4. Opening of the Meeting

4.1 The meeting was opened by Mr. Andrew Tiede on behalf of Mr. Mokhtar A. Awan, Regional Director of the Asia/Pacific Regional Office. Mr. Tiede welcomed all delegates to the Regional Office and outlined the substantial work programme that lay ahead. A great deal of work had already been accomplished off-line in the weeks before the meeting, which needed to be reviewed and endorsed by RASMAG. Of particular interest was the scheduled review of the safety assessment for the implementation of 50NM lateral/50NM longitudinal separation on ATS routes L642 and M771 in the South China Sea.

4.2 The Chairman, Mr. Butcher, welcomed participants to the meeting. He noted that there was a significant number of working papers and information papers to be considered during the course of the meeting and that a number of important subjects and issues would need to reviewed and resolved. Particularly Mr. Butcher reminded the meeting that the China RMA would be seeking RASMAG endorsement of their credentials for APANPIRG consideration to approve their status as an RMA within Asia/Pacific.

4.3 Whilst addressing the meeting a few days later, the ICAO Regional Director, Mr. Awan, drew attention to the continued substantial traffic growth in the region and thanked RASMAG members for their many contributions to effective safety oversight of regional operations. He wished the meeting every success.

5. Documentation and Working Language

5.1 The working language of the meeting as well as all documentation was in English.

5.2 Twenty-five (25) Working Papers and fourteen (14) Information Papers were presented to the meeting. A list of papers is included at **Appendix B** to this Report.

REPORT ON AGENDA ITEMS

Agenda Item 1: Adoption of Agenda

1.1 The following agenda was adopted for the meeting:

Agenda Item 1: Adoption of Agenda

Agenda Item 2: Review outcomes of related meetings

Agenda Item 3: Reports from Asia/Pacific RMAs

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 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 Global RMA meeting

2.1 A meeting of Global RMAs was held in conjunction with the SASP/WG/WHL/13 meeting in Montreal, Canada from 13-15 May, 2008. Representatives from each of the Global Regional Monitoring Agencies (RMAs) attended the meeting and secretarial services were provided by the ICAO HQ Secretariat.

2.2 The purpose of the meeting was to provide an opportunity for representatives of all RMAs to discuss matters of common interest and, in particular, to arrive at a common understanding on the part of all agencies of the tasks and responsibilities of such agencies. RMA points of contact were updated and would be listed on the RMA knowledge sharing network (KSN) site hosted by the FAA. The meeting encouraged all RMAs to list a general email address and at least two contacts for RMA matters.

2.3 A status report was given by all RMAs in relation to their areas of responsibility, problems being experienced and future plans. In line with the experiences of the Asia/Pacific RMAs, other RMAs reported proportionally high numbers of LHDs resulting from errors in ATC-to-ATC coordination. The Africa-Indian Ocean Regional Monitoring Agency (ARMA) reported that the reporting and collection of LHDs remains a problem and most reports are drawn from the flight deck reports made to the IATA reporting system. Other RMAs were also experiencing problems in reliably obtaining data in a timely manner.

2.4 The meeting considered processes to keep the airframe Minimum Monitoring Requirements (MMR) up to date, agreeing to remove the MMR from the RMA Manual and maintain it on the RMA KSN. The PARMO/NAARMO will develop a detailed process to maintain the MMR and will seek technical assistance of the North Atlantic Aircraft Operations and Airworthiness (OPS/AIR) Sub-

Group. The meeting briefly discussed how an RMA might address the 1,000 hour part of the monitoring requirement. One suggestion was that the RMAs track all aircraft against the two year provision and require the operator to demonstrate at 2-year intervals that the airframe had logged less than 1,000 hours since its last monitoring measurement.

RMA Manual

2.5 The PARMO presented updates to the draft RMA manual and proposed that the updated manual be reviewed and edited to move it to official publication. The meeting agreed to use this version as the starting point for the complete update of the Manual. The meeting agreed to include additional details in the RMA Manual regarding the establishment, composition and methodology of a Scrutiny Group and recommended a re-evaluation of the LHD reporting form.

2.6 The meeting agreed to the following actions to update the draft RMA Manual:

a) Form a drafting group administered by the PARMO/NAARMO
b) Determine the status of the RMA Manual with respect to Doc 9574 and ICAO Annexes
c) Update the Manual by using email, phone calls and the KSN
d) Submit major changes to the Manual to the drafting group by 1 Aug 08
e) Complete the Manual update for delivery to ICAO by the end of the next SASP meeting (October 2008)
f) Publish the ICAO RMA Manual by February 2009

Include risk due to "All Causes"

2.7 The Global RMA meeting discussed accounting for errors that may not be specific to RVSM in risk calculations. Some members thought that it was important to show the level of risk with RVSM specific errors and the level of risk without RVSM specific errors. Other members thought that all errors contributed to risk and thus it was necessary to determine risk with all errors considered. The meeting agreed to seek clarification from the developers of Doc 9574 and the SASP Math Sub-Group.

2.8 In considering this issue, the RASMAG/9 meeting noted that the RVSM Manual (Doc 9574) had established safety objectives for both technical risk and its contribution to overall risk and, in discussing the safety objective for overall risk, noted at paragraph 2.1.5 that:

> *Overall risk is the risk of collision due to all causes, which includes the technical risk and all risk due to operational errors and in flight contingencies, such as pilot/controller errors, height deviations due to emergency procedures, and turbulence.*

2.9 Accordingly, RASMAG/9 considered that risk due to 'all causes' should be considered and adopted this approach for application by all Asia/Pacific RMAs, noting that it was the long standing methodology in use by Asia/Pacific RMAs in any case. This approach meant that, rather than excluding any factors, all risk factors should be included in the safety analyses to give a final overall risk estimate. Subsequent analysis would then be applied with the objective of identifying the component contributors to the overall risk estimate to enable remediation.

2.10 The Global RMA meeting recognized the valuable outcomes that had been achieved and agreed that similar meetings should be convened periodically – at approximately 12-month intervals. A summary presentation of the outcomes of the meeting is included as **Appendix C** and the Global RMAs meeting agreed to the draft agenda and recommendations for such meetings as shown in **Appendix D.**

2.11 Noting the proposal that the next Global RMAs meeting be held in May 2009, the Secretariat highlighted that this was about the time of the normal RASMAG meeting. As the Asia/Pacific was home to 5 RMAs, who would also be attending the RASMAG meeting, it seemed logical that the Global RMA meeting be hosted at the Regional Office in Bangkok and be scheduled back to back and immediately before the RASMAG meeting to save on time and travel costs for participants. Consideration would need to be taken of the planned dates for the next SASP meeting scheduled for May 2009.

Technical Meeting of Asia/Pacific RMAs

2.12 The first day of the meeting period of RASMAG/9 was conducted as a technical meeting for Asia/Pacific RMAs. The intent of this meeting was to give the RMAs an opportunity to focus discussions on technical issues; identify resolutions to these issues and standardize regional processes.

2.13 A number of issues were identified and discussed by the RMAs. PARMO proposed that in relation to providing effective reporting to APANPIRG and other organizations, the RMAs could include a comparison of flight hours for the airspace. In that way it is possible to weight the risk exposure and demonstrate this more readily in a report. The Secretary was concerned that this might be too much technical information for APANPIRG, however PARMO indicated that this was important information which was useful to better understand the relative risk values and could also be used as a metric. The meeting was informed that RMAs could provide this information by taking the December one month traffic sample data and simply multiplying by 12 to obtain an annual figure, as that would result in a suitably accurate estimate. PARMO reported that there is a significant amount of traffic flight hours and sampling of this type provided on a monthly basis in the North Atlantic (NAT) for example. After further discussion the RMAs agreed this should be provided in reports where it was readily possible to do so.

2.14 The Chairman raised the issue of Operational Error (OE) data sharing amongst RMAs, as this had been agreed at RASMAG/8 as being one way that RMAs could become more aware of OEs that were affecting risk in the FIRs they were responsible. This was specifically the case in instances of poor reporting within those FIRs. The meeting was informed that following RASMAG/8, the AAMA had been forwarding a number of OEs to MAAR in accordance with this practice. PARMO commented that NARMO has a close regional relationship with other RMAs and that data is shared in that region on an informal basis. PARMO also commented that the number error type was Category E and that usually the receiving ACC is the one on the receiving end of the error, but the error is often not reported by the handing off ACC. The Secretary noted some concern that by agreeing to this practice, RMAs may be propping up a deficient safety management system in some States. After further discussion it was agreed that RMAs should exchange OE type data, and that this should be done as soon as possible after the reports are received so that volatile supporting data can be retained.

2.15 An issue was raised as to whether RMAs were considering A380 type aircraft dimensions in the collision risk model within Asia/Pacific. The meeting was informed that the size of the aircraft is quite specific to defining the risk. IFALPA commented that this had been raised at earlier RASMAG meetings and that the A380 dimensions had been accounted for except possibly for the increased tail height. General discussion noted that the CRM derives average aircraft size from a weighted average based on the portion of time the aircraft type remains in the airspace, as obtained from the TSD sampling, and that for accuracy this was the preferred method rather than using values representing the largest aircraft. As such, the A380 dimensions issue was already catered for under existing regional sampling and assessment arrangements.

2.16 The Technical Meeting reviewed papers from IATA detailing concerns about the 100 feet misalignment between the China FLOS and surrounding FLOS, and from China suggesting regional standardization of the processes and parameters of the Reich model used as the CRM for RVSM airspace. Discussion on these papers is detailed elsewhere in this report.

Review of RVSM/TF/33

2.17 RVSM/TF/33, the 90 day review meeting for the China RVSM implementation, was held from 9 to 11 April 2008. The meeting noted a number of important points in relation to the implementation of RVSM throughout the sovereign airspaces of China on 21 November 2007, including:

a) The many actions taken by China to ensure a smooth implementation;

b) The post implementation safety assessment showed that the TLS was satisfied;

c) The State Letter on circulation proposing a change to Annex 2 – *Rules of the Air*, Appendix 3 - Tables of Cruising Levels;

d) Amendments to the Regional Supplementary Procedures (Doc 7030) had been approved by ICAO to show all the Chinese FIRs as available for RVSM operations;

e) Requests from the Russian Federation and IATA for China to consider establishing more entry/exit points between the two States concerned;

f) Usage of lateral offset procedures in China was not in full accordance with the PANS-ATM provisions for Strategic Lateral Offset Procedures (SLOP) and encouraged China to consider closer compliance with the PANS-ATM;

g) Concerns raised by IATA as to whether an event involving an aircraft being 100 ft away from its assigned flight level resulting from an error should be treated as an LHD were relayed to RASMAG for resolution;

2.18 The Secretariat highlighted that virtually all airspaces of the Asia/Pacific Region had now implemented RVSM and that the work of the RVSM Task Force was therefore very close to completion. Accordingly, it was likely that APANPIRG/19 would consider whether the RVSM Task Force should be dissolved, to take effect after the 12-month review of China RVSM implementation in December 2008, and any residual matters be allocated to the respective ATS Coordination groups and ATM/AIS/SAR Sub-Group for action.

Review of WPAC/SCS RSG/4

2.19 The Fourth meeting of the Western Pacific/South China Sea RVSM Scrutiny Group (WPAC/SCS RSG/4, February 2008) was very pleased to note the continued improvements in RVSM safety performance of the WPAC/SCS airspace and attributed the improvements to the continued efforts of States involved under the strong focus and guidance of the WPAC/SCS RSG. Nevertheless, continued work was needed to address the high numbers of large height deviations (LHDs) attributable to ATC Unit to ATC Unit coordination errors.

2.20 Indonesia and the Philippines reached in-principle agreement for the realignment of the complex joint FIR boundary with Oakland in the vicinity of position approximately N0400 E13220. This was expected to reduce complexity and assist in reducing LHD numbers.

2.21 In order to allow sufficient time for all parties to make proper preparations for the complex change in the FLOS/FLAS, WPAC/SCS RSG/4 adopted a switchover date/time of 2100 UTC on 2 July 2008 to implement the new flight level arrangements. The meeting finalised the text of a suitable model AIP Supplement, including details of the No-Predeparture Coordination Procedure (No-PDC) flight levels applicable to each airway for use as the basis for State's AIP Supplements.

2.22 WPAC/SCS RSG/4 recalled that RVSM had been implemented in Indonesia in November 2003 using a restricted flight level band, from FL 310 to FL 410 inclusive. However, in order to harmonize RVSM operations in the region and coincide with the implementation of the new FLAS for the WPAC/SCS area, from July 2008 the Indonesian DGCA will implement the full RVSM level band between FL290 and FL410 throughout Indonesian airspace in accordance with the level band required by ICAO provisions.

2.23 The meeting noted the very positive outcomes of the Scrutiny Group which were evident in the improved safety performance being demonstrated. The implementation of the new flight level arrangements in early July was expected to bring additional improvements to safety performance. The meeting considered that these outcomes had been achieved in an exceptionally short time frame, given their complexity and the number of parties' involved in the coordination process. This was a tribute to the performance of all members of the Scrutiny Group and demonstrated the effectiveness of the Scrutiny Group mechanism in providing a 'core team' focused approach to address a specific problem.

2.24 Noting that as the Terms of Reference for the Scrutiny Group were likely to have been fully completed following the 90-day review scheduled in October 2008, the meeting recognized that it was likely that the Scrutiny Group would be disbanded by APANPIRG during 2009. It was regrettable that such a high performing group could not be redirected to address other focus areas in regional operations and the meeting agreed to further discuss this prospect during the December meeting, with the objective of suggesting to APANPIRG that the Scrutiny Group be retained and re-tasked.

Agenda Item 3: Reports from Asia/Pacific RMAs

AAMA's RMA activities

3.1 Australia presented the results of the safety assessments undertaken by the Australian Airspace Monitoring Agency (AAMA).

Australian Domestic and Indian Oceanic airspaces

3.2 In terms of the Australian Domestic and Indian Oceanic Airspaces the assessment covered the 12 month period ending on 30 April 2008 and, whilst the traffic sample data for December 2007 was obtained by the AAMA in accordance with agreed Asia/Pacific RMA procedure, the sample was found to be significantly corrupted and unusable. As a result the current assessment was developed using the traffic sample data obtained for December 2006.

3.3 The AAMA reported that the LHD occurrences in the Australian RVSM airspace were primarily captured as operational errors within the Airservices' Electronically Submitted Incident Report (ESIR) System. A total of 720 minutes duration was assigned to the 71 non-NIL LHDs identified through the assessment process, for the 12-month reporting period. The meeting noted that this was a significant increase in the total duration time identified in the previous report to RASMAG in December 2007. The AAMA report summarized these LHDs as follows:

- L Category LHDs remain the most significant in terms of duration even though the actual number of risk-bearing reports in this category remains relatively low. One new report of this type was received during April but only assessed as having duration of 1 minute. ATC queried the status of the aircraft's RVSM approval as it entered the Brisbane FIR from an adjacent Foreign FIR, as it appeared to have been incorrectly flight planned as 'approved'. There is doubt whether the handing off foreign ANSP was aware of the true approval status of the aircraft and it may have been operating in that FIR for a significant period of time. Therefore the AAMA has forwarded the report to the responsible RMA for review. The AAMA has continued to cross-check aircraft flight plan data against the CASA approvals database and continues to identify rogue aircraft. Follow up activity with CASA has resulted in improved validity of the database and direct action being undertaken by CASA in relation to non-approved aircraft that continue to incorrectly notify their RVSM status.

- The most significant type of LHD in terms of number of reports continues to be "Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues" (Category E). Thirteen reports related to this category were identified during April, however only one of these being assessed as risk bearing within the Australian FIRs with total duration of 1 minute. Details of all the reports will be passed to Monitoring Agency Asian Region (MAAR) who is responsible for the Jakarta, Ujung, Male and Colombo FIRs.

3.4 The meeting was informed that the assessment for the Australian airspace resulted in an estimation of the total risk as 5.82×10^{-9} fatal accidents per flight hour, which does not satisfy the agreed TLS values of no more than 2.5×10^{-9} (technical risk) and 5.0×10^{-9} (overall risk) fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes, respectively. Additionally, Australia commented that the risk value represents a continuance of an increasing trend observed over the last 12 months primarily as a result of the continued presence of a number of high-time error reports in the assessment sample and the identification of a number of reports in March 2008 which added 46 minutes of total duration to the sample. The trend is expected to start to decline during June 2008 when significant high time reports held in the rolling 12 months data sample are eliminated from the assessment sample.

3.5 **Table 1** below summarizes the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation in the Australian airspace as at April 2008.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.018×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	5.80×10^{-9}	-	-
Total Risk	$\mathbf{5.82 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Does not satisfy Overall TLS**

Table 1: Risk Estimates for the RVSM Implementation in Australian Airspace

3.6 In addition, **Figure 1** below presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month interval of LHD reports since May 2007.

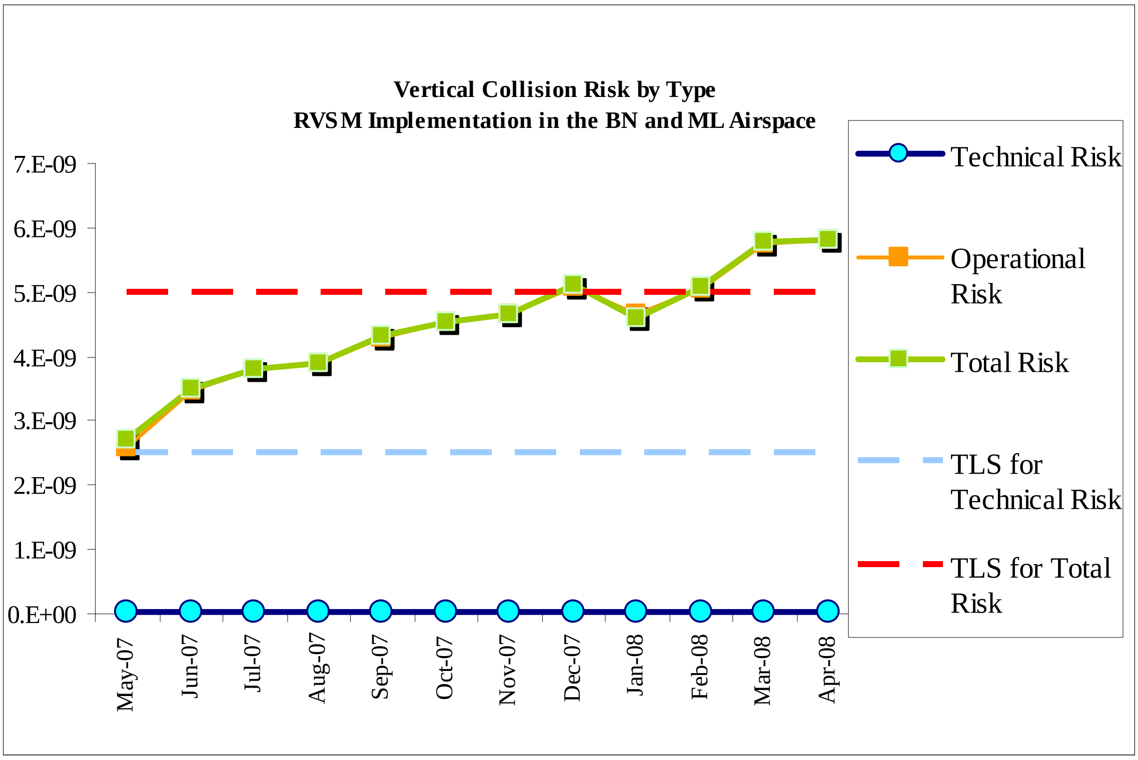

Figure 1: Trends of Risk Estimates for the Australian RVSM Airspace

3.7 The meeting noted the outcome for the Australian airspace in terms of estimated risk noting the trend in risk increase since May 2007 and that the AAMA expects this trend to reverse over the coming reporting period. The AAMA informed the meeting that Airservices Australia was monitoring this trend closely and had spent time identifying fully the sources of the errors that generated the high time LHDs and ensuring that appropriate risk controls were identified or in place.

Papua New Guinea airspace

3.8 Australia also presented the results of an initial safety assessment undertaken by the AAMA for the Papua New Guinea airspace. The meeting was informed that the assessment covered the 12-month period ending on 30 April 2008, noting that the traffic sample data for the month of December 2006 of aircraft operating in the Australian airspace was used to assess the safety of RVSM airspace. This is an interim sample as, while a traffic sample was provided to AAMA by Papua New Guinea, processing of that sample has not been completed and therefore was not available at the time of this report. As a result the estimated risk values in this assessment should be regarded as preliminary.

3.9 The report noted that no operational error reports or LHDs were received from Papua New Guinea for the period under assessment. The AAMA did have access to a number of reports provided by Australia that included possible risk bearing LHDs relative to the Port Moresby FIR and these were used in developing the safety assessment. The meeting was informed that a total of 4 minutes duration was assigned to the 3 non-NIL LHDs identified and these were summarized as follows:

- One D category – ATC loop error report was identified. The report involved Port Moresby Sector contacting Brisbane Ocean Nauru Sector and requesting a level change for a flight tracking ADBON to KAPUK (deviating left of track) at F350 to F370. Brisbane Ocean responded that the restriction was an aircraft tracking opposite direction at F360 with time of passing 1702, both aircraft established on datalink. After a slight delay the Moresby controller stated they would separate the two aircraft using a time standard. KAPOK is on the FIR boundary. Brisbane Ocean then observed by ADS-C that the flight did not reach F370 until 1654; 8 minutes prior to the time of passing.

- Two Category E – ATC coordination error reports were identified. Both were attributed to Airservices Australia but would have been risk bearing within the Port Moresby FIR.

3.10 The meeting was informed that the assessment for the Papua New Guinea airspace resulted in an estimation of the total risk as 2.86 x 10^{-9} fatal accidents per flight hour, which satisfies the agreed TLS values of no more than 2.5 x 10^{-9} (technical risk) and 5.0 x 10^{-9} (overall risk) fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes, respectively. However, the AAMA stated that the calculated risk value remains in doubt due to the lack of any operational error reports from Papua New Guinea.

3.11 **Table 2** below summarizes the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation in the Papua New Guinea airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.018 x 10^{-9}	2.5 x 10^{-9}	Satisfies Technical TLS
Operational Risk	2.67 x 10^{-9}	-	-
Total Risk	**2.86 x 10^{-9}**	**5.0 x 10^{-9}**	**Satisfies Overall TLS**

Table 2: Risk Estimates for the RVSM Implementation in Papua New Guinea Airspace

3.12 The meeting thanked Australia and particularly the AAMA for what is seen as a milestone report. The Secretary reminded the meeting of the specific issues previously identified by RASMAG regarding the lack of data from Papua New Guinea which resulted in the inability to effectively undertake a valid safety assessment for that airspace – a strategic FIR in the region. The meeting noted that Papua New Guinea has responded to initial direct coordination from the AAMA through the provision of a traffic sample for 2007 however it was noted that the AAMA still held significant concerns regarding the lack of any operational error data. The meeting encouraged the AAMA to work closely with the appropriate Papua New Guinea authorities in an attempt to resolve this issue and looked forward to the next report in December 2008.

Indonesian FIRs to AAMA

3.13 The meeting was informed that the ICAO Regional Office has taken steps to try to assist States with developing safety management systems, and has supported similar work by RASMAG to provide guidance and direct assistance to those States where specific assistance has been required. The Regional Office has also been keen to facilitate direct assistance from those States who have robust safety management systems and expertise that can be used to enhance safety within the Asia/Pacific airspace.

3.14 Additionally, the meeting was reminded of Australia's initiatives in relation to the Neighbourhood Program, which is aimed at fostering and promoting aviation safety and operational efficiency in the Indonesian and Papua New Guinea region with assistance from Australia. This program has received support from the Australian Government, the Governments of Indonesia and Papua New Guinea, relevant Government agencies and the aviation industry. As part of this program, RASMAG/8 endorsed a proposal by Australia that the responsibility for the provision of Regional Monitoring Agency services within the Port Moresby FIR should be transferred from PARMO to the AAMA. Recognizing the benefits of this arrangement, Indonesia requested that further consideration be given to similarly streamlining their RMA arrangements.

3.15 The meeting was informed that during July 2007 ICAO and Indonesia signed a formal declaration expressing their joint commitment to increase flight safety and security in Indonesia's areas of civil aviation responsibility. In this context, the ICAO Asia/Pacific Regional Office supports the view that the direct involvement of Australia in assisting Indonesia with implementing safety management systems, through the work of a number of Government aviation agencies, is likely to benefit safety performance on a number of fronts as well as in relation to RVSM matters. As such, the Regional Office has expressed strong support for Indonesia and Australia to work together and considers that the transfer of RMA responsibility for the Indonesian FIRs to the AAMA would be an expansion of the already significant interaction between the two States on aviation matters. Additionally, this would enable the AAMA to hold the additional RMA responsibility for the neighbouring areas of Papua New Guinea and Indonesia, resulting in standardized arrangements for the affected States.

3.16 Accordingly, the ICAO Regional Office and the AAMA had recently coordinated with MAAR on a proposal to transfer the RMA responsibility for the Indonesian FIRs to the AAMA. MAAR was supportive of the proposal given the demonstrated capability and commitment by Australia to provide these services, and the request by Indonesia that Australia consider taking RMA responsibility on the basis of treating all APODA States as one group because of their mutual relationship. The meeting discussed the paper in some detail and fully endorsed the proposal to transfer the responsibility for RMA services within the Port Moresby FIR to the AAMA. The AAMA and MAAR would coordinate the handover during the next few weeks.

China's RMA activities

3.17 RVSM was implemented throughout the entire Chinese sovereign airspace in late November 2007. The China RMA provided details of the post RVSM implementation risk assessment for this airspace. The meeting was informed that the safety assessment was conducted using a comprehensive traffic analysis of the traffic sample data (TSD) collected for the month of December 2007 as well as large height deviation (LHD) occurrences in sovereign Chinese airspace from January 2006 to February 2008.

3.18 Based on the collected TSD and LHD reports, the update of the vertical collision risk was performed to determine whether the TLS continued to be met in support of the ongoing safe use of RVSM since its implementation in China. The estimate of both technical and overall risks were found to satisfy the agreed TLS value of no more than 2.5×10^{-9} and 5.0×10^{-9} fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 300m (1,000ft) respectively. Of note are the values for technical and operational risk which were comparatively smaller than those obtained in the pre-implementation safety assessment, indicating that both technical and total risks had decreased after RVSM implementation.

3.19 The safety assessment process found that 98.3% of the aircraft operations in the sovereign Chinese airspace where RVSM is implemented were conducted by RVSM airworthiness approved aircraft and 97.273% by State approved operators and aircraft. Some violations of RVSM operational approval requirements were found, partly because the process of Approval data collection for the Chinese operators is still under development. China RMA intends to enhance the communication with CAAC inspectors to obtain the up-to-date approval information for the Chinese operators**. Table 3** below shows the total numbers of flights in the one month December 2007 TSD, and distribution throughout the respective FIRS of China.

FIR	Number of Flights			Total Number
	12/01 - 12/10	12/11 - 12/20	12/21 - 12/31	
Shenyang	4834	4762	5169	14765
Guangzhou	14129	13883	15954	43966
Wuhan	7908	7363	8264	23535
Lanzhou	5196	5102	5452	15750
Urumqi	1785	1776	1821	5382
Kunming	10357	10279	10922	31558
Beijing	8608	8775	9321	26704
Shanghai	14237	15408	17328	46973
Sanya (Island)	1784	1925	1993	5702
Procedural Control	2897	2816	3009	8722
Radar Control	35641	35862	39450	110953
State	36494	36680	40297	113471

Table 3: Number of Flights in Nine FIRs Airspace of China from the Collected TSD

3.20 A review of the LHD occurrences reported found that:

- In the period January 2006 – February 2008, a total of 41 LHD occurred in the sovereign Chinese airspace, accounting for 60 minutes of duration and 27 flight levels transitioned without proper clearance, in which:
  - o 27 events occurred in Radar Control airspace with 20 minutes of duration and 18 flight levels transitioned without proper clearance, and
  - o 14 events occurred in Procedural Control airspace with 40 minutes of duration and 9 flight levels transitioned without proper clearance
- 18 of these occurrences which account for 55.03 minutes of duration are due to the negative transfers or incorrect transfers of control responsibilities (Category E) between FIRs neighbouring China.
- In the most recent rolling 12 month sample from March 2007 to February 2008, 19 LHD occurred, accounting for 14.92 minutes of duration and 13 flight levels transitioned without proper clearance, in which:
  - o 15 events occurred in Radar Control airspace with 4.42 minutes of duration and 13 flight levels transitioned without proper clearance, and
  - o 4 events occurred in Procedural Control airspace with 10.5 minutes of duration and 0 flight levels transitioned without proper clearance
- Within these 19 LHD occurrences:
  - o 4 events with duration of 1.33 minutes and 2 levels transitioned without proper clearance were due to flight crew climbing/descending without ATC clearance;

- 2 events with duration of 1 minutes and 2 levels transitioned without proper clearance were due to incorrect operation or interpretation of airborne equipment
- 5 events with duration of 11.5 minutes and 0 level transitioned without proper clearance were due to coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues
- 1 event with duration of 0.1 minutes and 0 level transitioned without proper clearance was caused by airborne equipment failure leading to unintentional or undetected change of flight level
- 2 events were with duration of 0.23 minutes and 3 levels transitioned without proper clearance caused by turbulence or other weather
- 2 events with duration of 0.5 minutes and 2 levels transitioned without proper clearance were caused by TCAS resolution advisory - flight crew correctly following the resolution advisory, and
- 3 occurrences of 0.15 minutes and 3 levels transitioned without proper clearance involved deviation caused by display error of ATC automatic system and deviation caused by station interference (Category M)

- Within these 19 LHD occurrences, 2 events were reported after the RVSM implementation in China:
  - 1 event with duration of 0 minutes and 1 level transitioned without proper clearance were caused by incorrect operation or interpretation of airborne equipment
  - The other with duration of 2 minutes and 0 level transitioned without proper clearance were caused by incorrect operation or interpretation of airborne equipment

3.21 Based on the analyses of LHDs, China RMA considers:

a) The events that occurred in Radar Control airspace had more flight levels transitioned without proper clearance and the events in Procedural Control airspace had longer duration.

b) The events due to coordination errors in the ATC-to-ATC transfer of control responsibility (Category E) contribute the most to the operational risks.

c) The amount of LHD reports collected had reduced since the implementation of RVSM in China – this may be due to the highly focused measures taken by China as part of the RVSM implementation process.

3.22 **Table 4** and **Figure 2** below provide the estimates of technical, operational, and total risks for the RVSM implementation in the sovereign Chinese RVSM airspace in tabular and graphical format, respectively.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	6.216×10^{-12}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	1.091×10^{-9}	-	-
Total Risk	$\mathbf{1.097 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Satisfies Overall TLS**

Table 4: Risk Estimates in Sovereign Chinese RVSM Airspace

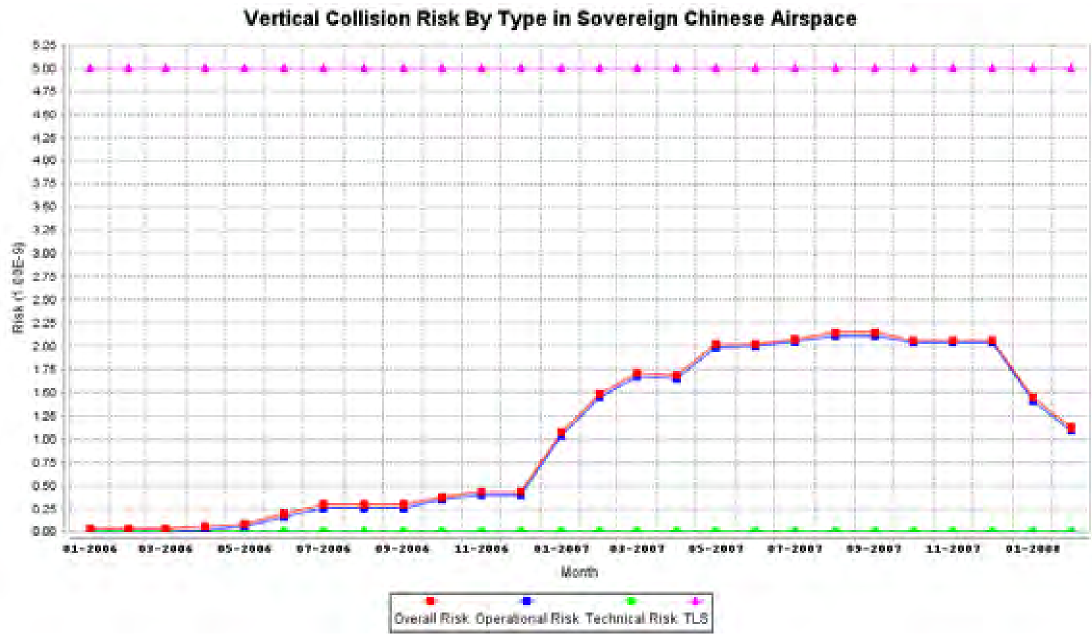

Figure 2: China - monthly trends of collision risk estimates

3.23 In the collision risk estimates of this report, China RMA made some changes to the pre-implementation methodology of risk calculation by introducing the traffic flying hours into the model as a weighting factor. The China RMA also took into account the LHD occurrences due to all causes, including ATC –to- ATC coordination errors (Category E).

3.24 The meeting thanked the China RMA for the detailed report provided, noting the satisfactory value of the risk estimate in relation to the TLS.

US FAA Review of China Safety Assessments

3.25 In accordance with the training and assistance arrangements between China and the United States Federal Aviation Administration, the (FAA) Technical Center via PARMO also agreed to provide a constructive review of the post-RVSM implementation safety assessment for sovereign Chinese airspace described above. The comprehensive review covered all facets of the China RMA assessment, including

a) Assessment of level of operator compliance with State approval requirements

- The data show a 13 percent improvement in the proportion of operations with full-RVSM approval; this result is likely due to the intensive work performed by China in preparing the operators and airspace for the implementation of the RVSM.

b) Overview of Safety Assessment Process

- The PARMO reviewed the modification made to the application of the collision risk model in the post implementation assessment, whereby certain collision risk model parameters are estimated separately for radar-controlled and procedural airspace, noting that that this appeared reasonable and that the PARMO uses a similar modification of the collision risk model for Pacific airspace.

c) Analysis of LHDs

- o In the post-implementation safety assessment, China has recomputed the vertical risk estimate using the recorded transfer of control events (Category E LHD), but separately calculating the risks in procedural and radar airspaces and then combining those estimates according to the relative airspace activity levels. The result is that the overall airspace vertical risk estimate is below the TLS and new transfer of control events have not been recorded since the implementation of RVSM.

3.26 The meeting was informed that overall, the PARMO considered that the modification made to the application of the collision risk model in the post-implementation safety assessment is reasonable. The operational differences between radar and procedural airspace affect the aircraft passing frequencies, number of crossing aircraft pairs and relative aircraft speeds. Also, the additional surveillance in the radar airspace should allow ATC to quickly mitigate any LHDs, which would result in shorter time durations per event when compared to procedural airspace. The PARMO considers that the resulting risk estimate using the modification in the application of the collision risk model more accurately reflects the operations in the airspace.

3.27 The meeting noted PARMO's review of the China RMA safety assessment report and thanked them for the continued support that they have provided to China to enable the development of specialist expertise by that organization to carry out its responsibilities as an RMA.

China – RASMAG Recommendation as APANPIRG RMA

3.28 Recognizing that it would be impractical for an RMA outside China to assume responsibility for such a large airspace as the sovereign Chinese RVSM airspace, as part of their RVSM implementation programme China had made significant steps towards establishing the China RMA to take on the long-term airspace monitoring and safety assessment responsibilities.

3.29 Issues associated with the regional credentialing of safety monitoring organizations had been discussed during previous RASMAG meetings and had led to the adoption of the RASMAG List of Competent Safety Monitoring Organizations. However, noting the inability of RASMAG to further progress this matter as a result of higher priority items on the RASMAG work programme, RASMAG/7 (June 2007) identified relevant material in Annex 11, the RVSM Manual (Doc 9574) and the RMA Manual which would provide an adequate basis against which to assess the capabilities of Asia/Pacific RMAs. Accordingly, China had been requested to provide a submission to RASMAG/9 detailing their performance/capability against the various provisions in these documents.

3.30 The submission prepared by China was reviewed by the meeting, who commended the comprehensive manner in which the documentation had been prepared. A website had also been established at http://www.chinarma.cn and contained full details of the capabilities and functions of the China RMA. The United States highlighted that during their close association of two years in training and working with the China RMA, it was very evident that China had shown considerable ability to fulfill the functions of an RMA. They had attended the recent Global RMA meeting to make all the necessary contacts and were already investing in both portable and fixed ground based height monitoring capability.

3.31 It was evident to the meeting that the performance of the China RMA was adequately demonstrated and documented against the provisions of Annex 11, the RVSM Manual and the RMA Manual and a summary of these outcomes has been retained as **Appendix E.** Additionally, as described elsewhere in this report, as well as preparing pre-implementation safety assessments, the China RMA had submitted a comprehensive post implementation safety assessment for RVSM operations in the Chinese sovereign airspace that was in the format and of the standard required by RASMAG for regional RVSM safety assessments.

3.32 Based on this review, the meeting considered that the China RMA had capably met all the requirements imposed by RASMAG in regard to demonstrating performance as an Asia/Pacific RMA and was very pleased to recommend to APANPIRG/19 that the China RMA be endorsed as an Asia/Pacific RMA, with ongoing responsibility for all sovereign RVSM airspaces in China. The meeting prepared the following draft Conclusion in this respect:

Draft Conclusion RASMAG 9/1 – Approval of China RMA as Asia Pacific RMA

That, having met all requirements established by the Regional Airspace Safety Monitoring Advisory Group (RASMAG), the China RMA be approved as an APANPIRG Asia/Pacific RVSM Regional Monitoring Agency with responsibility for all sovereign RVSM airspaces in China.

3.33 The meeting congratulated China for their dedication and application in achieving such a capable performance over a very compressed time frame. Pending the final approval from APANPIRG later in 2008, RASMAG looked forward to continuing to work with the China RMA in undertaking regional safety monitoring activities that would help to ensure the continued safe operation of reduced separation applications in the Asia/Pacific region.

3.34 China informed the meeting of the extensive support that had been received from the FAA Technical Center and MAAR in assisting their preparations as an RMA and expressed deep appreciation for this assistance. The close coordination between these agencies and the Regional Office had been very beneficial to China and it was their wish and expectation that this would continue.

China RMA – Verification of CRM parameters

3.35 The meeting recalled that the method used to evaluate collision risk in the Asia Pacific Region is by applying the Reich Collision Risk Model (CRM). This method is recommended by the International Civil Aviation Organization (ICAO) and accepted globally.

3.36 However, China RMA observed that each of the Asia/Pacific RMAs has independently created software and processes to estimate the parameters for the Reich model as applicable to the local airspaces under their jurisdiction. China RMA noted that some of the estimates required complex mathematical manipulation and suggested that it would be beneficial for RASMAG to define a standard procedure for the Asia/Pacific RMAs to verify the correctness of software algorithms.

3.37 After discussing the matter, the meeting concluded that although it was clearly desirable to have standardized software and parameter estimates etc, the local circumstances of the airspaces managed by each of the RMAs would always require a variation to the parameters used in the model. Unfortunately, it was not possible to have one region wide model that would fit all circumstances. However, verification of the model being used by each RMA was available by using one of the other RMAs to conduct a peer review of the safety model being used, in order that a third party check on the outcomes could be undertaken. The meeting agreed that RMAs should continue to work closely in this regard, assisting each other as required in order to achieve the best possible regional standardization.

JCAB's RMA activities

Fukuoka FIR airspace

3.38 The Japan Civil Aviation Bureau RMA (JCAB RMA) presented the meeting with the result of the most recent RVSM airspace safety assessment for the Fukuoka FIR. The meeting noted that during the period of 12 months from 1 May 2007 to 30 April 2008, JCAB RMA received 47 LHD reports in connection with the Fukuoka FIR. Of the 47 reports, 29 LHD occurrences were attributable to operational errors and 18 were attributable to technical errors.

3.39 Following detailed analysis of the 29 operational errors, JCAB RMA attributed 23 of them to Category E (i.e. errors in ATC-unit-to ATC-unit transfer). The percentage of Category E errors between Fukuoka FIR and each adjacent FIR was as follows:

a) 48% of errors were with Incheon ACC (11 out of 23 errors)
b) 31% of errors were with Manila ACC (7 out of 23 errors)
c) 13% of errors were with Vladivostok ACC (3 out of 23 errors)
d) 4% of errors were with Taipei ACC (1 out of 23 errors)
e) 4% of errors were with Yuzhnosahalinsk ACC (1out of 23 errors)

3.40 When compared with the percentage of traffic volume, there did not appear to be any direct correlation between the traffic volume and the number or duration of LHD occurrences. However, there was a disproportionately high LHD occurrence and duration resulting from the comparatively low traffic volumes with Manila FIR, as demonstrated in **Table 5** below. This suggested weaknesses in the coordination relationships with Manila ACC, which would be further investigated.

	Incheon	Manila	Taipei	Vladivostok	Yuzhno-Sahalinsk
Percentage of traffic volume (2007.05.01-2008.04.30)	58%	8%	28%	3%	3%
Percentage of LHD occurrences caused by transfer error	48%	31%	13%	4%	4%
Percentage of LHD duration (min) caused by transfer error	36%	48%	10%	3%	3%
Implementation plan of AIDC	2008	Nil	2012	Nil	Nil

Table 5: Comparative table of traffic volume, number of LHD occurrences, LHD duration caused by "errors in ATC-unit-to-ATC-unit transfer" (min) and implementation plan of AIDC

3.41 The **Table 6** below summarizes the results of the airspace safety oversight, as of April 2008, in terms of the technical, operational, and total risks for the RVSM implementation in the Fukuoka FIR and the outcomes are shown graphically in **Figure 3** below.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.4×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	11.0×10^{-9}		
Overall Risk	**11.4×10^{-9}**	**5.0×10^{-9}**	**Does not satisfy the TLS**

Table 6: Risk Estimates for safety assessment of the Fukuoka FIR RVSM airspace – April 2008

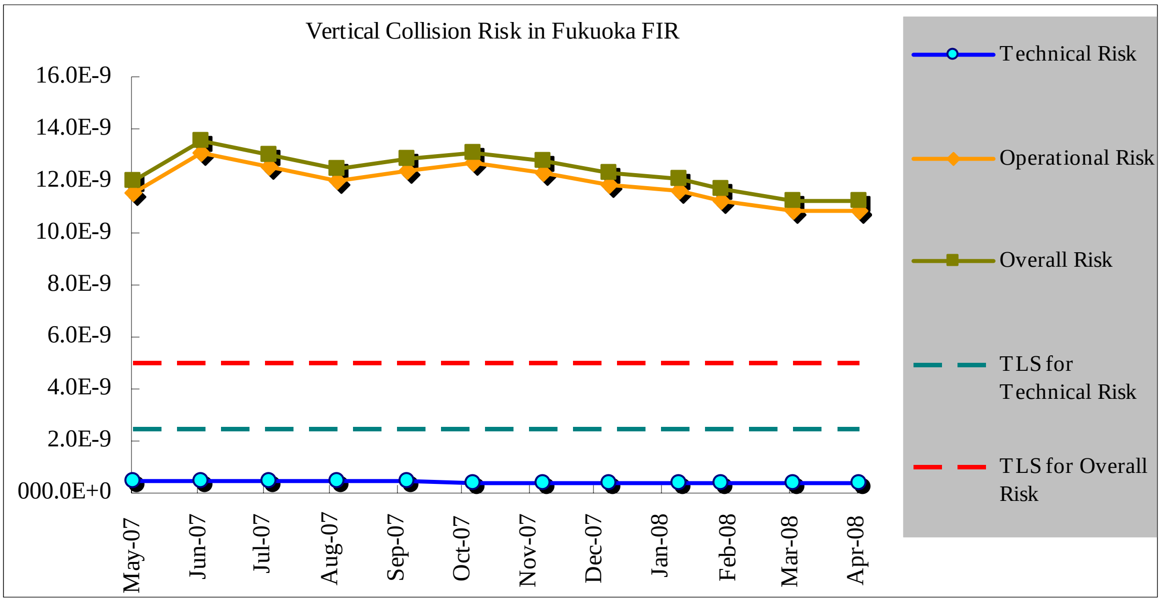

Figure 3: Trends of Risk Estimates for the RVSM Implementation in Fukuoka FIR

3.42 The meeting noted that the overall risk result of the RVSM safety assessment for the Fukuoka FIR exceeded the regionally agreed TLS mainly due to the LHDs caused by "errors in ATC-unit-to ATC-unit transfer' (Category E). As Asia/Pacific RMAs are obliged to assess risk arising from "all causes" the Category E errors must be included in the risk estimate, however the meeting recognized that, in the case of Fukuoka FIR, if the Category E errors were excluded from the calculation the overall risk estimate became 3.3×10^{-9} , which satisfied the TLS.

3.43 The meeting was concerned that the TLS was not being satisfied and recalled previous safety assessment results as follows:

RASMAG/7 (Jun 2007) = 8.61×10^{-9}
RASMAG/8 (Dec 2007) = 11.4×10^{-9}
RASMAG/9 (May 2008) = 11.4×10^{-9}

3.44 In this context, the Fukuoka FIR was not satisfying the regional RVSM TLS, however the trend was stable and had not changed over the period since the last RASMAG meeting. The meeting noted that causes of many of the LHDs resulting from ATC Unit to ATC Unit transfers were due to circumstances occurring in neighbouring FIRs while the LHD itself was exhibited in the Fukuoka FIR. The JCAB RMA had made JCAB aware of these circumstances and a number of initiatives had commenced in order to manage the situation, as described below.

3.45 With regard to the 23 LHDs caused by “Errors in ATC-unit-to ATC-unit transfer”, JCAB had continued coordination with affected ATC units with the aim of preventing further recurrence of similar errors. Since 1st June 2007, JCAB had been advised that remedial actions were undertaken by those ATC units, such as conducting refresher training courses for controllers and establishment of procedures to strengthen monitoring capability by supervisors as to transfer of control activities.

3.46 Additionally, Japan was an active member of the WPAC/SCS RSG and, as part of the work programme of the Scrutiny Group, revised flight level arrangements would be widely implemented from 3 July, along with ATS route enhancements aimed at reducing coordination complexity. Implementation of an additional route between the Manila and Fukuoka FIRs was expected to assist with the relatively high number of Category E occurrences with Manila ACC. JCAB will also continue monitoring the situation and cooperate with other ATC units for any improvements to reduce the level of overall risk.

3.47 The JCAB RMA noted that if the safety assessment was conducted excluding the ATC-to-ATC coordination errors, a risk estimate of 3.3×10^{-9} would result. Accordingly, to further assist in the prevention of such human error, JCAB considered that the implementation of AIDC would be one of the most effective remedial actions. Following the successful implementation of AIDC with Oakland ARTCC and Anchorage ARTCC, JCAB planned to implement AIDC with Incheon ACC by the end of 2008. Japan considered that further expansion of AIDC implementation was urgently required in order to reduce Category E errors and was undertaking planning and implementation activities with neighboring States in this respect.

3.48 The meeting thanked the JCAB RMA for the report noting the significant efforts Japan was undertaking to resolve issues related to errors. PARMO commented that it is quite notable that most of the Category E events are inbound to the Fukuoka FIR and that they have been captured quite quickly.

MAAR’s RMA activities

3.49 In providing updated safety assessment reports for the Bay of Bengal and Western Pacific/South China Sea areas, the Monitoring Agency for the Asia Region (MAAR) placed on record its appreciation for the effort and cooperation from those States providing safety related data for analysis. However, noting that some data was still missing, late, and/or presented in the wrong format, MAAR encouraged States to use the most updated traffic sample data and large height deviation templates to facilitate analysis. The most updated forms and templates are available for download on the website at http://www.aerothai.co.th/maar. Also, the meeting was advised that MAAR would be appreciative if States could strictly follow the instructions provided for the traffic sample data collection and large height deviation report. Any questions or comments should be directed to MAAR at maar@aerothai.co.th.

Bay of Bengal Airspace

3.50 MAAR provided a summary of airspace safety oversight for RVSM implementation in the Asia Region, focusing on 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 2007 and the most recent rolling 12 months of Large Height Deviation (LHD) reports between May 2007 and April 2008 submitted by relevant States in the BOB Region. LHD data provided by the neighbouring Australian Airspace Monitoring Agency (AAMA) is reviewed and used in the analysis where applicable. The risk estimation was conducted based on the single alternate flight orientation scheme (FLOS) applied on the EMARSSH route structure over the BOB airspace.

3.51 MAAR advised that annual flight hours, calculated based on the December 2007 TSD, were 1,056,925 hours for the BOB airspace and that LHD occurrences in the BOB RVSM airspace could be summarized as follows:

- Compared to the previous Meeting of RASMAG, the number of LHD occurrence reduces from 6 to 5 occurrences while total LHD duration increases from 9 to 28 minutes

- Average duration of large height deviation occurrence is 5.6 minutes with maximum of 13 minutes

3.52 **Table 7** below summarizes the results of the airspace safety oversight as of May 2008 in terms of the technical, operational, and total risks for the RVSM implementation in the BOB airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.82×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	0.83×10^{-9}	-	-
Total Risk	**1.65×10^{-9}**	**5.0×10^{-9}**	**Satisfies Overall TLS**

Table 7: Risk Estimates for the RVSM Implementation in BOB Airspace

3.53 In addition, **Figure 4** below presents the graphical trends of collision risk estimates for each month using the appropriate cumulative 12-months of LHD reports since May 2007.

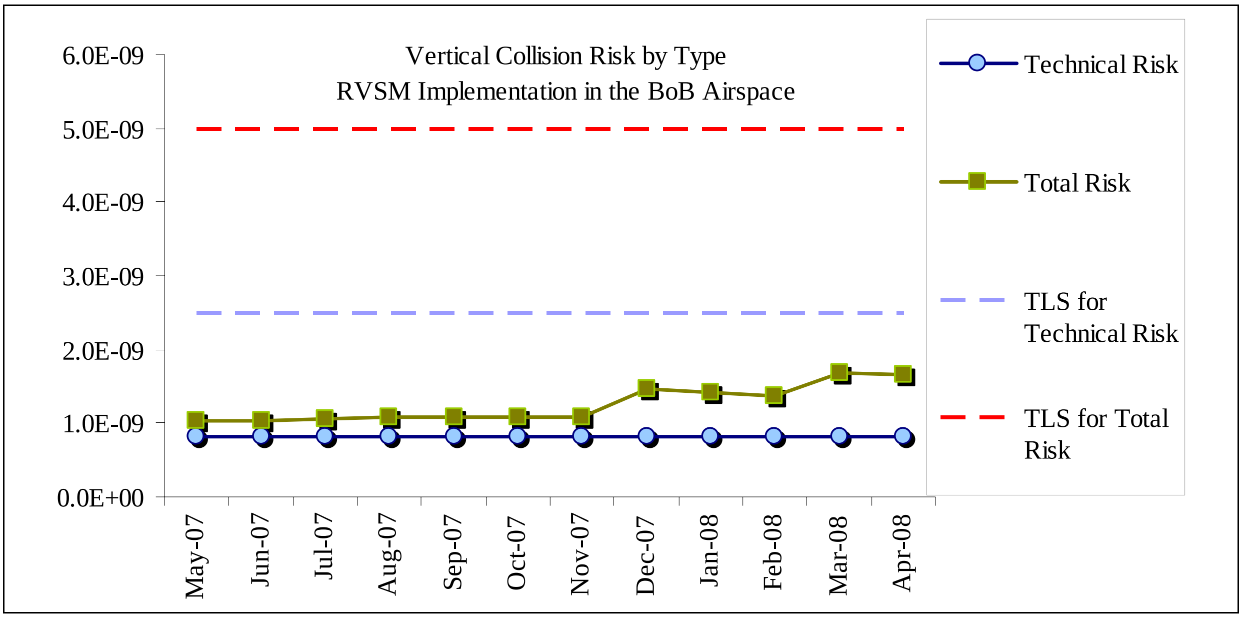

Figure 4: Trends of Risk Estimates for the RVSM Implementation in BOB Airspace

3.54 Based on these collision risk estimates, both technical and total risks for the Bay of Bengal area based on 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 due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes, respectively.

3.55 The Chairman commented that it was significant that the MAAR assessment of the BOB airspace continued to indicate that the operational risk estimate for such a large airspace is significantly low. Of particular concern was that only 5 LHDs (total duration 28 minutes) had been reported to MAAR for use in the 12 month analysis. Of note was the fact that data held by the AAMA relating to FIR boundary coordination errors that had been reported via the Airservices Australia safety management system and is depicted in the chart in **Appendix F,** shows a number of risk bearing errors relative to the boundary of the Australian FIRs and some FIRs that MAAR is the responsible RMA for. The Chairman stated that the AAMA, being aware of the detail of the error reports, would have expected to have seen corresponding reports for a number of these observed errors reflected in the MAAR analysis but regrettably this was not the case and therefore did not reflect the true situation in the BOB airspace.

3.56 The meeting recalled that RASMAG/8 had considered this issue in some depth, agreeing that Asia/Pacific RMAs would identify a process by which they would share any LHD reports provided to them that would also be of relevance to another RMA responsible for adjacent FIRs. By adopting this process the meeting hoped to improve reporting by States and to assist RMAs to validate LHDs of relevance to their area of jurisdiction. This approach was reaffirmed in the RMA technical meeting on the first day of RASMAG/9.

3.57 The meeting discussed these issues in some detail, agreeing that while MAAR had been diligently conducting its responsibilities in terms of the BOB airspace, it was evident that a number of States had deficient reporting processes in place, possibly as a result of the lack of robust safety management systems. The meeting also agreed that until some of these deficiencies within the BOB region could be resolved, a reliable estimation of risk within that airspace was unlikely to be determined. The AAMA agreed to continue to provide relevant error reports to MAAR concerning the FIRs that MAAR is responsible for.

Western Pacific/South China Sea Airspace

3.58 MAAR also provided a summary of airspace safety oversight for RVSM implementation in the Western Pacific/ South China Sea (WPAC/SCS) area. The RVSM safety oversight had been conducted based on a one-month traffic sample data (TSD) collected in December 2007 and the most recent rolling 12 months of Large Height Deviation (LHD) reports between May 2007 and April 2008 submitted by relevant States in the WPAC/SCS region. LHD data from the Australian Airspace Monitoring Agency (AAMA) is also reviewed and used in the analysis where applicable.

3.59 The meeting noted that since the last meeting, all outstanding data had been received from Vietnam in respect of the Hanoi and Ho Chi Minh FIRs and commended Vietnam for this result. Regrettably, the meeting noted that no LHD data had been received from the Philippines since their last submission in December 2007. As the large size and strategic location of the Manila FIR meant that the missing data could have a significant impact on the accuracy of the safety assessment, the Secretariat undertook to contact the Philippines and request the urgent provision of the missing data. The outstanding data for the Bangkok FIR had been received by MAAR a few days before the meeting and was therefore not able to be included in the safety assessment.

3.60 The meeting was informed that annual flight hours, calculated based on the December 2007 TSD, were 1,139,752 hours for the WPAC/SCS airspace, and that LHD occurrences in the WPAC/SCS RVSM airspace could be summarized as follows:

- compared to the previous RASMAG meeting, the total LHD duration reduces from 231 minutes to 154 minutes and the number of LHD occurrence decreases from 51 to 49 occurrences

- the Average duration of large height deviation occurrence is 3.14 minutes with maximum of 25 minutes

- a very significant portion of large height deviation occurrence (43 of 49 occurrences) as well as duration (143 of 154 minutes) is attributable to coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues (Category E)

3.61 **Table 8** below summarizes the results of the airspace safety oversight, as of May 2008, in terms of the technical, operational, and total risks for the RVSM implementation in the WPAC/SCS airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.54×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	3.03×10^{-9}	-	-
Total Risk	**3.57×10^{-9}**	**5.0×10^{-9}**	**Satisfies Overall TLS**

Table 8: Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

3.62 In addition, **Figure 5** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month of LHD reports since May 2007.

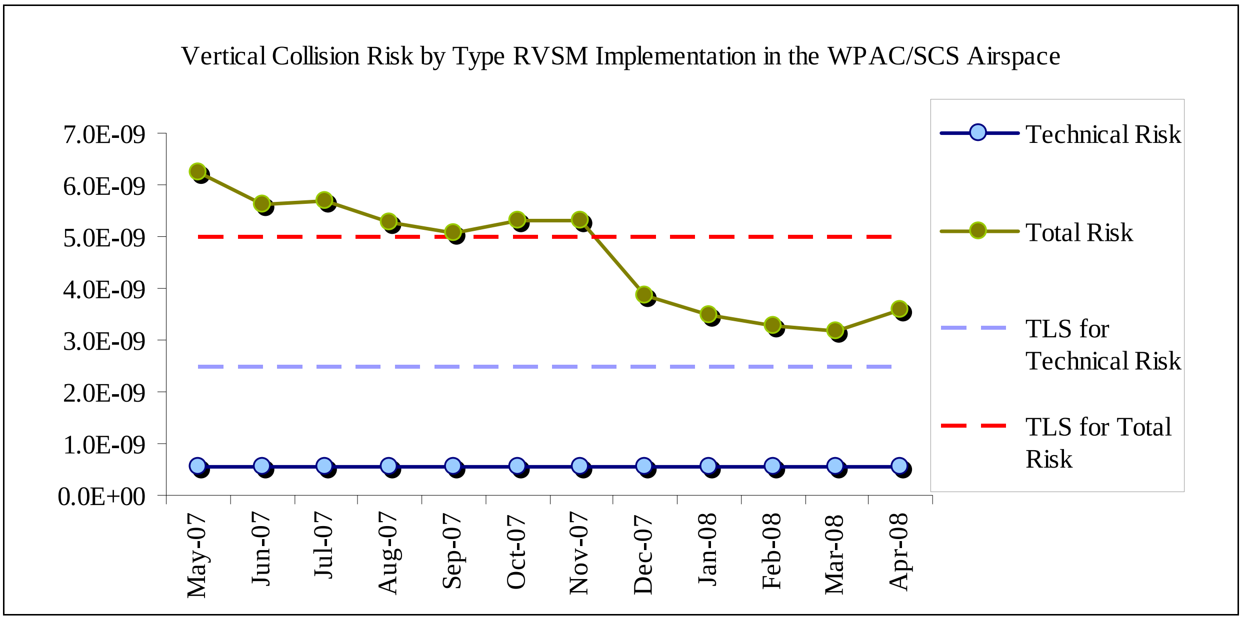

Figure 5: Trends of Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

3.63 Based on these collision risk estimates, 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 due to the loss of a correctly established vertical separation standard of 1,000 ft and to all causes, respectively.

3.64 The overall improvement in total risk is attributable to a decline in LHD durations. Despite the recent reduction in LHD durations, the number of large height deviation related to coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues remains excessive. Therefore, RASMAG recommends that States continue to work together to reduce the number of occurrences and duration of LHD to a minimum for safe and orderly air traffic services in the region.

3.65 The meeting was pleased to note that the decline in LHD occurrences since January 2007 that was observed by RASMAG/8 was maintained in this assessment. The meeting anticipated that the implementation of the revised flight level and ATS route arrangements on 3 July 2008 coupled with the level of awareness generated by the WPAC/SCS RSG about RVSM issues amongst affected States would continue to enhance safety performance in this area. The Chairman expressed the meeting's thanks to MAAR for the excellent work that they undertake in producing safety assessments for both the SCS/WPAC and BOB airspaces.

PARMO's RMA activities

3.66 The Pacific Approvals Registry and Monitoring Organization (PARMO) provided an update to the meeting including a summary of large height deviation reports, results of traffic data analysis, and an estimate of vertical risk for the airspaces under their responsibility. The report covers the current reporting period, 1 May 2007 through 30 April 2008. The meeting noted that there were twenty four reported large height deviations occurring within Pacific and North East Asia RVSM airspace during the assessment period.

3.67 Six of these reports were large height deviations that contribute to technical risk. The causes of three deviations were reported as pilot response to Traffic Alert and Collision Avoidance System (TCAS) or Airborne Collision Avoidance System (ACAS) resolution advisories. The cause of two deviations was reported to be turbulence or other weather-related causes. The cause of the final event was caused by an aircraft contingency event that led to the sudden inability to maintain the assigned flight level.

3.68 Eighteen reports were non-technical-risk large height deviations, all of which involved whole flight levels and contributed to the operational risk in the Pacific and North East Asia airspace. Sixteen of these eighteen events were related to air traffic control. The causes of thirteen of the eighteen events were related to errors in coordination of control between ATC facilities. All of these events were related to human factor issues. Of these thirteen events, six occurred in Pacific airspace, and seven events occurred in a portion of North East Asia airspace.

3.69 Two events related to air traffic control were ATC loop errors, these errors occurred in Pacific airspace. The final event relating to air traffic control occurred because the receiving ATC facility was unaware that the aircraft had been cleared for a block altitude by the previous ATC facility.

3.70 The PARMO analysis demonstrates that the largest contributor to risk-bearing large height deviations is coordination error in the ATC-unit-to-ATC-unit transfer of control responsibility as a result of human factors issues. This type of event includes late or non-existent coordination, incorrect time estimate/actual, and flight level and/or ATS route not in accordance with agreed parameters. This is the only type of error reported in a portion of North East Asia RVSM airspace.

Pacific Airspace

3.71 In reviewing the outcomes of the Pacific airspace, the meeting noted the excellent rate of data submission that had been achieved by the States involved, with all States submitting required TSD and monthly LHD reports. In particular, the meeting noted that Tahiti has been reliably submitting LHD since September 2007 and had also presented the December 2007 TSD as required. The meeting recognised the role that IFALPA had played in achieving this outcome, recalling that the Executive Vice President for Asia/Pacific had taken the time during a scheduled airline overnight stop in Tahiti to take a break from active flying duties and visit the ATS Unit in Tahiti in order to describe the reasons behind the data requirements. The meeting thanked IFALPA for this productive intervention.

3.72 The technical risk was estimated to be 0.095 x 10^{-9} fatal accidents per flight hour. The operational risk estimate is 0.872 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk was 0.967 x 10^{-9} fatal accidents per flight hour, which easily satisfies the regionally agreed TLS value of 5.0 x 10^{-9} fatal accidents per flight hour. This estimate was based on the most recent 12 months of large height deviation reporting and recently updated collision risk parameters based on the December 2007 traffic samples collected and is shown in **Table 9** below.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.095 x 10^{-9}	2.5 x 10^{-9}	Satisfies Technical TLS
Operational Risk	0.872 x 10^{-9}	-	
Total Risk	**0.967 x 10^{-9}**	**5.0 x 10^{-9}**	**Satisfies Overall TLS**

Table 9: Vertical Collision Risk Estimates for Pacific Airspace

3.73 **Figure 6** below provides a graphical representation of the updated risk estimates for Pacific RVSM airspace based on the recent 12 months of large height deviations.

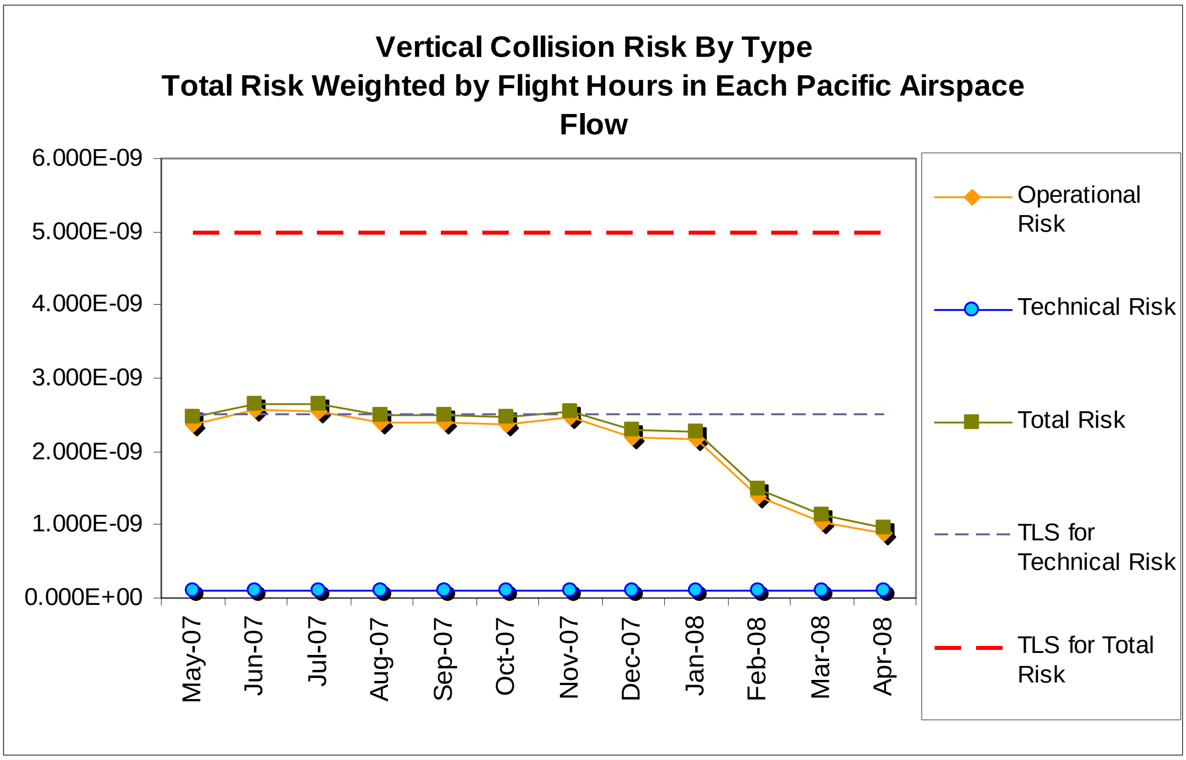

Figure 6: Vertical Collision Risk for Pacific RVSM Airspace

<u>North East Asia Airspace</u>

3.74 In the North East Asia airspace the technical risk is estimated to be 0.177.x 10^{-9} fatal accidents per flight hour. The operational risk estimate is 2.928 x 10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is 3.105 x 10^{-9} fatal accidents per flight hour. This estimate is below the regionally agreed TLS value of 5.0 x 10^{-9} fatal accidents per flight hour. This estimate was based on the most recent 12 months of large height deviation reporting and is shown in **Table 10** below.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.177×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	2.928×10^{-9}	-	
Total Risk	$\mathbf{3.105 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Satisfies Overall TLS**

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

3.75 **Figure 7** below provides a graphical representation of the updated risk estimates for North East Asia RVSM airspace based on the recent 12 months reports of large height deviations.

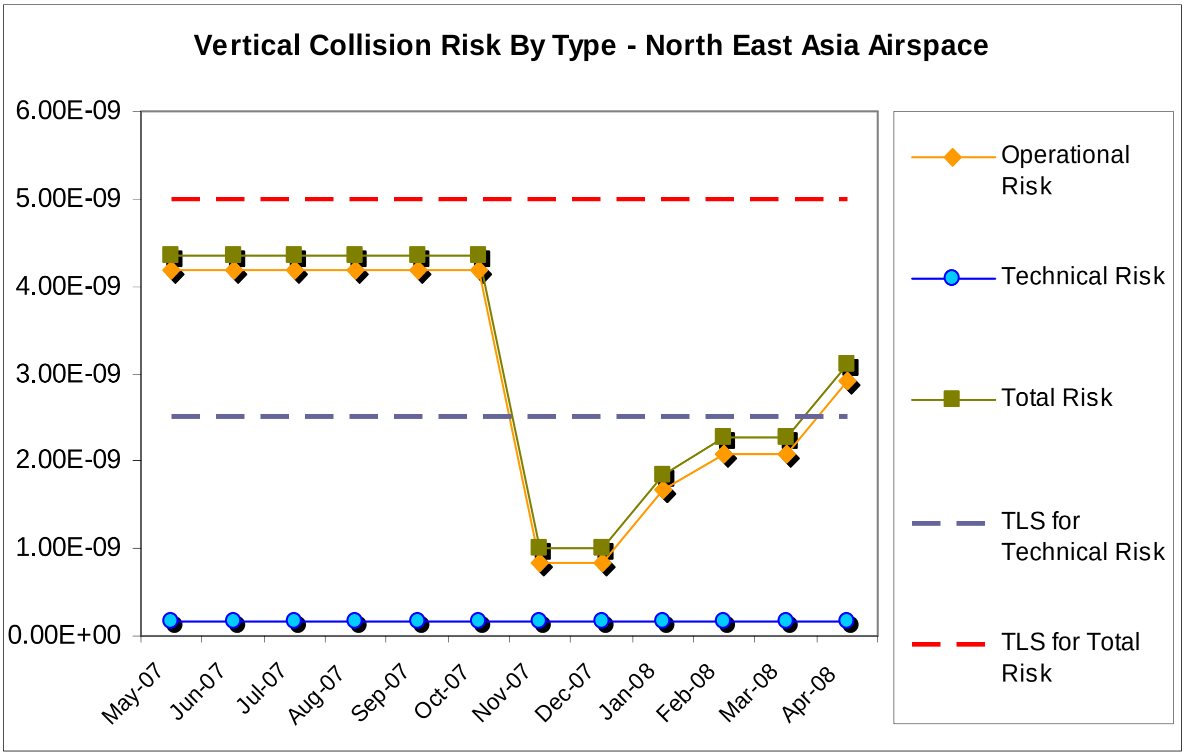

Figure 7: Vertical Collision Risk for North East Asia RVSM Airspace

Non RVSM approved operators using Pacific and North East Asia Airspace

3.76 The PARMO informed the meeting that amongst the duties and responsibilities of an RMA is the performance of periodic checks of the approval status of operators and aircraft using airspace where RVSM is applied. This activity, termed "monitoring operator compliance with State approval requirements", is especially important if RVSM is applied on an exclusionary basis, that is, if State RVSM approval is a prerequisite for use of the airspace.

3.77 In conducting this work, a comparison was made between the annual December traffic sample data (TSD) for 2007 and the combined approvals database maintained by PARMO. Those flights in the TSD but failing to match with the approvals database appear to lack State RVSM approval and were then the subject of subsequent correspondence between the PARMO and the relevant State authorities and operators.

3.78 The checks revealed that, in general, operator compliance was considered to be very high. However, some instances of apparent non-compliance resulting from likely systematic causes were observed and a small number of possible instances of operator non-compliance are currently under investigation by PARMO.

3.79 The meeting expressed serious ongoing concern at the number of flights that were apparently using RVSM airspace when they did not have the State approvals to do so. This meant that it was likely that in some circumstances the 1000 feet separation was being inadvertently applied by ATC when the 2000 foot standard was required – this was a breakdown of separation incident. Questions were raised about the legal responsibility of an ANSP who knew, through the RMA work in this area for example, that some identified airframes were filing “W” when they were not authorized to do so but took no action to apply the greater vertical separation standard.

3.80 Australia gave examples of their method of managing this issue, in which the ATC system flight plans for these identified airframes were modified by the ANSP to remove the ‘W’ indication, thereby ensuring that the reduced separation was not applied by ATC. In agreeing that this issue required regulatory intervention, the meeting recognized that the Australian approach was appropriate for the ‘non-exclusive’ RVSM airspace model applied by Australia, but noted that application of this method in other airspaces required further study.

Thanks PARMO

3.81 The Chairman thanked PARMO on behalf of the meeting for the continued excellent reporting that PARMO provides for the airspaces under its responsibility and for the specialist support that it provides to both RASMAG and directly to a number of States. The PARMO had played a very significant role in the work of RVSM implementation and monitoring in the Asia/Pacific Region over the years and had been directly responsible for training and assisting all of the Asia/Pacific RMAs. This dedication and professionalism was a tribute to PARMO and was well recognized by the States of the region and the Regional Office. The meeting thanked the United States for their demonstrated and serious commitment in this respect.

Agenda Item 4: Airspace safety monitoring documentation and regional guidance material

SMA Handbook

4.1 The meeting recalled that Action item 2/4 of the RASMAG action items list identified the need to develop a handbook and/or guidance material for planned regional Safety Monitoring Agencies (SMAs) that would undertake safety assessment and monitoring in the horizontal plane. Work on this matter has been on-going within RASMAG for a considerable time and RASMAG/8 considered that the final version of the SMA Handbook needed to be presented to RASMAG/9 during mid 2008 for review.

4.2 Subsequent to RASMAG/8, a drafting group – the SMA Handbook Review Team (SMAHRT) **-** was established and substantial work was completed on the draft Handbook, as presented to the RASMAG/9 meeting. The RASMAG would retain editorial responsibility for the document, in coordination with the Regional Office. Following review and discussion, the meeting updated the SMA Handbook to the extent possible and retained the updated version as **Appendix G.**

4.3 The meeting, recognizing that the preparation of such guidance material was a complex and time consuming task, thanked the members of the drafting team for their concentrated efforts in recent weeks which had resulted in the current advanced version of the Handbook. The drafting team would continue work on the document, incorporating the wide ranging discussions during the meeting, with the objective of enabling RASMAG/10 (December 2008) to endorse a final version. The drafting team noted the recommendation from the meeting that the Singapore 50/50NM 'Know Your Airspace' analysis and safety assessment provided valuable guidance and should be included as appendices to the SMA Handbook.

Amendment to End-to-End Guidance Material

4.4 The Guidance Material for End-To-End Safety and Performance Monitoring of Air Traffic Service (ATS) Datalink Systems in the Asia/Pacific Region was prepared by the RASMAG and adopted by APANPIRG/16 in 2005.

4.5 Subsequently, the recently available *RTCA DO-306/EUROCAE ED-122, Safety and Performance Standard for Air Traffic Datalink Services in Oceanic and Remote Airspace* (the Oceanic SPR) was reviewed and adopted by the ISPACG during their March 2008 meeting. The Oceanic SPR requirements are specified in terms of Required Communication Performance (RCP) and this, coupled with additional information that had become available as a result of the ongoing monitoring of CPDLC and ADS-C datalink performance, necessitated some amendments to the guidance material.

4.6 The amendments proposed also incorporate feedback from discussions at the North Atlantic Systems Planning Group Technical Task Force Meeting on datalink applications communications requirements (NAT SPG/TF RCP) which was held at the Paris Office of ICAO in February 2008. As an overview outcome of these discussions, in-principle agreement was reached that NAT and APAC parties would work together in order to align, to the extent possible, operational arrangements for datalink. This approach is strongly supported by ICAO Secretariat in HQ, Paris and Bangkok Offices.

4.7 Recognizing that the proposal represents important initial steps by NAT and APAC to align datalink monitoring requirements, the meeting adopted an amendment to the End-to-End Guidance Material as shown in **Appendix H**. The Secretariat would post the updated document on the Regional Office website, as well as providing the updated version to the ICAO Paris and Montreal Offices for their review.

Amendment to Procurement Guidance Material

4.8 The Guidance Material for The Asia/Pacific Region for ADS/CPLDC/AIDC Ground Systems Procurement and Implementation was prepared by the RASMAG and adopted by APANPIRG/18 in 2007. Since then, the Required Communication Performance (RCP) concept has been introduced and has been included as a factor in the determination of some reduced separation minima requirements. Additionally, the RTCA DO-306/EUROCAE ED-122, *Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace* (Oceanic SPR Standard) is available.

4.9 Accordingly, amendments to the Procurement Guidance material are necessary to reference RCP, include changes the System Performance Criteria at Appendix C to reflect those for RCP240 and RCP400 as defined in the Oceanic SPR Standard and complete editorial amendments to the Glossary and References etc.

4.10 The meeting adopted the updated version of the Procurement Guidance Material included as **Appendix I** and requested that the Secretariat post the updated document on the Regional Office website, as well as providing a copy to the ICAO Paris and Montreal Offices for their review. The meeting also specifically acknowledged the significant work undertaken by Mr. Farmer from New Zealand in developing and progressing the work on both the *Guidance Material for End-To-End Safety and Performance Monitoring of Air Traffic Service (ATS) Datalink Systems in the Asia/Pacific Region* and *The Asia/Pacific Region for ADS/CPLDC/AIDC Ground Systems Procurement and Implementation*.

RASMAG List of Competent Airspace Safety Monitoring Organizations

4.11 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 made a number of updates to the "RASMAG List of Competent Airspace Safety Monitoring Organizations" (shown at **Appendix J**) for use by States requiring airspace safety monitoring services.

Agenda Item 5: Airspace safety monitoring activities/requirements in the Asia/Pacific Region

IATA – Management of 100 foot Operational Errors

5.1 IATA drew the attention of the meeting to the fact that following the implementation of RVSM in China using a unique FLOS, operational errors between a Chinese FIR and an adjacent FIR applying the traditional ICAO RVSM FLOS could result in the aircraft being misaligned by 100 feet. For example, an aircraft that was required to transition to FL331 from FL330 (or vice versa) but failed to do so would be misaligned by plus (or minus) 100 feet.

5.2 IATA noted that some examples of this type of event had been reported to the RVSM/TF/33 90-day review meeting in April and had been referred to RASMAG for consideration. IATA's concern lay in the fact that because the misalignment was only 100 feet, it did not meet the 300 feet criteria of an LHD as defined under the RASMAG plain language definition of LHD and was therefore not eligible to be included in the RVSM safety assessments. IATA considers that the extent of the deviation is irrelevant as the occurrence is a systemic problem that should be assessed under the risk model.

5.3 This matter was the subject of extensive discussion, resulting in two primary conclusions:

a) The misalignment of 100 feet was an operational error and therefore should be identified and addressed by State and airline safety management systems, with remedial measures applied accordingly, and

b) The globally recognized collision risk model applied for the RVSM had been developed over a long period of time and used an empirical basis coupled with robust mathematical methodologies to exclude height deviations of less than 300 feet for the assessment of operational errors. However, the technical risk component considers all errors, including 100 feet errors, in its assessment. This determination of the assigned altitude deviation (AAD) is statistically combined with the altimetry system error (ASE) and assures that the total vertical error (TVE) distribution includes estimates of this nature of behavior, complete with its relative proportion.

5.4 The meeting considered that as any individual occurrence of this type of event was eligible for resolution under normal State and airline safety management processes, there was no cause for concern in relation to current operations. IATA also raised the concern that since the 100 feet deviation was within the normal ATC margins, airline and State ATS safety management reporting processes may not be configured to catch this error. However, it was recognized that there was absence of accurate information about the number and circumstances in which these types of events were occurring and the meeting agreed that efforts should be made to collect additional information to enable further study.

Review of APANPIRG Conclusion 16/9

5.5 During August 2005, in response to a number of persistent safety issues, APANPIRG/16 was informed that States were having difficulties implementing Annex 11 compliant safety management systems, adopting the following Conclusion:

Conclusion 16/19 – Study of States' preparedness to implement safety management systems

That, a study of States' preparedness to implement ICAO safety management systems in accordance with Annex 11 be undertaken by the Asia/Pacific Regional Office in conjunction with the ATS coordination groups and RASMAG by the first quarter of 2006, and a plan of action developed to be reported to APANPIRG/17 in September 2006.

5.6 The meeting was informed that although the Conclusion was raised in 2005 for action, resource limitations at the Regional Office mean that the survey has not yet been carried out. Ongoing resource limitations require the careful prioritization of work programmes and, at the moment, the conduct of the survey has not been earmarked for Secretariat action in the foreseeable future.

5.7 However, since the Conclusion was raised ATS safety management matters have been progressed in other ways. In September 2006, two SMS courses of 35 participants each were conducted at the Regional Office. These training courses were delivered by accredited personnel from ICAO Headquarters and were addressed at the level of the State Regulator, for officers with responsibilities for Annexes 6 and 14 as well as Annex 11, including the implementation and/or oversight of safety management systems in the area of air traffic services. This programme is scheduled to continue on a global basis for the foreseeable future under the auspices of ICAO HQ. Additionally, the Regional Office conducted a SIP during September 2006 on ATS Safety Management System Training, with the objective of assisting States to meet obligations for ATS safety management.

5.8 Since that time, safety work has continued in various regional forums including RASMAG, resulting in valuable improvements in terms of the horizontal and vertical safety management issues. Notably, in the Western Pacific/South China Sea area a horizontal safety assessment has been conducted and follow up work has commenced to update the lateral monitoring arrangements. Compliance with the regional target level of safety for RVSM operations has also been achieved in the WPAC/SCS area. Additional RMA capability has been established, with Japan gaining APANPIRG approval and China achieving RASMAG recommendation during this meeting. Singapore has made good progress in terms of SMA activities for the implementation of 50/50NM separation in the South China Sea. A revised FLOS/FLAS has been agreed for implementation in the WPAC/SCS area on 3 July 2008 and implementation arrangements for this change are advanced.

5.9 Also of significance is the increased tempo of the ICAO USOAP audit programme, with a large number of audits already completed in Asia/Pacific region and more audits scheduled. Annex 11 SMS is one of the areas assessed by the USOAP audits and the State Corrective Action Plans required under the audit programme are an effective way of ensuring that the attention of States is drawn to the implementation of ATS safety management systems.

5.10 Accordingly, on the basis that ATS safety management work was progressing consistently in a number of other forums around the region, the meeting considered that Conclusion 16/9 had been overtaken by events and agreed to recommend to APANPIRG/19 that the Conclusion be closed.

RNP-SEA/TF – Implementation of 50NM/50NM Separation on L642 and M771

5.11 Singapore provided information on the progress by the South-East Asia RNP Implementation Task Force (RNP-SEA/TF) towards implementing RNP 10 (PBN RNAV 10) based 50NM lateral/50NM longitudinal separation of ATS routes L642 and M771 in the South China Sea.

5.12 The RNP-SEA/TF/2 meeting in March 2008 had agreed to **Table 11** below summarizing the Operational Concept and Implementation Requirements for 50NM/50NM reduced separation based on RNP 10 (PBN RNAV 10) on the affected routes.

FIR	**50NM/50NM Requirements and Existing CNS Infrastructure**			**Additional Information on Current Mode of Operations on L642 & M771**	**Adequate for 50NM/50NM Operation?**
	50NM/50NM Communications Requirements Direct controller-pilot communication in voice/CPDLC	**50NM/50NM Navigation Requirements** RNP10 Approval	**50NM longitudinal Surveillance Requirements** Procedural position reports at least every 24 minutes		
	Communication Means	**Navigation Specification**	**Surveillance In Place**		
Hong Kong	VHF direct communication between ATC and pilots	RNP 10 Approval	Frequent position update by radar	Use of Radar to monitor RNP 10 operation	Yes
Sanya	VHF direct communication between ATC and pilots	RNP 10 Approval	Frequent position update by radar	Use of Radar to monitor RNP10 operation	Yes
Ho Chi Minh	VHF direct communication between ATC and pilots, CPDLC available as secondary communication means	RNP 10 Approval	Frequent position update by radar	Use of Radar as primary means of separating aircraft, ADS-C for monitoring FANS 1/A aircraft as added surveillance	Yes

<table>
<tr><th rowspan="3">FIR</th><th colspan="3">50NM/50NM Requirements and Existing CNS Infrastructure</th><th rowspan="3">Additional Information on Current Mode of Operations on L642 & M771</th><th rowspan="3">Adequate for 50NM/50NM Operation?</th></tr>
<tr><th>50NM/50NM Communications Requirements

Direct controller-pilot communication in voice/CPDLC</th><th>50NM/50NM Navigation Requirements

RNP10 Approval</th><th>50NM longitudinal Surveillance Requirements

Procedural position reports at least every 24 minutes</th></tr>
<tr><th>Communication Means</th><th>Navigation Specification</th><th>Surveillance In Place</th></tr>
<tr><td>Singapore</td><td>CPDLC as primary communication between ATC and pilots for FANS 1/A aircraft, direct HF as secondary communication</td><td>RNP 10 Approval</td><td>Procedural position reporting, intervals between successive waypoints less than 24 minutes</td><td>ADS-C surveillance on FANS 1/A aircraft, periodic reporting interval less than 27 minutes</td><td>Yes</td></tr>
</table>

Table 11: Operational Concept and Implementation Requirements for 50NM/50NM on L642 and M771

5.13 RNP-SEA/TF/2 was informed that the implementation safety assessment would be completed and be presented at RASMAG/9 in May 2008 subject to the timely provision of data required to complete the safety assessment. The meeting agreed that the required data be provided to Singapore as soon as available from the Ho Chi Minh, Hong Kong, Kuala Lumpur and Sanya FIRs. In expectation that the data would be provided, the meeting agreed that the implementation time/date should be 2100 UTC, 2 July 2008, coincident with the implementation of the revised flight level arrangements in the South China Sea. The Go/No Go meeting would be held in the first week of June.

Safety Assessment – 50/50NM reduced separation on L642 and M771

5.14 In accordance with information provided to previous meetings of RASMAG, Singapore informed the meeting that they had engaged the services of a consultant, CSSI of the United States, to assist them with the establishment of SMA capability for the South China Sea and the preparation of a safety assessment for the implementation of 50/50NM reduced separation on L642 and M771

‘Know Your Airspace’ Analysis

5.15 Singapore had conducted a through ‘Know your Airspace’ analysis for operations on RNAV routes L642 and M771 based on the December 2007 traffic sample data (TSD) sets from the Ho Chi Minh, Hong Kong, Sanya and Singapore flight information regions. After processing and merging, a total of 5743 flight operations were observed on L642 and M771 during December 2007. The analysis had identified and quantified several important characteristics of airspace use - notably the operators, aircraft types, origin-destination pairs, flight level use and operator/aircraft-type combinations.

5.16 Each traffic movement was examined to determine the operator conducting the flight. A total of 61 unique three-letter ICAO operator designators were observed with the top four operators (SIA, CPA, AXM, MAS) accounting for nearly half of the operations. The top four aircraft types (A320, B772, A333, B773) account for 60 percent of the operations, nearly one in five operations flew between Singapore Changi Airport and Hong Kong International Airport and, in order of use, FLs 360, 380 and 340 are the preferred altitudes on the routes and account for 77 percent of the operations.

Safety Assessment

5.17 Singapore presented the fully documented formal safety assessment of the risk associated with introducing 50-NM lateral and longitudinal separation standards on South China Sea RNAV routes L642 and M771 – a copy of the safety assessment has been attached as **Appendix K**.

5.18 The safety assessment was conducted using internationally applied ICAO collision risk methodology, making use of relevant results developed in other portions of the Asia and Pacific Region where appropriate. Principal sources of data used in the safety assessment are information extracted from the December 2007 Traffic Sample Data collection, radar-based measurements of position obtained from the Singapore Area Control Center, and the results of monitoring navigational performance on the routes – a process which has been underway on a continuous basis since November 2001. The risk associated with the 50-NM lateral separation standard is estimated, with high statistical confidence, to be in compliance with the Regional Target Level of Safety (TLS). Examination of the risk associated with the 50-NM longitudinal separation standard also indicates that the TLS is satisfied.

5.19 All information available to the safety assessment indicates that the factors affecting risk – such as along-track position keeping and loss of planned separation between pairs of co-altitude aircraft – are consistent with those leading to TLS compliance. In light of favorable risk estimates and the ongoing program for monitoring navigational performance, the safety assessment supports introduction of 50-NM lateral and longitudinal separation standards on L642 and M771.

5.20 The meeting engaged in a searching review of the safety assessment documentation, noting and appreciating the many aspects that had been covered, recognizing that the assumptions that had been made were reasonable, agreeing that the safety assessment was robust and fully endorsing the outcomes. The meeting congratulated Singapore on both the professional, thorough and comprehensive safety assessment process and the positive outcomes that had resulted. RASMAG confirmed that from the aspect of the safety assessment, there was no impediment to the implementation of 50NM/50NM as planned by the RNP-SEA/TF.

5.21 The meeting recognized that 'Know Your Airspace' analysis and the Safety Assessment that had been prepared by Singapore were of such high quality that they were extremely useful as guidance material and would serve as valuable models for regional review. The information contained in them was expressed in a manner that was clear and easy to follow as well as addressing the appropriate ICAO provisions for such and implementation. The work of the PBN/TF was expected to lead to an accelerated implementation of 50/50 and 30/30 reduced separations across the region and similar safety assessments would be required. As such, the meeting recommended that both documents be included as Appendices to the SMA Handbook.

Establishment of Singapore SMA - SEASMA

5.22 At the Seventeenth meeting of the ATM/AIS/SAR Sub-Group (July 2007), Singapore was tasked by the Sub-Group to revise the current LOA for the monitoring of aircraft gross navigation errors in the South China Sea area and the collection of additional data on L642 and M767 for the conduct of safety assessment to implement 50/50NM and 30/30NM reduced horizontal separation in the South

China Sea area in the near future. Accordingly, Singapore developed a new LOA in coordination with the other air navigation service providers in the South China Sea.

5.23 As noted previously, the RNP-SEA/TF has committed to implementation of 50-NM lateral and longitudinal separation standards on South China Sea RNAV routes L642 and M771. In order to provide adequate SMA support for this initial implementation in the South China Sea, Singapore has committed to establishing an SMA for the South China Sea, with the objective of providing full SMA services from 1 July 2008.

5.24 Singapore has adopted the title *"South East Asia Safety Monitoring Agency" (SEASMA)* as the name for the SMA. With assistance from CSSI, SEASMA has prepared both an interim and, as described elsewhere in this report, the final safety assessment to support to 50NM/50NM implementation. Staff for the SEASMA will be drawn from the ranks of CAAS personnel with appropriate qualifications, however Singapore will use CSSI resources to supplement permanent SEASMA staff until necessary training of CAAS personnel is complete.

5.25 SEASMA has made good progress towards addressing the requirements for an SMA as outlined in the draft Asia/Pacific SMA Handbook and has also contributed significantly to the writing of the Handbook. Recognizing the value of an Internet presence, Singapore is in the initial stages of developing the SEASMA website, having directed CSSI to develop a prototype, and has already taken steps to procure the URL www.seasma.com. Tentative plans call for the SEASMA website to be operational during the third quarter of calendar year 2008.

5.26 Four training sessions are planned to assist CAAS staff to operate the SEASMA. The sessions, intended to be in a workshop format featuring practical training scenarios, will be conducted by CSSI personnel experienced in carrying out the various duties and responsibilities of an SMA. While Singapore has yet to define specific dates for the training, current planning calls for the first session to be held in the third quarter of calendar year 2008.

5.27 Singapore expects to provide regular reports to the RASMAG concerning compliance of South China Sea RNAV route operations with the Regional TLS, using the existing RMA reporting methodology as a guide. The format and content of the periodic report will be a subject covered during SEASMA staff training.

5.28 The meeting commended Singapore's strong commitment to providing SMA services for the South China Sea. The absence of SMA services had previously been an impediment to the smooth implementation of reduced horizontal separations in the region, requiring Australia to undertake the one-off pre-implementation safety assessments for both the South China Sea parallel route structure and the EMARSHH routes in the Bay of Bengal. Post implementation safety assessments had been problematic to complete. Also, the recent work on the ICAO PBN Concept and establishment of the Asia/Pacific PBN Implementation Task Force was expected to lead to widespread implementations of 50/50NM and 30/30NM horizontal separations and SMA capability was considered essential in implementing and operating these reduced horizontal separations.

5.29 The meeting thanked Singapore for their considerable efforts and expressed full support to Singapore in this undertaking. RASMAG would continue to work off-line towards finalizing the Asia/Pacific SMA Handbook, to provide suitable guidance to assist Singapore in operating the SMA, with the objective of having a final draft ready for consideration by RASMAG/10 in December 2008. It was also anticipated that RASMAG/10 would be able to clarify the outstanding matters in relation to the operation of an SMA, as highlighted in paragraphs 5.34 to 5.40 below.

SMA Activities conducted by PARMO

5.30 The United States provided information in relation to the safety monitoring agency (SMA) activities undertaken by the PARMO for the Oakland and Anchorage FIRs, noting that the same FAA Technical Center personnel responsible for the PARMO RMA activities also provide similar services for aircraft separations in the horizontal plane for the Oakland and Anchorage FIRs. The FAA Technical Center has established and maintains a RNP approvals database for the Pacific. The RNP approvals database includes airframe specific data on both RNP4 and RNP10 approvals related to operations in oceanic/international airspace.

5.31 FAA Order 7110.82C provides procedures for processing Oceanic Navigational Error Reports (ONER) and Erosion of Longitudinal Separation Reports (EOLS). It requires ATC to file an ONER report when an aircraft is observed 25 nm or more from the centerline of the route on which it was cleared. It also requires ATC to file an EOLS report when an aircraft's estimated time of arrival for an oceanic reporting point differs by 3 minutes or more from the aircraft's actual time of arrival. According to the procedures specified in the Order, copies of the ONER and EOLS reports are sent to the FAA Technical Center. The FAA Technical Center is required to:

(1) Maintain a record of all oceanic deviation reports.

(2) Perform analyses of deviations and determine if the data indicates any significant changes in the navigation environment that may require corrective action.

(3) Provide periodic data summaries and analyses to FAA Flight Standards Service.

(4) Recommend corrective action when indicated or required.

5.32 As part of the 30/30NM operational trial in the Oakland Oceanic FIR, the FAA formed a group of experts, the "30/30 Scrutiny Group", to evaluate performance of the various components of the system supporting the reduced separation minima. One of the FAA Technical Center contributions to the Scrutiny group is a check on the filed flight plans of the operator-aircraft combinations identified as approved for reduced horizontal separation standards. This activity corresponds to a check on the "approval status" of aircraft operating in Oakland and Anchorage airspace and enables identification of non-approved operators and aircraft using the airspace.

5.33 The FAA Technical Center also conducts evaluations of the lateral navigational performance for Automatic Dependent Surveillance-Contract (ADS-C) operations in the Oakland FIR. An estimate of the distribution of lateral deviations from route centerline for aircraft equipped with ADS operating in the Oakland oceanic airspace was produced as part of the estimation of collision risk for the airspace.

SMA – Matters for clarification

5.34 Following the presentations from Singapore and the United States in relation to the provision of SMA services, the meeting engaged in extensive discussions relating to the roles and functions of SMA. The meeting recognized that there were a number of areas that required clarification, covering both the administrative and technical aspects of an SMA. Given the accelerated work programme of the Asia/Pacific PBN Task Force and the preparations being made by Singapore and Japan to provide SMA capability in addition to Australia and the United States, many of these issues required urgent clarification.

5.35 In relation to administrative matters, the meeting recalled that APANPIRG/16 (August 2005) had adopted the following Decision:

APANPIRG Decision 16/1 – Safety Monitoring Agency (SMA)

That, the term Safety Monitoring Agency (SMA) be used to describe an organization approved by regional agreement to provide airspace safety monitoring and implementation services for international airspace in the Asia/Pacific region for implementation and operation of reduced horizontal separation.

5.36 It was clear that the intent of this decision was that Asia/Pacific SMAs would be *"approved by regional agreement"* i.e. an APANPIRG approval in a similar manner to the process adopted for RVSM RMAs. The meeting recognized that the RMA requirements were precipitated, in part, by the Standard in Annex 11 that required RVSM monitoring to be conducted on a 'regional' basis – Annex 11, paragraph 3.3.5.1 refers. However, although horizontal monitoring was also required under ICAO provisions, the stipulation that the monitoring be conducted on a regional basis was not made – meaning that each State held individual responsibility and could conduct the monitoring on an individual basis. Notwithstanding, the meeting recognized that for many of the States with smaller airspaces to conduct monitoring individually would not be as efficient and effective as working together in a sub regional manner. The example of SEASMA, the Singapore SMA, was a case in point as SEASMA was undertaking SMA functions for five FIRs in the South China Sea and the meeting considered it likely that APANPIRG had been cognizant of these factors in adopting Decision 16/1.

5.37 However, there were a number of other agencies supporting different types of safety monitoring in the region, notably the CRA and FIT groups that were investigating the communications and surveillance performance of FANS 1/A datalink. Similar provisions for the "APANPIRG approval" of these agencies had not been considered necessary, although their work was essential in demonstrating the technical performance of satellite data link. Recognizing that the adoption of an "APANPIRG Approval" process for SMAs brought with it additional complexities in credentialing these agencies, the meeting sought reassurance that adopting such a process for the region was warranted.

5.38 As a component of this discussion, the Secretariat was of the view that the fundamental difference between RMAs/SMAs and the other monitoring agencies was that the RMAs and SMA signed off on safety assessments, thereby taking a large and direct responsibility in the implementation and ongoing monitoring of reduced separation implementations. Although the CRAs and FITs were doing essential work in monitoring and correcting technical communications and surveillance performance, their work comprised a component input to a safety assessment, rather than the safety assessment itself. Therefore, as the responsibility level was higher, it was perhaps logical that an "APANPIRG Approval" was justified for RMAs and SMAs.

5.39 In terms of the technical issues, the meeting recognized that the implementation of reduced horizontal separations to the RNP/4 level, for example, required availability of higher performance communications and surveillance capabilities that were an integral part of the reduced separation application, in addition to the enhanced navigation performance requirements. In reviewing the draft SMA handbook, the meeting noted that although many aspects had been fully covered, there were minimal provisions in the Handbook in terms of addressing communications and surveillance aspects. Noting, as described in the previous paragraph, that in the Asia/Pacific context the CRAs and FITs held responsibilities for the technical performance of surveillance and communications aspects of FANS data link, the meeting questioned whether formal relations ships needed to be established between, for example, the SEASMA, the FIT-SEA and the FIT-SEA CRA in terms of ensuring that implementations of reduced separations like RNP/4 were appropriately managed.

5.40 The meeting agreed that further discussion around the SMA administrative and technical issues was necessary and that work should proceed off-line in such a manner that RASMAG/10 in December 2008 could be fully informed and enabled to make appropriate decisions.

PBN Task Force – FPO & Assistance with Safety Documentation

5.41 The meeting studied the outcomes of the PBN/TF/1 and PBN/TF/2 meetings, held in January and April 2008 respectively, noting the excellent progress that was being made toward the drafting of regional and State PBN implementation plans.

ICAO Flight Procedures Office

5.42 In terms of implementation, the meeting noted that the PBN/TF had identified a number of issues to be addressed in progressing PBN implementations regionally and had highlighted a number of instrument procedure design-related issues and problems faced by States. In order to address these issues in a timely and standardized manner, the Secretariat had advanced a proposal for the formation of an ICAO Asia Pacific Flight Procedure Office (FPO). The goal of the FPO would be to address some of the issues identified by the PBN/TF and foster implementation of flight procedures, developed with the appropriate quality systems, especially PBN and vertically guided instrument approach procedures by:

a) Assisting those States with sufficient density of procedures to establish a sustainable internal procedure design capability capable of meeting the requirements of PANS OPS and their responsibility under Annex 15 for the quality of their procedures;

b) Providing the appropriate level of technical expertise necessary to enable States that do not have the density of procedures necessary to sustain an internal procedure design capability, to meet their responsibilities under Annex 15 and PANS OPS; and

c) Providing a vehicle to improve quality in the States' procedure design process through access to procedure design automation solutions and associated data storage.

5.43 A State Letter had been circulated by the Regional Office seeking State comments on this proposal, for consideration by the PBN/TF/3 meeting scheduled in July 2008.

Safety Documentation for Regional Implementation Plan

5.44 In its review of the draft regional implementation plan that had been prepared by the PBN/TF, the meeting noted that the need for appropriate safety monitoring and assessment had been identified and some preliminary text included in the plan. Recognizing that the primary regional expertise in safety related matters resided with RASMAG, the meeting agreed that it would be appropriate for RASMAG to assist the PBN/TF with the drafting of this component of the regional implementation plan. An examination of the RASMAG terms of reference (**Appendix L** refers) confirmed that RASMAG was within its mandate to conduct this work.

5.45 The meeting agreed to form a small drafting group, comprising representatives from Australia, New Zealand, Singapore, United States and IFALPA, with the RASMAG Chairman as the primary coordinator. The objective would be to work with the ATM Secretariat to provide an advanced draft of the safety related material necessary for the PBN Regional Implementation Plan to the PBN/TF meeting in mid July. Accordingly, a cut off date of the end of June was set to have the material to the ATM Secretariat for relay to the PBN/TF. An item was added to the Task list in this respect.

Global Long Term Height Monitoring

5.46 The meeting recalled that as a result of its review of these matters, APANPIRG/18 had recognised that the pending implementation of global long term monitoring requirements would have significant impacts in the way regional monitoring was managed, including the need for widespread regional height monitoring infrastructure capability to be made available. Under the terms of Conclusion 18/4, APANPIRG had tasked Asia/Pacific RMAs in conjunction with RASMAG to prepare a regional impact statement summarizing the estimated consequences for the Region, including consideration of the numbers of airframes required to be monitored.

5.47 RASMAG/8 had commenced work in this regard, identifying six Long Term Height Monitoring (LTHM) Actions which had subsequently been circulated by ICAO State Letter (Ref: T3/10.1.17 – AP018/08 ATM) during January 2008. Regrettably, as a result of high workloads on all the RMAs and the Regional Office, work had stalled in respect to the formulation of a regional impact statement. The meeting agreed that APANPIRG/19 in September 2008 should be informed about the 6 LTHM Actions agreed by RASMAG/8 and that RASMAG was still attempting to progress work in this respect.

5.48 The meeting also agreed that the Asia/Pacific RMAs should form a small team to focus attention on the preparation of the regional impact statement, with the objective of submitting an advanced draft to the RASMAG/10 meeting in December for review. The RASMAG Chairman would act as the Coordinator for this project, assisted by the Secretariat as required.

5.49 Noting that the pending global monitoring provisions would be in the form of an Annex 6 Standard, and therefore the responsibility of States rather than RMAs to implement, the meeting recognised the excellent assistance that RMAs would be able to provide to the respective States associated with each RMA. However, many of the LTHM Actions promulgated by RASMAG/8 had a common focus in attempting to strengthen the coordination relationships between the RMAs and their associated States. The need to include this type of initiative in the RASMAG LTHM Actions arose out of the long experience by RMAs of the coordination difficulties with States. This was again evidenced by the complete lack of response received by Asia/Pacific RMAs to the State Letter containing the RASMAG LTHM actions and continued fundamental problems with States providing timely and accurate safety data for use by RMAs in regional safety assessments –as required by a number of related APANPIRG Conclusions. The meeting agreed that effective coordination arrangements between States and RMAs was a very critical first step and drafted the following Conclusion for consideration by APANPIRG/19:

Draft Conclusion RASMAG 9/2 – Enhanced communications between States and RVSM RMAs

That, noting the pending Annex 6 provisions for the global long term monitoring of airframes used for RVSM operations and the critical role of Asia/Pacific RVSM Regional Monitoring Agencies (RMAs) in monitoring the safety of RVSM operations, the Regional Office draw the attention of States to the Long Term Height Monitoring Actions promulgated by RASMAG. In particular, States are encouraged to immediately strengthen relationships with their respective RMAs to ensure that information in relation to RVSM approval status is continuously available to RMAs.

Correlation between ATC-to-ATC coordination errors and automated messaging

5.50 Previous RASMAG meetings had continually noted that the category of LHD that contributes the most to the operational risk estimates are errors in transfer of control from one ATC unit to the adjacent ATC unit (Category E). Globally, regions with collision risk estimates that exceed the TLS have cited Category "E" events as the largest contributor to the risk estimate.

5.51 The United States presented research conducted into this issue in terms of operations in the Oakland and Anchorage airspace, where the implementation of automated messaging capability between ATC systems meant that in many instances flight data was automatically transferred between facilities, rather than by voice coordination between Controllers.

5.52 Due to a lack of historical data prior to the implementation of automated messaging including AIDC in some airspaces, it was not possible to compare the number of Category E errors before and after implementation. However, it was possible to examine the number of Category E events which have occurred over the past two years in Oakland and Anchorage airspace and determine if automatic transfers were available at the time of each of the events.

5.53 The majority of the transfers between Oakland and Anchorage and adjacent facilities are supported by an automated interface. However, an examination of quality assurance data from Oakland and Anchorage from April 2006 through April 2008 showed that there were nine Category E events recorded. In eight of these cases, automated transfer of control was not implemented for use in these circumstances. In the one case where the automatic transfer was implemented the controller failed to enter a change to the flight level in the automation system prior to the aircraft being transferred to the adjacent facility.

5.54 Additionally, data from Oakland Center showed that there were five instances where errors occurred which could have lead to Category E events had the receiving controller not contacted the transferring controller to confirm the altitude of the aircraft prior to the aircraft entering their airspace. In all of these events automatic transfer was not implemented and the fact that an LHD did not occur was prevented only by the receiving controller questioning the aircrafts altitude.

5.55 Noting the lack of reported Category E errors whilst automated data transfer was available compared to the occurrences of Category E errors when the automated systems were not implemented, the meeting considered that the majority of the Category E events described above were likely to have been prevented had automated transfer of control system been in use. The meeting noted that if AIDC capabilities were implemented between all FIRs in the Asia/Pacific region, this would have an immediate positive benefit in terms of reduced ATC-to-ATC coordination errors and strongly encouraged States to consider accelerating AIDC implementation planning in order to achieve the direct safety benefits that would result.

ATC to ATC coordination errors affecting Brisbane and Melbourne FIRs

5.56 The AAMA pointed to the work of PARMO and the United States in progressing research on ATC to ATC coordination errors and that Australia had likewise sought to assess the effect of the implementation of AIDC messaging on this error rate. These LHDs are classified by Asia/Pacific RMAs as Category E (i.e. resulting from human factors issues) or Category F (i.e. resulting from equipment outage or technical issues).

5.57 Australia considered these matters to be important, given the large number of Category E and F LHDs that were being reported in relation to coordination being conducted across FIR boundaries with States neighbouring Australia. Australia was also interested in clarifying whether the implementation of AIDC between Australia and some neighbouring ANSPs had led to a reduction in the numbers of coordination related LHDs being reported.

5.58 To facilitate this work, the AAMA produced the chart shown at **Appendix M**, which depicts the general location of Category E and Category F LHD reports for the 12 month period from 1 May 2007 – 30 April 2008. Risk bearing Category E incidents relative to the Australian FIRs are coded in red; non-risk bearing incidents are coded in yellow; and non-risk bearing Category F incidents are coded green. There were no risks bearing Category F incidents identified in the 12 months sample.

5.59 The data shows that ATC coordination errors are much more prevalent along those FIR boundaries where AIDC messaging is not available. Many of these reports concerned situations where aircraft reported at or inside the FIR boundary at levels different to that coordinated. A number of the non-risk bearing reports concerned situations where the coordination was late, in other words was not completed in the time defined in letters of agreement, or where the error was identified by Australian controllers prior to the aircraft crossing the boundary.

5.60 Of interest is the number of reports along the eastern boundary between Australia and the Nandi and Auckland Oceanic FIRs where AIDC is available. Of the Category E errors identified here, the majority were instances where the AIDC was working satisfactorily but the data in the message was incorrect. Two of the reports concerned instances where voice coordination was used as a result of AIDC not being available, and the voice coordination information was incorrect. Of the Category F errors identified, all were the result of degradation in the AIDC messaging due to technical reasons.

5.61 The cluster of Category F reports on the north-eastern boundary between Brisbane/Honiara and Nauru FIRs are the result of coordination not able to be completed effectively due to a failure of communications between Brisbane Centre and Nauru FIS. This is a common occurrence due to technical issues in Nauru and is currently the focus of technical effort to provide some resolution.

5.62 The meeting was informed that Australia continues to monitor the number and severity of coordination errors occurring at FIR boundaries and considers that additional implementations of AIDC should resolve some of the issues identified above.

Use of ADS-B data for monitoring Altimetry System Error (ASE)

5.63 ASE is a measure of the height-keeping performance of an aircraft. In airspace where RVSM is applied, the importance of accurate aircraft height-keeping is magnified. ASE is not detectible in routine operations; specialized measurement equipment is necessary to independently measure the errors. The United States provided information in relation to the progress in attempts to use the aircraft geometric height data obtained from Automatic Dependent Surveillance – Broadcast (ADS-B) messages as one method of monitoring RVSM height keeping performance.

5.64 In preparation for the implementation of the RVSM, the FAA developed a process to determine Total Vertical Error (TVE), ASE and Assigned Altitude Deviation (AAD). Figure 8 provides an illustration of the relationship between these errors. One method of estimation uses a portable device, called the Enhanced GPS-based monitoring unit (EGMU) which is placed on board an aircraft; it collects GPS pseudo-ranges through the aft windows on the flight deck. These data are then differentially corrected to improve their accuracy and aircraft position is estimated, which results in aircraft geometric height data. The corrected geometric height information is compared to the geometric height of the flight level flown by the aircraft, with the latter obtained using global meteorological model data. The EGMU also collects Mode C returns for the flight with its Altitude Recorder Device (ARD) component, producing data used to estimate AAD. All three of these data sources are then combined in a process which estimates TVE and ASE.

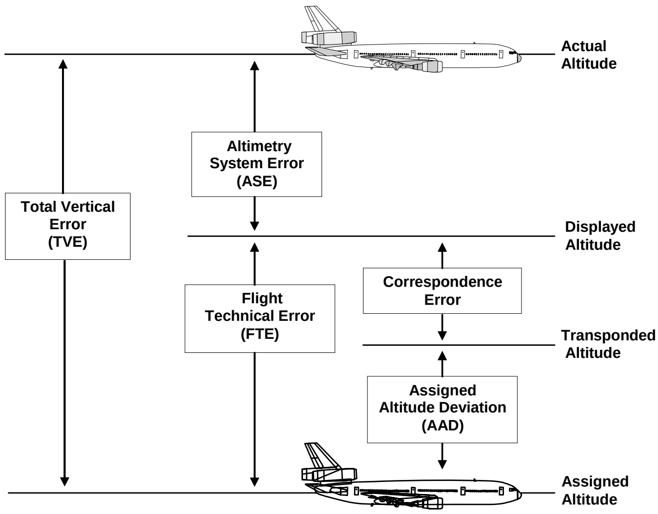

Figure 8. Components of Total Vertical Error (TVE)

5.65 An ADS-B-equipped aircraft uses an on-board GPS receiver to determine its position. This time-stamped information is then broadcast along with other information to all ADS-B capable aircraft and to ADS-B ground or satellite communications stations. These stations then forward the information to air traffic control centers. The ADS-B message includes aircraft geometric height and pressure altitude in reference to a standard atmosphere, which are key components in the ASE estimation

5.66 However, the GPS-derived geometric height contained in the ADS-B message is not differentially corrected and it is not possible to post-process these geometric heights because the information needed to correct the errors is not included in the ADS-B messages. Therefore, the underlying issue is whether the uncorrected GPS geometric height contained in the ADS-B message is sufficiently accurate to support aircraft height monitoring.

5.67 The FAA Technical Center has a fleet of research aircraft that are used for conducting tests and evaluations of avionics systems and some testing of ADS-B message data has been completed, with encouraging results. Over the next few months, several test flights will be conducted, modifying the aircraft and ground monitoring systems to accommodate high altitude testing. The test flights will provide the data needed to compare the aircraft ASE resulting from three independent sources; EGMU, ADS-B, and an independent onboard-GPS system. The geometric heights provided by the EGMU and the independent onboard-GPS system will be corrected for position errors. Further testing may be required depending on the comparison results. Once the planned tests are completed, it should be possible to compare the FAA's estimation of ASE resulting from ADS-B message data to other methodologies.

Deficiencies List

5.68 The meeting recalled that APANPIRG/18 had raised the following Conclusion:

Conclusion 18/2 – Non-Provision of Safety-Related Data by States

That, as a result of the non-provision of safety related data to approved regional safety monitoring agencies as required by APANPIRG Conclusion 16/4, Fiji, Lao PDR, Myanmar, Papua New Guinea and Tahiti be included in the APANPIRG List of Deficiencies in the ATM/AIS/SAR Fields in accordance with APANPIRG Conclusion 16/6.

5.69 In reviewing this situation, the meeting was pleased to note that Fiji, Lao PDR and Tahiti had provided appropriate TSD for December 2007 and had established a reliable record of providing the monthly LHD reports, including 'NIL' reports, to Asia/Pacific RMAs as required by APANPIRG Conclusion 16/4. Accordingly, RASMAG/9 recommends to APANPIRG/19 that Fiji, Lao PDR and Tahiti be removed from the APANPIRG list of deficiencies in the ATM/AIS/SAR fields.

5.70 Regrettably, the meeting noted that there was no change in the circumstances for Myanmar, and recommended retention on the deficiency list. Australia was working closely with Papua New Guinea, as highlighted previously in this report, and it was anticipated that the safety data problems would be overcome as a result of this relationship. Unfortunately, data provision from Bangladesh, Philippines and Sri Lanka had ceased recently. RMAs and the Regional Office would attempt to follow up to obtain the required data however, in the absence of improvement, RASMAG would be obliged to recommend to APANPIRG in 2009 that these States be included on the list.

Agenda Item 6: Review and update RASMAG Task List

6.1 In reviewing the RASMAG task list, the meeting was informed about the status of items considered complete and suitable for closure as well as those remaining open, noting the progress that had been made. The meeting agreed that the updated task list included as **Appendix N** accurately reflected the work programme of RASMAG.

Agenda Item 7: Any other business

Global Aviation Safety Plan (GASP)

7.1 The meeting reviewed information on the recent development of the ICAO Global Aviation Safety Plan (GASP) that provides a common frame of reference for all stakeholders in order to allow a more proactive approach to aviation safety and to help coordinate as well as to guide safety policies and initiatives worldwide in order to reduce the accident risk for civil aviation.

7.2 The meeting noted that the GASP was finalized on the basis of the Global Aviation Safety Roadmap developed by the Industry Safety Strategy Group and that it includes twelve Global Safety Initiatives (GSIs – **Appendix O** refers) which support the implementation of the ICAO Safety Strategic Objective. Each initiative relies on a set of best practices, metrics and maturity levels defined in the Global Aviation Safety Roadmap to ensure that implementation makes full use of the collective experience of the aviation community and that progress is measured in a transparent and consistent way. The GASP follows an approach and philosophy which is consistent with the Global Air Navigation Plan (Doc 9750) and calls for a collaborative approach in the formulation of an action plan that defines, at the regional, sub-regional or national level, the specific activities that should take place in order to improve safety. The meeting agreed that States should routinely incorporate the GASP principles, objectives and methodologies in future activities.

Monitoring FANS 1/A Performance against Oceanic SPR

7.3 ICAO Annex 11 requires that data link performance is monitored to verify that an acceptable level of safety continues to be met. New data link performance requirements for the application of reduced separation standards, as defined in ICAO Doc444, are contained in the recently published RTCA DO_306/EUROCAE ED-122, Safety and Performance Standard for Air Traffic Datalink Services in Oceanic and Remote Airspace (the Oceanic SPR). These new performance requirements are specified in terms of Required Communications Performance (RCP) and also include surveillance requirements.

7.4 The meeting was provided with a copy of a paper that Airways New Zealand had presented to ISPACG FIT/15 (March 2008) on "Monitoring FANS-1/A Performance against Oceanic SPR Standard". The paper reviews the results of data link performance monitoring against the Oceanic SPR. Some interesting variations in datalink performance between aircraft types, between individual airframes of particular types and between the aircraft of different operators were evident. Analysis of the data emphasizes the importance of end-to-end monitoring of performance by individual airline aircraft types at an ANSP level.

IATA – Lost communications in transition

7.5 IATA drew the attention of the meeting to situations whereby a flight experienced a loss of communications whilst in transition between varying flight level orientation schemes (i.e. imperial to metric and vice versa). While transition generally involves only one flight level option, this is not always the case and transition procedures have been implemented that rely on ATC instructions with regards to new level assignment. In the event of a loss of communications during the transition phase and prior to the issuance of ATC instructions, there may be some confusion as to the required level to be maintained.

7.6 The ICAO PANS-ATM (Doc 4444) indicates that in the event of a loss of communications an aircraft is expected to maintain their last assigned level for either 7 or 20 minutes, depending on the type of surveillance coverage. Thereafter they are expected to continue making level adjustments in accordance with filed flight plan. However, when the aircraft is in the process of transitioning from one table of cruising levels to another, the last assigned level no longer exists.

7.7 The time pressures of the meeting meant that this matter was not discussed, however IATA is of the view that the actions to be taken in the event of a loss of communication should be specified, including the level to maintain or transition to as well as the point at which transition should occur.

Availability of Model ATM Contingency Plan

7.8 On completion of coordination between affected States and the final development of the Indonesia Contingency Plan, the Contingency Plan Finalization Meeting was held at the Head Office of the ATS service provider, PT (Persero) Angkasa Pura II (AP-II) at Jakarta, Indonesia from 25 to 27 April 2007. The meeting reviewed and formally endorsed the Indonesia Contingency Plan, which had been prepared with the assistance of the Regional Office. Since the Plan was too voluminous to be published by Aeronautical Information Publication (AIP), a short summary of the Plan and information that a copy of the Plan could be obtained from the DGCA Indonesia was promulgated by aeronautical information circular (AIC).

7.9 States were urged to take action in accordance with APANPIRG/17 Conclusion 17/11 to adapt the model provided by the Indonesian Contingency Plan for regional use. Copies of the plans can be obtained from the website of the ICAO Asia and Pacific Office at http://www.bangkok.icao.int/ under the 'APAC eDocuments' menu.

Collection of information on wake vortex

7.10 Attention of the meeting was drawn to a State Letter (Ref: AN 13/4-07/67) recently issued by ICAO Headquarters in regard to ICAO's efforts to collect and analyse data concerning wake vortex encounters of all aircraft types on a worldwide basis.

7.11 The meeting was informed that the A380 Wake Vortex Steering Group had been created as a result of wake turbulence concerns regarding the Airbus A380-800 entering into service. The Steering Group considered that an overall review of wake turbulence provisions including the current wake turbulence categorization scheme in the *Procedures for Air Navigation Services – Air Traffic Management* (PANS – ATM, Doc 4444) should be undertaken.

7.12 In order to provide a sound basis for any necessary amendment to these Doc 4444 provisions, the Steering Group had developed reporting forms for the collection and analysis of information on wake vortex encounters of all aircraft types on a worldwide basis. States were requested to commence the wake vortex reporting scheme as soon as practicable by making available the template reporting forms A and B provided in the State Letter to pilots, aircraft operators and air navigation service providers. Reports should be submitted to the Regulator of the State of Occurrence and could also be filed through E-mail to wakevortex@icao.int.

Agenda Item 8: Date and venue of the next RASMAG meeting

8.1 The meeting considered that many benefits had resulted from the combined Asia/Pacific RMAs technical meeting that had been held as the first day of this meeting and agreed to continue with this format indefinitely. In particular, the next meeting would use the opportunity presented by the combined RMAs Technical meeting to finalise the draft Regional Impact Statement for long term monitoring.

8.2 The meeting acknowledged the value of the RMA technical meeting being the first day of each RASMAG meeting, specifically as this meeting during RASMAG/9, had enabled Asia/Pacific RMAs to deal with a range of issues face to face. The meeting agreed that RASMAG/10 would be held from 15-19 December 2008, at the Regional Office premises. The Secretariat would make appropriate arrangements and issue meeting invitations in due course that noted that the first day was reserved for the combined RMAs technical meeting.

9. Closing of the meeting

9.1 The Chairman, Mr. Butcher, thanked the meeting participants for their diligent efforts during what had been a busy meeting in terms of the numbers and breadth of issues discussed and resolved. He commended the continuing excellent work of the RMAs and recognized that RASMAG has been happy to recommend to APANPIRG that the China RMA be approved as an Asia/Pacific RVSM RMA with responsibility for the Chinese sovereign airspace.

9.2 The Chairman commented on the significant and detailed work undertaken by Singapore in developing the safety assessment for the 50/50 implementation in the South China Sea and, on behalf of the meeting, supported their continued work towards establishing the SEASMA. He also noted that the meeting had seen a number of RASMAG developed documents and guidance material progressed further towards finalization and/or update and identified the good work specifically undertaken by Mr. Farmer of the New Zealand CAA. Again, the Chairman thanked the meeting for their valued input and hard work in what had been a very fruitful meeting.

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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	2	Review of the 33rd Meeting of the RVSM Implementation Task Force	Secretariat
WP/3	5	Summary of the First and the Second Meetings of Asia/Pacific Performance Based Navigation Task Force	Secretariat
WP/4	4	Review of RASMAG List of Competent Airspace Safety Monitoring Organizations	Secretariat
WP/5	5	Long Term Height Monitoring Actions	Secretariat
WP/6	6	Review of RASMAG Task List	Secretariat
WP/7	5	Summary of the Second Meeting of South-East Asia Required Navigation Performance Implementation Task Force (RNP-SEA/TF/2)	Singapore
WP/8	5	Assisting Singapore to be established as a Safety Monitoring Agency and Conduct of Safety Assessment for the Implementation of RNP10 Operations on L642 and M771	Singapore
WP/9	5	Summary of RVSM Airspace Safety Assessment for the Fukuoka FIR	JCAB RMA
WP/10	4	Amendments to the Guidance Material for the Asia/Pacific Region for ADS/CPDLC/AIDC Ground Systems Procurement and Implementation	New Zealand
WP/11	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/12	5	Review of APANPIRG Conclusion 16/19	Secretariat
WP/13	5	RASMAG Terms of Reference	Secretariat
WP/14	5	Assessment of the Safety of Implementing 50-NM Lateral and Longitudinal Separation Standards on RNAV Routes L642 and M771	Singapore
WP/15	3	Post-RVSM Implementation Risk Assessment for the Sovereign Chinese Airspace	China
WP/16	3	Application for the Establishment of China as APANPIRG RMA for the Chinese Sovereign Airspace	China
WP/17	5	Safety Monitoring Report from the Pacific Approvals Registry and Monitoring Organization, May 2007 – April 2008	United States
WP/18	3	Safety Assessment of RVSM within the Brisbane and Melbourne Flight Information Regions	Australia

NUMBER	AGENDA	TITLE	PRESENTED BY
WP/19	5	Provision of Regional Monitoring Agency Services for Jakarta and Ujung Flight Information Regions	Australia AAMA
WP/20	5	Categorisation of Large Height Deviation	IATA
WP/21	3	China RMA's Concern on the Establishment of Procedures used in the Verification of the Method for Reich Collision Risk Model Parameter Estimate	China RMA
WP/22	5	Safety Assessment of RVSM within the Port Moresby Flight Information Region	Australia
WP/23	5	Summary of the Airspace Safety Review for the RVSM Implementation in Asia Region	MAAR
WP/24	4	Safety Monitoring Agency Handbook	SMAHRT
WP/25	5	An Investigation into the Correlation between ATC-ATC Coordination Errors and the Presence of Automated Transfer of Flight Data Capability in Oakland and Anchorage Airspace	United States

INFORMATION PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
IP/1	-	List of Working Papers (WPs) and Information Papers (IPs)	Secretariat
IP/2	7	Availability of Model ATM Contingency Plan	Secretariat
IP/3	7	The ICAO Global Aviation Safety Plan (GASP)	Secretariat
IP/4	5	Monitoring FANS-1/A Performance against Oceanic SPR Standard	New Zealand
IP/5	7	Collection of Information on Wake Vortex	Secretariat
IP/6	2	The Fourth Meeting of the Western Pacific/South China Sea RVSM Scrutiny Group	Secretariat
IP/7	5	Examination of Operations Conducted on RNAV Routes L642 and M771	CSSI on behalf of Singapore
IP/8	5	Outcome of FAA Technical Center Review of Scrutiny and Safety Assessments conducted to support the Post-Implementation of the Reduced Vertical Separation Minimum in Sovereign Chinese Airspace	United States
IP/9	5	Safety Monitoring Agency Activities conducted by the Pacific Approvals Registry and Monitoring Organization (PARMO)	United States
IP/10	5	Investigation into the Use of Automatic Dependent Surveillance-Broadcast Data for Monitoring Aircraft Altimetry System Error	United States
IP/11	5	ATC to ATC Coordination Errors relative to the Brisbane and Melbourne Flight Information Regions	Australia

NUMBER	AGENDA	TITLE	PRESENTED BY
IP/12	5	Loss of Communications	IATA
IP/13	5	Report of the Global RMA Meeting Montreal, Canada, 13-15 May 2008	Australia
IP/14	5	Progress in Establishing the Singapore Safety Monitoring Agency	Singapore

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Appendix C to the Report of RASMAG/9

Status of RVSM Regional Monitoring Agency Activity & Outcomes of Global RMAs meeting 13-15 May 08

22 May 2008

RVSM Regional Monitoring Agency (RMA)

- Purpose
- RMA Responsibilities
- Current RMAs
- Special Coordination Meeting 13-15 May 08
  - Agenda
  - Discussions/Problems
  - Agreements/Recommendations
- Target Level of Safety

CSSI, INC.

Purpose of an RVSM RMA

- Contribute to the safe implementation of the Reduced Vertical Separation Minimum (RVSM) and the continued safe use of the RVSM

RMA Responsibilities

- Ref: Draft RMA Manual
  - Establish and maintain a database of RVSM approvals
  - Monitor aircraft height-keeping performance and the occurrence of large height deviations, and report results appropriately
  - Conduct safety and readiness assessments and report results appropriately
  - Monitor operator compliance with State approval requirements after RVSM implementation
  - Initiate necessary remedial actions if RVSM requirements are not met
- Detailed description of RMA responsibilities can be found in the ***Manual on Implementation of a 300 m (1 000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive* (Doc 9574) Second Edition 2002**

RMAs

- RMAs currently operating
  - Australian Airspace Monitoring Agency (AAMA)
  - Africa-Indian Ocean Regional Monitoring Agency (ARMA)
  - Caribbean-South American Monitoring Agency (CARSAMMA)
  - China RMA
  - North Atlantic Central Monitoring Agency (NAT CMA)
  - EUR RMA
  - Japanese Civil Aviation Bureau (JCAB) RMA
  - Monitoring Agency for Asia Region (MAAR)
  - Middle East (MID) RMA
  - Pacific/North American Approvals Registry and Monitoring Organization (PARMO/NAARMO)
  - South Atlantic Monitoring Agency (SATMA)
- All participated in Special Coordination Meeting 13-15 May 08

Special Coordination Meeting 13-15 May 08

- Agenda
  1. Purpose & Objectives of meeting and draft agenda
  2. Introduction of participating RMAs, status of their regional activities
  3. Safety assessment methodologies
  4. Aeroplane monitoring and approval process
  5. Draft RMA manual
  6. Other business.

Special Coordination Meeting 13-15 May 08

- Discussion Highlights
  - Value of discussions with other RMAs
    - Safety Assessment Methodology
    - Collision Risk Model Parameters
    - Data sharing
    - Operational contributions to risk
    - Remedial actions
  - RMA Manual significant changes
    - Removal of Minimum Monitoring Requirements
    - Addition of large height deviation (LHD) and Scrutiny Group information
  - Update process for Minimum Monitoring Requirements
  - Update process for RMA Manual
  - RMA Manual valuable for States to understand and support RMA responsibilities

Special Coordination Meeting 13-15 May 08

- Discussion Highlights
  - Most significant contribution to risk is operational errors or large height deviations (LHDs)
  - Most common reason for LHDs across all RMAs:
    - ATC-ATC coordination
    - Pilot deviations (EUR)
  - Common problems in operating an RMA
    - State support and participation
      - Supplying traffic data
      - LHD reporting
      - Subject Matter Expert availability (ATC, Pilot, Airworthiness)

Special Coordination Meeting 13-15 May 08

- Agreements/Recommendations
  - Use RMA knowledge sharing network (KSN) web site for coordination and collaboration
  - Complete draft of RMA Manual by Oct 08
  - Publish RMA Manual by Feb 09
  - Establish annual All RMA Meeting
    - First meeting May 09
    - Hosted by an RMA TBD
  - Separation and Airspace Safety Panel (SASP) review RMA work

Target Level of Safety (TLS)

- ICAO developed ***quantitative*** safety metric
- Expressed in terms of ***fatal accidents per flight hour***
- Adopted by Regional Planning Groups
- RMAs estimate safety risk against TLS using ICAO methodology
- All RVSM implementations have taken place with estimates of safety risk that were lower than the TLS
- Post-implementation ***estimates of risk*** in some regions have exceeded TLS
- Risk estimates against TLS drive all important ***remedial actions*** to reduce safety risk

- An estimate of risk expressed in fatal accidents per flight hour is **not** a measurement of actual safety

Global RMAs Meeting - Draft Agenda

(as proposed during first Global RMAs meeting, 15-17 May 2008, Montreal, Canada)

1. Review of Data Exchange Activity
2. Data Exchange Issues
3. Safety Assessment Issues
    a. Technical Risk and Airworthiness Issues
        i. Examination of Aircraft Group Height-Keeping Performance (as measured by monitoring data)
        ii. Minimum Monitoring Requirements
            1. Aircraft Category Changes
            2. Aircraft Group Changes
            3. New Aircraft Type Category and Group Determination
        iii. Remedial and Mitigation Action
    b. Operational Risk Issues
        i. Review of Regional Scrutiny Group Findings
        ii. Event (errors and deviations) Trends
        iii. Remedial and Mitigation Action
4. Proposed Revisions to RMA Manual
5. Other Coordination and Harmonization Issues
6. Other Business and RMA Best Practices “Round Table”

6.2 The meeting agreed to add Future Monitoring Systems to the agenda.

6.3 The meeting agreed that a periodic all-RMA meeting was valuable in accomplishing the following:

1. Improve RMA-RMA coordination for:
    a. Exchange approval data and information
    b. Collision risk model parameter values and distribution data
    c. State authority action and follow-up
    d. ATC provider, State authority, manufacturer and design organization action and follow-up
2. Address aircraft operator and international organization calls for harmonization
3. Maintaining minimum monitoring requirements and RMA Manual
4. Providing discipline for action item follow-up and agreed procedures

6.4 The meeting also made the following recommendations concerning the periodic RMA meeting:

1. Conducted annually
2. 4-5 days in length
3. Hosted by an RMA
4. First meeting conducted May 2009 (host to be determined)
5. Outcomes reviewed by SASP PT2

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

	Annex11-Air Traffic Services			
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	States shall establish a safety program, in order to achieve an acceptable level of safety in the provision of ATS.		ATMB, CAAC as the civil aviation authority of China providing ATS for the sovereign Chinese airspace, has established a safety program to ensure the operational safety of the whole Chinese airspace. In addition, China has taken steps to strengthen the safety assessment and monitoring capability as part of the safety program.	Annex11- Air Traffic Services Chapter 2, paragraph 2.27.1
Mandatory	For all airspace where a reduced vertical separation minimum of 300 m (1000 ft) is applied between FL 290 and FL 410 inclusive, a program shall be instituted, on a regional basis, for monitoring the height-keeping performance of aircraft operating at these levels, in order to ensure that the implementation and continued application of this vertical separation minimum meets the safety objectives. The coverage of the height-monitoring facilities provided under this program shall be adequate to permit monitoring of the relevant aircraft types of all operators that operate in RVSM airspace.	The number of separate monitoring programs should be restricted to the minimum necessary to effectively provide the required services for the region.	China RMA expects to be authorized by APANPIRG as an official RMA to provide RVSM safety assessment and monitoring services of the sovereign Chinese airspace. China RMA will conduct Height-Keeping Performance (HKP) monitoring by using EGMUs imported from FAA. In addition, noting the pending provisions in Annex 6 for global height monitoring effective from 2010, China started to research the feasibility and the solution	Annex11- Air Traffic Services Chapter3, paragraph 3.3.5.1

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

	Annex11-Air Traffic Services			
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
			of using ground-based monitoring units. The monitoring capability of China will become stronger in the future.	
Mandatory	Arrangements shall be put in place, through interregional agreement, for the sharing between regions of data from monitoring programs.	Guidance material relating to vertical separation and monitoring of height-keeping performance is contained in the Manual on Implementation of a 300 m (1000 ft) Vertical Separation Minimum Between FL 290 and FL 410 Inclusive (Doc 9574).	China RMA has already commenced and will continue sharing the relevant information (including TSD, large height deviation (LHD), aircraft approval data and so on) with Monitoring Agency for Asia Region (MAAR), and Pacific Airspace Registry and Monitoring Organization (PARMO). China RMA established the effective connection with other ICAO RMAs during the global special coordination meeting of RMAs in Montreal during May 2008. Our data will continue to be shared with them in future.	Annex11- Air Traffic Services Chapter3, paragraph 3.3.5.2

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	Establish a database of aircraft approved by the respective State authorities for operations at RVSM levels in that region.		Database has been established by the technical group of CAAC and will be continually maintained.	ICAO RVSM Manual (Doc 9574) paragraph 6.4.4
Mandatory	RMAs in regions that have previously established databases share approvals and height -monitoring data among each other.		Database information is in similar format to that used by MAAR and PARMO, and information was shared with other RMAs when China participated in the global RMA special meeting (May 2008). China is going to provide height-monitoring service and the data will be shared in China RMA website.	Doc 9574 paragraph 6.4.4

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	a) Receive reports of height deviations of non-compliant aircraft which are of a magnitude equal to or greater than the following criteria.	1) TVE – 90m (300ft); 2) ASE – 75m (245ft);and 3) ADD – 90m (300ft).	1) China RMA conducted test flight to obtain the height deviation information by using EGMU for detection of technical errors. 2) China has started the research of the feasibility and the solution of using ground-based monitoring units. 3) China RMA has established an effective mechanism to ensure the reporting of LHD by air traffic controllers since May, 2007. LHD reporting requirements are published in the AIP.	Doc 9574 paragraph 6.4.5
Mandatory	b) Take necessary action with the relevant State and operator to:	1) Determine the likely cause of the height deviation. 2) Verify the approval status of the relevant operator.	1) China RMA contacts the controllers in the area control centers to check the detail of LHD report information. 2) China RMA investigates the details of the events to determine the likely cause of the height deviation and contact relevant operator if necessary. 3) For the deviation information reported from monitoring result, China RMA will investigate all causes of height-keeping	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
			performance data to determine the likely cause of the height deviation. She will also contact the responsible CAA and verify the approval status of the relevant operators by checking databases.	
Mandatory	c) Recommend, wherever possible, remedial action.		China RMA develops recommendations for remedial action wherever necessary. China RMA keeps close contact with ATMB and will report deviation information and recommendations regularly. ATMB will make suggestions for these events and take proper actions	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	d) Analyze data to detect height deviation trends and, hence, to take action as in c).		China RMA has purchased post flight data processing software and completed the training. Currently, China RMA has demonstrated her ability to detect height-keeping trends and analyze monitoring data by successfully completed the data processing for test flights. China RMA will develop recommendations for remedial action wherever necessary. China RMA is going to provide aircraft height-keeping performance monitoring service this year.	Doc 9574 paragraph 6.4.5
Mandatory	e) Undertake such data collections as required by the RPG to;	1) investigate height-keeping performance of the aircraft in the core of the distribution.	The FAA has provided training to the ATMB to investigate height-keeping performance of the aircraft in the core of the distribution. ATMB purchased two sets of EGMU from CSSI and had a comprehensive training. ATMB has been capable of the investigation. ATMB also plans to establish ground-based monitoring facilities in the near future.	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
		2) establish or add to a database on the height-keeping performance of: -the aircraft population; -aircraft types or categories; and -individual airframes;	China RMA has demonstrated her ability in the test flight and the post-flight data processing. The results turned out to be satisfied after comparison with the ones given by the CSSI. Engineer and FAA experts. China is going to provide the height-monitoring service this year and the monitoring results will be added to the database.	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	f) Monitor the level of risk of collision as a con-sequence of operational errors and in-flight contingencies as follows;	1) Establish a mechanism for collation and analysis of all reports of height deviations of 90m (300ft) or more resulting from the above errors/actions. 2) Determine, wherever possible, the root cause of each deviation together with its size and duration. 3) Calculate the frequency of occurrence. 4) Assess the overall risk (technical combined with operational and in-flight contingencies)in the system against the overall safety objectives 5) Initiate remedial action as required.	1) China RMA has established LHD reporting procedures in the AIP. 2) China RMA established LHD data collection mechanism and received LHD reports due to all causes. 3) China RMA also investigated State database of air safety incident reports and voluntary reporting safety database as the event resources and conducted safety risk analysis using collected LHD reports and traffic sample data in accordance with international methodologies adopted by global RMAs and as required by RASMAG. 4) China RMA consulted MAAR and PARMO for CRM parameter estimate in the complicated ATC condition of China domestic airspace.	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	g) Institute checks on the “approval status” of aircraft operating in the relevant RVSM air-space, identify non-approved operators and aircraft using RVSM airspace and notify the appropriate State of Registry/State of the Operator accordingly;		1) China RMA has a database of aircraft approved by CAAC for operations at RVSM levels, and maintains the data by regularly sharing with other RMAs. 2) China RMA established effective mechanism for TSD collection. From these data, China RMA extracted the listing of operators, the aircraft type, registration marks and the number of operations of aircraft operating in the airspace. China RMA compared these data to approval database to check the approval status of the aircraft and identify non-approved operators and aircraft. For violations, China RMA will notify the appropriate State of Registry/State of the Operator according to the POC database.	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

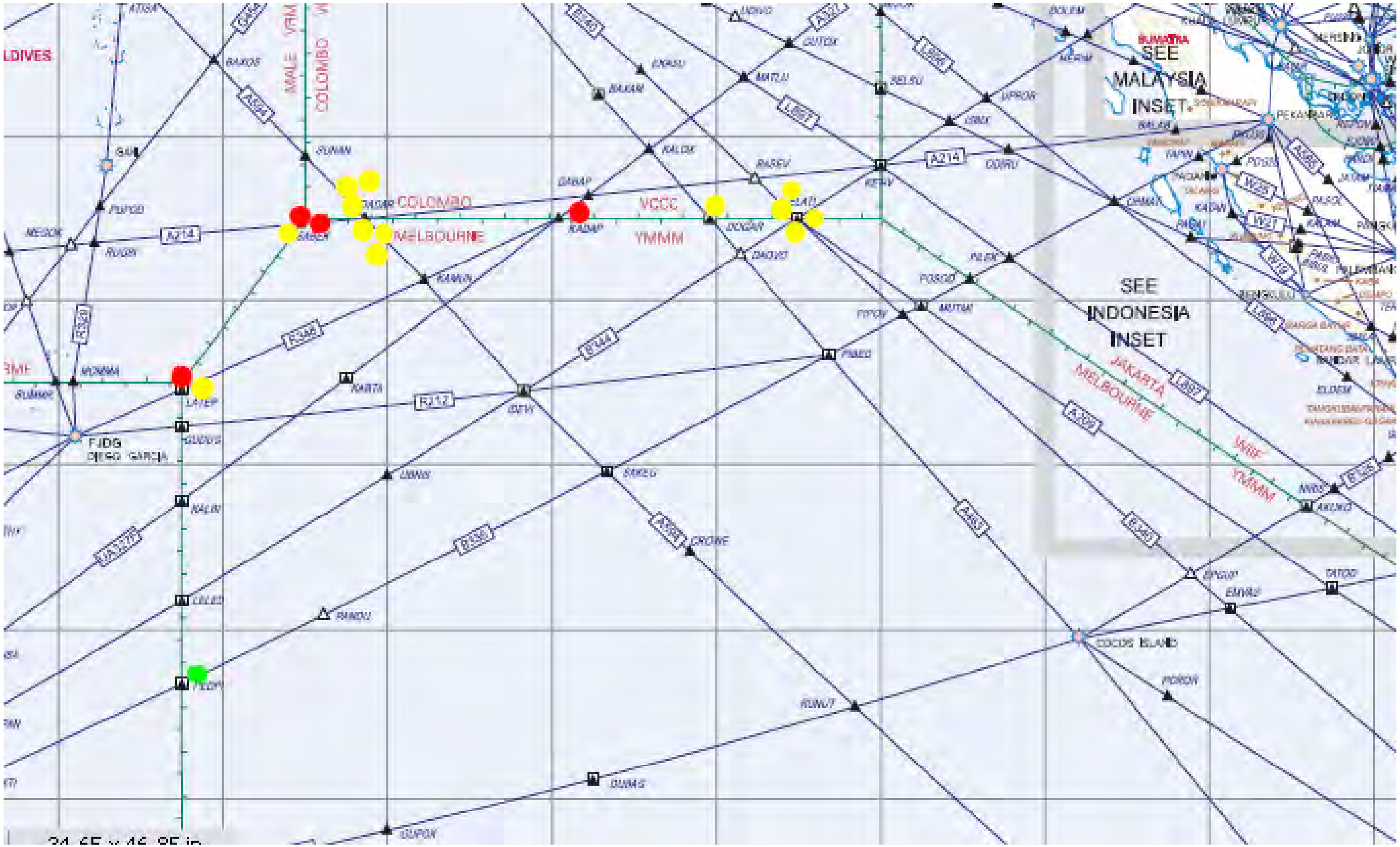
RVSM Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	h) Circulate regular reports on all height-keeping deviations, together with such graphs and tables necessary to relate the estimated sys-tem risk to the TLS.		1) China RMA is a member of RASMAG and provides this information routinely to RASMAG meetings in respect of sovereign Chinese airspace. 2) China RMA will follow the outcome of coordination among the Asia/ Pacific RMAs.	Doc 9574 paragraph 6.4.5
Mandatory	i) Submit annual reports to the RPG.		China RMA has presented three airspace safety assessment reports to ICAO through RVSM Task Force and RASMAG, since the first assessment in July, 2007 under guidance from MAAR and PARMO, and will continue to report as part of the regional process established by RASMAG.	Doc 9574 paragraph 6.4.5

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RMA Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	An RMA must have both the authority and technical competence to carry out its functions.	a) the organization must receive authority to act as an RMA as the result of a decision by a State, a group of States or a planning and implementation regional group (PIRG)	1) China RMA has received the authorization from CAAC in April this year. 2) China RMA submitted formal application material to RASMAG/9 for review and approval. 3) It is expected that this application will be recommended to APANPIRG for further admission.	RMA Manual Chapter 1, Paragraph 1.3.1
		b) the organization acting as an RMA has adequate personnel with the technical skills and experience to carry out the functions	1) ATMB, CAAC established RVSM technical group composed of personnel with the technical skills and experience in 2006. 2) ATMB has been working closely with FAA and MAAR which has experts and can provide expertise. 3) ATMB officials have been given trainings as required, and have sufficient knowledge and experience to carry out duties.	RMA Manual Chapter 1, Paragraph 1.3.1

China RMA – Submission for APANPIRG approval as Asia/Pacific RVSM Regional Monitoring Agency

RMA Manual				
Mandatory or Desirable	**Requirements for establishment and operation of an RMA**	**Detail**	**Status**	**Reference**
Mandatory	It is responsibility of the body authorizing establishment of an RMA to ensure that the requirements are met.		China RMA submitted formal application material to RASMAG/9 for review and approval. It is expected that this application will be recommended to APANPIRG for further admission.	RMA Manual Chapter 1, Paragraph 1.3.2
Desirable	The organization intending to be an RMA participates in a training program under the guidance of one of the established RMA's.	For an organization with no prior experience with RVSM monitoring, such a program could take as long as one year and should include both formal and on-the-job training.	1) China RMA has been working closely with FAA and MAAR and has been given several trainings on risk assessment, RMA establishment and monitoring data processing. 2) China RMA has completed three risk assessments for the sovereign Chinese airspace which demonstrates knowledge and capability in the RVSM risk safety assessment. 3) China RMA also gained the ability of conducting Aircraft Height Keeping Performance Monitoring using EGMU equipment.	RMA Manual Chapter 1, Paragraph 1.3.2



MALE
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JAKARTA
MELBOURNE
WIIF
YMMM
FJDG
DIEGO GARCIA
COCOS ISLAND
A214
R212
R348

REGIONAL AIRSPACE SAFETY MONITORING ADVISORY GROUP

ASIA/PACIFIC

SAFETY MONITORING AGENCY

HANDBOOK

VERSION 1.8.3

FOREWORD

The Regional Airspace Safety Monitoring Advisory Group (RASMAG) was established during 2004 by the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to achieve a regional approach for coordination and harmonization of airspace safety monitoring activities, and to provide assistance to States in this respect. The RASMAG 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 had requirements for monitoring other air traffic management (ATM) services, such as reduced horizontal separation based on performance based navigation (PBN), or for monitoring of air traffic services (ATS) data link systems. For RVSM, a handbook with detailed guidance on the requirements for establishing and operating Regional Monitoring Agencies (RMA) had been developed by the ICAO Separation and Airspace Safety Panel (SASP), with the intent that the handbook be applied globally. There was no comparable global document under development by ICAO for the continued safe use of a horizontal-plane separation minimum where PBN is applied.

ICAO provisions require that the implementation of specified reduced separation minima, e.g. 50 NM lateral separation based on PBN RNAV 10, 50 NM longitudinal separation based on PBN RNAV 10 and Direct Pilot Controller Communication (DCPC), and 30 NM lateral and longitudinal separation based on Automatic Dependent Surveillance (ADS), Controller Pilot Data Link Communication (CPDLC) and PBN RNP 4, must first meet safety management system requirements and undergo a safety assessment based on collision risk modelling to confirm that the regionally established target level of safety (TLS) has been met for the airspace. Additionally, periodic safety reviews must be performed in order to permit continued operations. To date, the performance of safety assessments and continued monitoring for reduced horizontal separation minima had been carried out by a few specialized teams made up of technical experts and contractors supporting States within the region.

Under Decision 16/1, APANPIRG had adopted the term Safety Monitoring Agency (SMA) to mean an organization approved by regional agreement to provide airspace safety monitoring and implementation services for international airspace in the Asia/Pacific region for implementation and operation of reduced horizontal separation. The RASMAG agreed that there was a need to develop a handbook aimed at standardizing the principles and practices of such SMAs, in order to ensure the continued safe application of reduced horizontal separation standards in international airspace. Inclusion of the previously independent RNP and RNAV concepts under ICAO's global PBN concept has led to uncertainty amongst States regarding the monitoring requirements for new separation minima implementations where these minima are based on PBN approvals. In anticipation of more widespread use of the PBN RNAV 10 and RNP 4 navigation specifications within the international airspace of the Asia/Pacific Region, this handbook is being provided to identify the monitoring requirements and related SMA duties and responsibilities associated with those navigation specifications and the reduced separation minima which may be implemented based upon compliance with them. It should be noted that, with the exception of 50 NM lateral separation, introduction of the reduced horizontal minima necessitates satisfaction of explicit communications and surveillance requirements as well as the navigation performance requirements.

It is intended that this handbook will introduce a common set of principles and practices for monitoring in connection with reduced horizontal-plane separation minima based on the application of PBN. The handbook will also help to promote an interchange of information among Asia/Pacific States in support of achieving common operational monitoring procedures and of pooling data resulting from application of those procedures.

The Handbook is presented in two parts. Part 1 defines an SMA, describes its functions by means of a list of duties and responsibilities, and identifies the process by which an organization receives credentials as an SMA. Part 2 provides specific guidance to assist an SMA in carrying out the duties and responsibilities presented in Part 1.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

ADS	Automatic dependent surveillance
ANSP	Air navigation service provider
APANPIRG	Asia Pacific Air Navigation Planning and Implementation Regional Group
ATC	Air traffic control
ATM	Air traffic management
ATS	Air traffic services
CPDLC	Controller pilot data link communication
CRM	Collision risk model
FIR	Flight Information Region
FTP	File transfer protocol
ICAO	International Civil Aviation Organization
LLD	Large lateral deviation
LLE	Large longitudinal error
MASPS	Minimum aviation system performance standard
NM	Nautical miles
PBN	Performance-based navigation
RASMAG	Regional Airspace Safety Monitoring Advisory Group of APANPIRG
RMA	Regional Monitoring Agency
RNAV	Area navigation
RNP	Required navigation performance
RVSM	Reduced vertical separation minimum
SASP	Separation and Airspace Safety Panel
SMA	Safety Monitoring Agency.
SSR	Secondary surveillance radar
STC	Supplemental Type Certificate
TLS	Target level of safety

EXPLANATION OF TERMS

Collision risk.
The expected number of mid-air collisions in a prescribed volume of airspace for a specific number of flight hours due to loss of planned separation. (*Note: One collision is considered to produce two accidents.)*

Exclusionary PBN airspace.
Airspace in which flight cannot be planned by civil aircraft which do not hold a valid PBN approval from the appropriate State authority.

Horizontal separation.
The spacing provided between aircraft in the horizontal plane to avoid collision.

Large lateral deviation (LLD).
Any deviation of 15 NM or more to the left or right of the current flight-plan track.

Large longitudinal error (LLE).
Any along-track error of 10 NM or more, or 3 minutes or more, as derived from surveillance data or calculated from the difference between an estimate for a given fix and the actual time of arrival over that fix, as applicable.

Occupancy.
A parameter of the collision risk model which is twice the count of aircraft proximate pairs in a single dimension divided by the total number of aircraft flying the candidate paths in the same time interval.

Operational Approval.
The process of assuring the State authority that an operator meets all the requirements for operating aircraft in airspace where reduced horizontal separation based on PBN been implemented.

Operational risk.
The risk of collision due to operational errors and in-flight emergencies.

Overall risk.
The risk of collision due to all causes, which includes the technical risk and the operational risk.

Passing frequency.
The frequency of events in which the centers of mass of two aircraft are at least as close together as the metallic length of a typical aircraft when traveling in the opposite or same direction on adjacent routes separated by the planned lateral separation at the same flight level.

Target level of safety (TLS).
A generic term representing the level of risk which is considered acceptable in particular circumstances.

Technical Risk
The risk of collision associated with aircraft navigation performance.

PART 1

1 Description of a Safety Monitoring Agency, Its Functions and Establishment

1.1 Description

1.1.1 A safety monitoring agency (SMA) comprises a group of specialists who carry out specific functions to support introduction and continued safe use of horizontal-plane separation minima which are based on the application of PBN navigation specifications and additional requirements adopted by ICAO. These functions are shown in the following set of SMA duties and responsibilities.

1.2 SMA Duties and Responsibilities

1.2.1 The duties and responsibilities of an organization providing airspace monitoring in connection with PBN-based horizontal-plane separation minima are:

1.2.1.1 to establish and maintain a database of aircraft approved by the respective State authorities for PBN operations and other required aircraft capabilities such as data link;

1.2.1.2 to coordinate monitoring of horizontal-plane navigational performance and the identification of large horizontal-plane deviations;

1.2.1.3 to receive reports of large horizontal-plane deviations identified during monitoring; to take the necessary action with the relevant State authority and operator to determine the likely cause of the horizontal-plane deviation and to verify the approval status of the relevant operator;

1.2.1.4 to analyze data to detect horizontal-plane deviation trends and, hence, to take action as in the previous item;

1.2.1.5 to undertake data collections as required by RASMAG to:

a) investigate the navigational performance of the aircraft in the core of the distribution of lateral deviations;

b) establish or add to a database on the lateral navigational performance of:

- the aircraft population
- aircraft types or categories
- individual airframes;

c) examine the forecast accuracy of aircraft-provided times at future required reporting points

1.2.1.6 to archive results of navigational performance monitoring and to conduct scheduled risk assessments in light of agreed regional safety goals;

1.2.1.7 to contribute to a regional database of monitoring results;

1.2.1.8 to initiate necessary remedial actions and coordinate with specialist groups as necessary in the light of monitoring results;

1.2.1.9 to monitor the level of risk as a consequence of operational errors and in-flight contingencies as follows:

a) determine, wherever possible, the root cause of each deviation together with its size and duration;

b) calculate the frequency of occurrence;

c) assess the overall risk in the system against the overall safety objectives; and

d) initiate remedial action as required;

1.2.1.10 to initiate checks of the approval status of aircraft operating in the relevant airspace where PBN is applied, identify non-approved operators and aircraft using the airspace and notify the appropriate State of Registry/State of the Operator accordingly; and

1.2.1.11 to submit reports as required to APANPIRG through RASMAG.

1.3 Process for Establishing an SMA

1.3.1 An organization proposing to offer SMA services must be approved by the APANPIRG. The process for such credentialing consists of technical preparations, endorsement by the RASMAG and, finally, APANPIRG review and approval.

1.3.2 In order to effectively carry out the duties and responsibilities of an SMA, an organisation must be able to demonstrate an acceptable level of competence. Competence may be demonstrated by:

a) previous monitoring experience; or

b) participation in ICAO technical panels or other bodies which develop horizontal separation requirements or criteria for establishing separation minima based on PBN; or

c) establishment of a formal relationship with an organization qualified under (a) or (b).

1.3.3 Once competence has been demonstrated, the SMA should receive a formal endorsement by RASMAG and receive approval from APANPIRG.

1.3.4 Appendix A lists the RASMAG SMAs and the FIRs for which they are responsible.

PART 2

2. Guidance on the Responsibilities and Standardised Practices of Safety Monitoring Agencies

2.1 Purpose of this part

2.1.1 The purpose of this part of the Handbook is to document experience gained by organizations supporting the introduction of PBN-based horizontal-plane separation minima within the Asia and Pacific Region, and elsewhere, in order to assist an SMA in fulfilling its responsibilities. Where necessary to ensure standardized practices among SMAs, detailed guidance is elaborated further in appendices.

2.2 Establishment and Maintenance of a Database of PBN and Other Necessary Approvals

2.2.1 The experience gained through the introduction of RVSM within Asia/Pacific has shown that the concept of utilising monitoring agencies is essential to ensure safety in the region. They have a significant role to play in all aspects of the safety monitoring process. One of the functions of an SMA is to establish a database of operators and aircraft approved by their respective State authorities for PBN operations and, if necessary, for use of data link in the region for which the SMA has responsibility. This information is of vital importance in effectively assessing the risk in the airspace.

2.2.2 Aviation is a global industry; many operators may be approved for PBN operations and their approvals registered with an SMA operating in a region where reduced horizontal separation has been implemented. Thus, there is considerable opportunity for information sharing among SMAs. While a region or sub-region introducing reduced horizontal-plane separation may need its own SMA to act as a focal point for the collection and collation of approvals for aircraft operating solely in that region, it may not need to maintain a complete database of all approved aircraft in the world. It will, however, be required to establish links with other SMAs in order to determine the PBN status of aircraft, so that an assessment of the technical risk can be made.

2.2.3 To avoid duplication by States in registering approvals with SMAs, the concept of a designated SMA for the processing of approval data has been established. Under the designated SMA concept, all States are associated with a specified SMA for the reporting of PBN approvals. Appendix B provides a listing of States and the respective cognizant SMA for PBN approvals. SMAs may contact any State to address safety matters without regard to the designated SMA for approvals.

2.2.4 It is important to note that, in general, the aircraft operating in airspace where implementation of PBN-based separation is planned can be categorized into two classes. Some aircraft operate solely within the airspace targeted for introduction of reduced separation standards (and therefore may not have PBN and other required approval status), and others operate both within that airspace and other portions of airspace requiring PBN and other approvals. It is the responsibility of the SMA supporting introduction of reduced separation to gather State approvals for the former category of aircraft from authorities responsible for issuing those approvals. To do so requires that the SMA establish a communication link with each such State authority and provide a precise description of the approvals information required. Appendix C provides the pertinent forms, with a brief description of their use, that an SMA should supply to a State authority to obtain information on aircraft PBN approval status.

2.2.5 Where possible, the SMA should collect State approvals information for the latter category of aircraft – those already operating in other airspace where reduced horizontal-plane separation minima are applied – from other SMAs. This collection will be facilitated if each SMA maintains, in a similar electronic form, a database of State PBN approvals.

2.2.6 Appendix D contains the minimum database content required and the format in which it should be maintained by an SMA. Appendix D also contains a description of the data to be shared by SMAs and the procedures for sharing.

2.3 Monitoring of Horizontal-Plane Navigation Performance

2.3.1 An SMA must be prepared to collect the information necessary to monitor horizontal-plane navigational performance as part of the risk assessment. It must institute procedures for the collection of information descriptive of large deviations in the horizontal plane and operational errors caused by non-compliance with air traffic control (ATC) instructions or loop errors within the ATC system.

2.3.2 An SMA must enlist the cooperation of States and air navigation service providers (ANSPs) in monitoring horizontal-plane navigational performance through the use of secondary surveillance radar or other appropriate surveillance systems. States and ANSPs have the responsibility to cooperate with the SMA and supply any requested data that will contribute to the evaluation of navigational performance.

Monitoring the Occurrence of Large Lateral Deviations and Large Longitudinal Errors

2.3.3 Experience has shown that large lateral deviations (LLD) (deviations of 15NM or more in magnitude) and large longitudinal errors (LLE) (errors of more than 10 NM or 3 minutes) have had significant influence on the outcome of safety assessments before and after implementation of PBN-based separation in a portion of airspace. Accordingly, a principal duty of an SMA is to ensure the existence of a program to collect this information and assess the importance of such occurrences.

2.3.4 Section 2.6 provides direction to an SMA for taking such remedial actions as may be necessary to resolve systemic problems uncovered by this program.

2.3.5 Within the airspace for which it is responsible, each ANSP will need to establish the means to detect and report the occurrence of large horizontal-plane deviations. Experience has shown that the primary sources for reports of large horizontal-plane deviations are the ATC units providing air traffic control services in the airspace where reduced separation is or will be applied. The surveillance information available to these units – in the form of voice or ADS reports and, where available, surveillance radar or ADS-B returns – provides the basis for identifying large horizontal-plane deviations. A program for identifying large horizontal-plane deviations should be established and ATC units should report such events monthly. A suggested form for these monthly reports is shown in Appendix E. These reports should contain, as a minimum, the following information:

a) Reporting unit

b) Location of deviation, either as latitude/longitude or ATC fix

c) Date and time of large horizontal-plane deviation

d) Sub-portion of airspace, such as established route system, if applicable

e) Flight identification and aircraft type

f) Actual flight level or altitude

g) Horizontal separation being applied

h) Size of deviation

i) Duration of large deviation

j) Cause of deviation

k) Any other traffic in potential conflict during deviation

l) Crew comments when notified of deviation

m) Remarks from ATC unit making report

2.3.6 Other sources for reports of large horizontal-plane deviations should also be explored. An SMA is encouraged to determine if operators within the airspace for which it is responsible are willing to share pertinent summary information from internal safety oversight databases. In addition, an SMA should enquire about access to State databases of safety incident reports which may be pertinent to the airspace. An SMA should also examine voluntary reporting safety databases, where these are available, as possible sources of large horizontal-plane deviations incidents in the airspace for which it is responsible.

2.3.7 While an SMA will be the recipient and archivist for reports of large navigation errors, it is important to note that an SMA alone cannot be expected to conduct all activities associated with a comprehensive program to detect and report large horizontal-plane deviations. Rather, an SMA should enlist the support of RASMAG, the ICAO regional office, appropriate implementation task forces, or any other entity that can assist in the establishment of such a program.

2.4 Conducting Safety Assessments and Reporting Results

Safety Assessment

2.4.1 A safety assessment conducted by an SMA consists of estimating the risk of collision associated with the horizontal-plane separation standard and comparing this risk to the established TLS. Examples of CRMs used in the development of separation minima are included in Appendix H of this document and in the ICAO Doc 9689 *Manual of airspace Planning Methodology for the Determination of Separation Minima*. An SMA will need to acquire an in-depth knowledge of the use of the airspace within which the horizontal-plane separation has been implemented. Experience has shown that such knowledge can be gained through acquisition of charts and other material describing the airspace, and through periodic collection of samples of traffic movements within the airspace.

2.4.2 RASMAG will determine the safety reporting requirements for the SMA.

Establishing the Competence Necessary to Conduct a Safety Assessment

2.4.3 Conducting a safety assessment is a complex task requiring specialized skills which are not practiced widely. As a result, prior to receiving regional approval to operate as an SMA, the organization will need to demonstrate the necessary competence to complete the required tasks.

2.4.4 Ideally, an SMA will have the internal competence to conduct a safety assessment. However, recognizing that personnel with the required skills may not be available internally, an SMA may find it necessary to augment its staff, either through arrangements with another SMA or with an external (i.e. non SMA) organization possessing the necessary competence.

2.4.5 If it is necessary to use an external organization to conduct a safety assessment, an SMA must have the competence to judge that such an assessment is done properly. This competence could be acquired through an arrangement with an SMA which has conducted safety assessments.

2.4.6 An SMA will need to take into account that a safety assessment must reflect the factors which influence collision risk within the airspace where the reduced horizontal-plane separation will be applied. Thus, an SMA will need to establish a method to collect and organize pertinent data and other information descriptive of these airspace factors. As will be noted below, some data sources from other airspace where reduced horizontal-plane separation has been implemented may assist an SMA in conducting a safety assessment. However, an SMA may not use the safety assessment results from another portion of airspace as the sole justification for concluding that the TLS will be met in the airspace where the SMA has safety assessment responsibility.

Assembling a sample of traffic movements from the airspace

2.4.7 Samples of traffic movement data should be collected for the entire airspace where reduced horizontal-plane separation will be implemented. As a result, ANSPs providing services within the airspace are required to cooperate in providing this data.

2.4.8 In planning the timing and duration of a traffic movement data sample, an SMA should take into account the importance of capturing any periods of heavy traffic flow which might result from seasonal or other factors. The duration of any traffic sample should be at least 30 days, with a longer sample period left to the judgment of an SMA. (Note: by agreement, traffic sample data within the Asia-Pacific Region is collected by all States for the month of December each year for purposes of RVSM monitoring. SMAs may wish to arrange for the augmentation of this sample to enable them to acquit their monitoring activity.)

2.4.9 The following information should be collected for each flight in the sample:

a) date of flight

b) flight identification or aircraft call sign, in standard ICAO format

c) aircraft type conducting the flight, as listed in the applicable edition of ICAO Doc 8643, Aircraft Type Designators

d) aircraft registration mark, if available

e) origin aerodrome, as listed in the applicable edition of ICAO Doc 7910, Location Indicators

f) destination aerodrome, as listed in the applicable edition of ICAO Doc 7910, Location Indicators

g) entry point (fix or latitude/longitude) into the airspace

h) time at entry point

i) flight level (and assigned Mach number if available) at entry point

j) exit point from the airspace

k) time at exit point

l) flight level (and assigned Mach number if available) at exit point

m) additional fix/time/flight-level combinations that the SMA judges are necessary to capture the traffic movement characteristics of the airspace

2.4.10 Where possible, in coordinating collection of the sample, an SMA should specify that information be provided in electronic form (for example, in a spreadsheet). Appendix F contains a sample specification for collection of traffic movement data in electronic form, where the entries in the first column may be used as column headings on a spreadsheet template.

2.4.11 Acceptable sources for the information required in a traffic movement sample could include one or more of the following: ATC observations, ATC automation system data, automated air traffic management system data and secondary surveillance radar (SSR) reports.

Agreed Process for Determining Whether the TLS is satisfied as the Result of a Safety Assessment

2.4.12 "Technical risk" is the term used to describe the risk of collision associated with aircraft navigation performance. Some of the factors which contribute to technical risk are:

a) errors in aircraft navigation systems; and

b) aircraft equipment failures resulting in unmitigated deviation from the cleared flight path, including those where not following the required procedures further increased the risk.

2.4.13 The term "operational error" is used to describe any horizontal deviation of an aircraft from the correct flight path as a result of incorrect action by ATC or the flight crew. Examples of such actions are:

a) a flight crew misunderstanding an ATC clearance, resulting in the aircraft operating on a flight path other than that issued in the clearance;

b) ATC issuing a clearance which places an aircraft on a flight path where the required separation from other aircraft cannot be maintained;

c) a coordination failure between ATC units in the transfer of control responsibility for an aircraft, resulting in either no notification of the transfer or in transfer at an unexpected transfer point;

d) weather deviation (Note: these deviations may be instances where the aircraft captain initiates the manouvre using operational authority but without advising ATC, and are not necessarily deemed as being incorrect action).

2.4.14 The TLS which must be satisfied is established by regional agreement and documented in the Regional Supplementary Procedures (Doc 7030). The generic Asia/Pacific TLS is presently established, for each dimension (lateral, longitudinal and vertical), as 5×10^{-9} fatal accidents per flight hour due to loss of planned separation; however, specific TLS values may be determined by ICAO for application of a particular separation minimum.

2.5 Monitoring Operator Compliance with State Approval Requirements

2.5.1 The overall intent of post-implementation SMA activities is to support continued safe use of the reduced horizontal-plane separation. One important post-implementation activity is carrying out periodic checks of the approval status of operators and aircraft using airspace where PBN-based separation is applied. This is vital if reduced separation is applied on an exclusionary basis, that is, if State PBN approval is a prerequisite for use of the airspace. This activity is termed monitoring operator compliance with State approval requirements. RASMAG should consider whether the SMA needs to conduct an annual safety assessment as a means to determine whether the TLS continues to be met.

2.5.2 An SMA will require two sources of information to monitor operator compliance with State approval requirements: a listing of the operators, and the type and registration marks of aircraft conducting operations in the airspace; and the database of State PBN approvals.

2.5.3 Ideally, this compliance monitoring should be done for the entire airspace on a daily basis. Difficulties in accessing traffic movement information may make such daily monitoring impossible. As a minimum, an SMA should conduct compliance monitoring of the complete airspace for at least a 30-day period annually.

2.5.4 When conducting compliance monitoring, the filed PBN approval status shown on the flight plan of each aircraft movement should be compared to the database of State PBN approvals. When a flight plan shows a PBN approval not confirmed in the database, the appropriate State authority should be contacted for clarification of the discrepancy. An SMA should use a letter similar in form to that shown in Appendix G for the official notification.

2.5.5 An SMA should keep in mind that the State authority has the responsibility to take any action should an operator be found to have filed an incorrect declaration of State PBN approval.

2.6 Remedial Actions

2.6.1 Remedial actions are those measures taken to remove causes of systemic problems associated with factors affecting safe use of the PBN-based separation. Remedial actions may be necessary to remove the causes of problems such as the following:

a) failure of an aircraft to comply with PBN requirements

b) aircraft operating practices resulting in large horizontal-plane deviations

c) operational errors.

2.6.2 An SMA should review monitoring results periodically in order to determine if there is evidence of any recurring problems.

2.6.3 As a minimum, an SMA should conduct an annual review of reports of large horizontal-plane deviations with a view toward uncovering systemic problems. Should such a problem be discovered, an SMA should report its findings to the organization overseeing PBN-based separation implementation, or to the RASMAG. An SMA should include in its report the details of large horizontal-plane deviations suggesting the existence of a systemic problem.

2.7 Review of Operational Concept

2.7.1 Experience has shown that the operational concept adopted by bodies overseeing horizontal-plane separation implementations can affect substantially the collision risk in airspace.

2.7.2 An SMA should review carefully the operational concept agreed by the body overseeing implementation of reduced horizontal separation based on PBN with a view to identifying any features of airspace use which may influence risk. An SMA should inform the oversight body of any aspects of the operational concept which it considers important in this respect.

LIST OF APPENDICES

APPENDIX A

Flight Information Regions and Responsible Safety Monitoring Agency

Responsible SMA	FIR
PARMO	Anchorage Oceanic
	Auckland Oceanic
AAMA	Brisbane
	Honiara
	Inchon
AAMA	Melbourne
	Nadi
	Naha
	Nauru
PARMO	Oakland Oceanic
	Port Moresby
	Tahiti
	Tokyo
	Bangkok
	Calcutta
	Chennai
	Colombo
	Delhi
	Dhaka
	Hanoi
SEASMA	Ho Chi Minh
SEASMA	Hong Kong
	Jakarta
	Karachi
	Kathmandu
	Kota Kinabalu
	Kuala Lumpur
	Lahore
	Male
SEASMA	Manila
	Mumbai
	Phnom Penh
SEASMA	Sanya AOR
SEASMA	Singapore
	Taibei
	Ujung Pandang
	Ulaan Baatar
	Vientiane
	Yangon

APPENDIX B

States and Designated SMA for the reporting of PBN approvals

The following table provides a listing of States and the respective designated SMA for the reporting of PBN approvals. Each designated SMA should advise the relevant States of its requirements with respect to reporting of PBN approvals.

ICAO Contracting State	Designated SMA for PBN Approvals	
Afghanistan		
Australia	AAMA	
Bangladesh		
Bhutan		
Brunei Darussalam		
Cambodia		
China	SEASMA	
Cook Islands		
Democratic People's Republic of Korea		
Fiji		
India		
Indonesia		
Japan		
Kiribati		
Lao People's Democratic Republic		
Malaysia		
Maldives		
Marshall Islands		
Micronesia (Federated States of)		
Mongolia		
Myanmar		
Nauru		
Nepal		
New Zealand		
Palau		
Papua New Guinea		
Philippines	SEASMA	
Republic of Korea		
Samoa		
Singapore	SEASMA	
Solomon Islands		
Sri Lanka		
Thailand		
Tonga		
United States	PARMO	
Vanuatu		
Viet Nam	SEASMA	

APPENDIX C

SMA forms for use in obtaining record of PBN approvals from a State authority

NOTES TO AID COMPLETION OF SMA FORMS A1, A2, AND A3

1. Please read these notes before attempting to complete forms SMA A1, A2, and A3.

2. It is important for the SMAs to have an accurate record of a point of contact for any queries that might arise from monitoring of navigation performance. Recipients are therefore requested to include a completed SMA A1 with their first reply to the SMA. Thereafter, there is no further requirement unless there has been a change to the information requested on the form.

3. If recipients are unable to pass the information requested in the SMA A2 to the SMA by electronic means, a hard copy SMA A2 must be completed for each aircraft granted a PBN approval. The numbers below refer to the superscript numbers on the blank SMA A2.

   (1) Enter the single letter ICAO identifier as contained in ICAO Doc 7910. In the case of their being more than one identifier designated for the State, use the letter identifier that appears first.
   (2) Enter the operator's 3 letter ICAO identifier as contained in ICAO Doc 8585. For International General Aviation, enter "IGA". For military aircraft, enter "MIL". If none, place an X in this field and write the name of the operator/owner in the Remarks row.
   (3) Enter the ICAO designator as contained in ICAO Doc 8643, e.g., for Airbus A320-211, enter A320; for Boeing B747-438 enter B744.
   (4) Enter series of aircraft type or manufacturer's customer designation, e.g., for Airbus A320-211, enter 211; for Boeing B747-438, enter 400 or 438.
   (5) Enter ICAO allocated Aircraft Mode S address code.
   (6) Enter yes or no.
   (7) Example: For 26 October, 2007 write 26/10/07.
   (8) Use a separate sheet of paper if insufficient space available.

4. The above numbers refer to those superscript numbers used in SMA A3 - "Withdrawal of PBN Approval." ***SMA A3 must be completed and forwarded to the SMA immediately when the State of registry has cause to withdraw the approval of an operator/aircraft for PBN operations.***

SMA A1
POINT OF CONTACT DETAILS/CHANGE OF POINT OF CONTACT DETAILS FOR MATTERS RELATING TO PBN APPROVALS

This form should be completed and returned to the address below on the first reply to the SMA or when there is a change to any of the details requested on the form (PLEASE USE BLOCK CAPITALS).

STATE OF REGISTRY:

STATE OF REGISTRY (ICAO 2 LETTER IDENTIFIER):

Enter the 2-letter ICAO identifier as contained in ICAO Doc 7910. In the event that there is more than one identifier for the same State, the one that appears first in the list should be used.

ADDRESS:

CONTACT PERSON:

Full Name:

Title: Surname: Initials:

Post/Position:

Telephone #: Fax #:

E-mail:

Initial Reply*/Change of Details* (**Delete as appropriate)*

When complete, please return to the following address:

SMA Address

Telephone:
Fax:
E-Mail:

SMA A2
RECORD OF PBN APPROVAL

1. When a State of Registry approves or amends the approval of an operator/aircraft for PBN, details of that approval must be recorded and sent to the appropriate SMA without delay.

2. *Before providing the information as requested below, reference should be made to the accompanying notes* **(PLEASE USE BLOCK CAPITALS)**.

State of Registry[1]:

Name of Operator[2]:

State of Operator[1]:

Aircraft Type[3]:

Aircraft Series[4]:

Manufacturers Serial No:

Registration No:

Mode S Address Code[5]:

Airworthiness Approval[6]:

Date Issued[7]:

PBN Approval Type[6]:

Date Issued[7]:

Date of Expiry[7] (If Applicable):

Method of Compliance
(E.g Service Bulletin):

Remarks[8]:

When complete, please return to the following address.
SMA Address

Telephone:
Fax:
E-Mail:

SMA A3
WITHDRAWAL OF PBN APPROVAL

1. When a State of Registry has cause to withdraw the PBN approval of an operator/aircraft, details as requested below, must be submitted to the SMA by the most appropriate method.

2. *Before providing the information as requested below, reference below, reference should be made to the accompanying notes* **(PLEASE USE BLOCK CAPITALS)**.

State of Registry[1]: | | |

Name of Operator[2]: | | | |

State of Operator[1]: | | |

Aircraft Type[3]: | | | | |

Aircraft Series[4]: | | | | | | |

Manufacturers Serial No: | | | | | |

Registration: | | | | | | |

Aircraft Mode S Address Code[5]: | | | | | | |

Date of Withdrawal of PBN Approval[7]: | | | | | | |

Reason for Withdrawal of PBN Approval[8]:

Remarks:

When complete, please return to the following address.

SMA Address

Telephone:
Fax:
E-Mail:

APPENDIX D

Minimal informational content for each State PBN approval to be maintained in electronic form by an SMA

Aircraft PBN Approvals Data

To properly maintain and track PBN approval information some basic aircraft identification information is required (e.g., manufacturer, type, serial number, etc.) as well as details specific to an aircraft's PBN approval status. Table 1 lists the minimum data fields to be collected by an SMA for an individual aircraft. Table 1a describes the approvals database record format.

Note: This appendix primarily details the different data elements to be stored by and/or exchanged between SMAs. The details of data types, unit and format will be defined in document TBA

Table 1. Aircraft PBN Approvals Data

Field	Description
Registration Number	Aircraft's current registration number.
Mode S	Aircraft's current Mode S code 6 hexadecimal digits.
Serial Number	Aircraft Serial Number as given by manufacturer
ICAO type Designator	Aircraft Type as defined by ICAO document 8643
Series	Aircraft generic series as described by the aircraft manufacturer (e.g., 747-100, series = 100).
State of Registry	State to which the aircraft is currently registered as defined in ICAO document 7910
Reg. Date	Date registration was active for current operator.
Operator ICAO Code	ICAO code for the current Operator as defined in ICAO document 8585.
Operator Name	Name of the current Operator.
State of Operator	State of the current Operator as defined in ICAO document .7910
Civil or military indication *	Aircraft is civil or military
Airworthiness (MASPS) Approved	Yes or no indication of airworthiness approval
Date Airworthiness Approved	Date of Airworthiness Approval
PBN Approval type	PBN approval – eg RNP 4, RNAV 2, RNP 1
Region for PBN Approval	Name of region where the PBN approval is applicable Note: Only required if PBN Approval is issued for a specific region.
State Of PBN Approval	State granting PBN approval as defined in ICAO document 9613
Date PBN Approved	Date of PBN Approval
Date of PBN Expiry	Date of Expiry for PBN Approval
Method of Compliance (service bulletin or STC)	Reference number/name of compliance method used to make a/c MASPS compliant.
Remarks	Open comments
Date of Withdrawal of Airworthiness (MASPS) Approval	Date of withdrawal of the aircraft's Airworthiness approval (if applicable)
Date of Withdrawal of PBN approval	Date of withdrawal of the aircraft's PBN approval (if applicable)
Info by Authority	Yes or no indication "Was the information provided to the SMA by a State Authority?"

* not necessarily a separate field. Can be a field on its own, or. It is indicated in the operator ICAO code as MIL when the military has an ICAO code designator.

Table 1a. Approvals Database Record Format

Field	Description	Type	Width	Valid Range
1	State of Registry	Alphabetic	2	AA-ZZ
2	Operator	Alphabetic	3	AAA-ZZZ
3	State of Operator	Alphabetic	2	AA-ZZ
4	Aircraft Type	Alphanumeric	4	e.g. MD11
5	Aircraft Mark / Series	Alphanumeric	6	
6	Manufacturer's Serial/Construction Number	Alphanumeric	12	
7	Aircraft Registration Number	Alphanumeric	10	
8	Aircraft Mode "S" Address (Hexadecimal)	Alphanumeric	6	000001-FFFFFF
9	Airworthiness Approved	Alphabetic	1	"Y", "N"
10	Date Airworthiness Approval Issued (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
11	PBN Approval Type	Alphanumeric	6	e.g RNP4
12	Date PBN Approval Issued (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
13	Date of Expiry of PBN Approval (if any) (dd/mm/yyyy)	Date	8	e.g. 31/12/1999
14	National Remarks	Alphanumeric	60	ASCII text
15	Method of compliance	Alphanumeric	60	ASCII text

Aircraft Re-Registration/Operating Status Change Data

Aircraft frequently change registration information. Re-registration and change of operating status information is required to properly maintain an accurate list of the current population as well as to correctly identify height measurements. Table 2 lists the minimum data fields to be maintained by an SMA to manage aircraft re-registration/operating status change data.

Table 2. Aircraft Re-Registration/Operating Status Change Data

Field	Description
Reason for change	Reason for change. Aircraft was re-registered, destroyed, parked, etc.
Previous Registration Number	Aircraft’s previous registration number.
Previous Mode S	Aircraft’s previous Mode S code.
Previous Operator Name	Previous name of operator of the aircraft.
Previous, Operator ICAO Code	ICAO code for previous aircraft operator.
Previous State of the Operator	ICAO code for the previous State of the operator
State of New Operator	ICAO code for the State of the current aircraft operator.
New Registration Number	Aircraft’s current registration number.
New State of Registration	Aircraft’s current State of Registry.
New Operator Name	Current name of operator of the aircraft.
New Operator ICAO Code	ICAO code for the current aircraft operator.
Aircraft ICAO Type designator	Aircraft Type as defined by ICAO document 8643
Aircraft Series	Aircraft generic series as described by the aircraft manufacturer (e.g., 747-100, series = 100).
Serial Number	Aircraft Serial Number as given by manufacturer
New Mode S	Aircraft’s current Mode S code 6 hexadecimal digits.
Date change is effective	Date new registration/ change of status became effective.

Contact Data

An accurate and up to date list of contacts is essential for an SMA to do business. Table 3 lists the minimum content for organizational contacts and Table 4 lists the minimum content for individual points-of-contact.

Table 3. Organizational Contact Data

Field	Description
Type	Type of contact (e.g., Operator, Airworthiness Authority, Manufacturer)
State	State in which the company is located.
State ICAO	ICAO code for the State in which the company is located.
Company/Authority	Name of the company/authority as used by ICAO (e.g., Bombardier)
Fax No	Fax number for the company.
Telephone Number	Telephone number for the company.
Address (1-4)	Address lines 1-4 filled as appropriate for the company.
Place	Place (city, etc.) in which the company is located.
Postal code	Postal code for the company.
Country	Country in which the company is located.
Remarks	Open comments
Modification Date	Last Modification Date.
Web Site	Company Web HTTP Location.
e-mail	Company e-mail address.
civ/mil	Civil or Military.

Table 4. Individual Point of Contact Data

Field	Description
Title Contact	Mr., Mrs., Ms., etc.
Surname Contact	Surname of point of contact.
Name Contact	Name of point of contact.
Position Contact	Work title of the point of contact.
Company/Authority	Name of the company/authority as used by ICAO (e.g., Bombardier)
Department	Department for the point of contact.
Address (1-4)	Address lines 1-4 filled as appropriate for the point of contact.
Place	Place (city, etc.) in which the point of contact is located.
Postal code	Postal code for the location of the point of contact.
Country	Country in which the point of contact is located.
State	State in which the point of contact is located.
E-mail	E-mail of the point of contact.
Telex	Telex number of the point of contact.
Fax No	Fax number of the point of contact.
Telephone no 1	First telephone number for the point of contact.
Telephone no 2	Second telephone number for the point of contact.

Data Exchange Between SMAs

The following sections describe how data is to be shared between SMAs as well as the minimum data set that should be passed from one SMA to another. This minimum sharing data set is a sub-set of the data defined in previous sections of Appendix D.

All SMAs receiving data have responsibility to help ensure data integrity. A receiving SMA must report back to the sending SMA any discrepancies or incorrect information found in the sent data.

Data Exchange Procedures

The standard mode of exchange shall be e-mail or FTP. Data shall be presented in Microsoft Excel or Access. SMAs must realize that the data is current only to the date of the created file.

Table 5. SMA Data Exchange Procedures

Data Type	Data Subset	Frequency	When
PBN Approvals	All	Monthly	First week in month
Aircraft Re-registration/status	New since last broadcast	Monthly	First week in month
Contact	All	Monthly	First week in month
Non-Compliant Aircraft/Group	All	As Required.	As Occurs

In addition to regular data exchanges, one-off queries shall be given to an SMA on request. This includes requests for data in addition to the minimum exchanged data set such as service bulletin information.

Exchange of Aircraft Approvals Data

An SMA shall only exchange PBN Approvals data with another SMA when an aircraft is at minimum Airworthiness Approved. The following table defines the fields required for sending a record to another SMA.

Table 6. Exchange of Aircraft Approvals Data

Field	Needed to Share
Registration Number	Mandatory
Mode S	Desirable
Serial Number	Mandatory
ICAO type Designator	Mandatory
Series	Mandatory
State of Registry	Mandatory
Registration Date	Desirable
Operator ICAO Code	Mandatory
Operator Name	Desirable
State of Operator	Mandatory
Civil or military indication (not a field on its own. It is indicated in the ICAO operator code as MIL except when the military has a code)	Desirable
Airworthiness (MASPS) Approved	Mandatory
Date Airworthiness Approved	Mandatory
PBN Approval Type	Mandatory
State Of PBN Approval	Mandatory
Date PBN Approved	Mandatory
Date of PBN Approval Expiry	Mandatory
Method of Compliance (service bulletin or STC)	Desirable
Remarks	No
Date of Withdraw of Airworthiness (MASPS) Approval	Mandatory
Date of Withdraw of PBN approval	Mandatory
Info by Authority	Mandatory

Aircraft Re-Registration/Operating Status Change Data

An SMA shall share all re-registration information.

Table 7. Exchange of Aircraft Re-Registration/Operating Status Change Data

Field	Need to Share
Reason for change (ie. re-registered, destroyed, parked)	Mandatory
Previous Registration Number	Mandatory
Previous Mode S	Desirable
Previous Operator Name	Desirable
Previous, Operator ICAO Code	Mandatory
Previous State of Operator	Mandatory
State of Operator	Mandatory
New registration number	Mandatory
New State of Registration	Mandatory
New Operator Name	Desirable
New Operator Code	Desirable
Aircraft ICAO Type designator	Mandatory
Aircraft Series	Mandatory
Serial Number	Mandatory
New Mode S	Mandatory
Date change is effective	Desirable

Exchange of Contact Data

Only State Data, Manufacturer and Design Organizations

Table 8. Exchange of Organizational Contact Data Fields

Field	Need to Share
Type	Mandatory
State	Mandatory
State ICAO	Desirable
Company/Authority	Mandatory
Fax No	Desirable
Telephone Number	Desirable
Address (1-4)	Desirable
Place	Desirable
Postal code	Desirable
Country	Desirable
e-mail	Desirable
civ/mil	Desirable

Table 9. Exchange of Individual Point of Contact Data Fields

Field	Need to Share
Title Contact	Desirable
Surname Contact	Mandatory
Name Contact	Desirable
Position Contact	Desirable
Company/Authority	Mandatory
Department	Desirable
Address (1-4)	Desirable
Place	Desirable
Postal code	Desirable
Country	Desirable
State	Desirable
E-mail	Desirable
Fax No	Desirable
Telephone no 1	Desirable
Telephone no 2	Desirable

Confirmed Non-Compliant Information

As part of its monitoring assessments an SMA may identify a non-compliant aircraft or discover an aircraft group that is not meeting the ICAO performance requirements or the MASPS. This should be made available to other SMAs.

When identifying a non-compliant aircraft an SMA should include

- Notifying SMA
- Date Sent
- Field
- Registration Number
- Mode S
- Serial Number
- ICAO Type Designator
- State of Registry
- Registration Date
- Operator ICAO Code
- Operator Name
- State of Operator
- Date(s) of non-compliance(s)
- Action Started (y/n)
- Date Non-compliance Resolved

Data specific to Risk Assessment

This data will not be shared between SMAs as it is specific to the airspace being assessed and in some cases confidential information. This includes Flight Plan Data, Operational Error Data, Occupancy Data, Aircraft type proportions, and Flight time information.

Fixed parameters -Reference Data Sources

Some of the data that are used internally to an SMA and form some of the standard for data formats are listed below.

- ICAO Doc. 7910 " Location Indicators"
- ICAO Document 8585 " Designators for Aircraft Operating Agencies, Aeronautical Authorities, and Services"
- ICAO Document 8643 " Aircraft Type Designators"
- IATA "Airline Coding Directory"

APPENDIX E

Suggested Form for ATC Unit Monthly Report of Large Lateral Deviations or Large Longitudinal Errors

SAFETY MONITORING AGENCY NAME

Report of Large Lateral Deviation or Large Longitudinal Error

Report to the (Safety Monitoring Agency Name) of a lateral deviation of 15 NM or longitudinal error of [10 NM or 3 minutes], including those due to contingency events.

Name of ATC unit:____

Please complete Section I or II as appropriate

SECTION I:

There were no reports of large lateral deviations or large longitudinal errors for the month of __________

SECTION II:

There was/were _____ report(s) of a lateral deviation of 15 NM or more
There was/were _____ report(s) of a longitudinal error of [10 NM or 3 minutes].
Details of the lateral deviation(s) and longitudinal error(s) are attached.

(Please use a separate form for each report of lateral deviation or longitudinal error).

SECTION III:

When complete please forward the report(s) to:

Safety Monitoring Agency Name
Postal address
Telephone:
Fax:
E-Mail:

____

APPENDIX F

Sample Content and Format for Collection of Sample of Traffic Movements

The following table lists the information required for each flight in a sample of traffic movements.

INFORMATION FOR EACH FLIGHT IN THE SAMPLE

The information requested for a flight in the sample is listed in the following table with an indication as to whether the information is necessary or is optional:

ITEM	EXAMPLE	MANDATORY OR OPTIONAL
Date (either month/day/year or day/month/year format)	5/01/00 or 01/05/00 for 1 May 2000	MANDATORY
Aircraft call sign	XXX704	MANDATORY
Aircraft Type	B734	MANDATORY
Aircraft registration mark	VH-ABC	OPTIONAL
Origin Aerodrome	WMKK	MANDATORY
Destination Aerodrome	RPLL	MANDATORY
Entry Fix into Airspace	MESOK	MANDATORY
Time at Entry Fix	2:25 (or 0225)	MANDATORY
Flight Level at Entry Fix	330	MANDATORY
Assigned Mach number at Entry Fix	M0.77	OPTIONAL
Exit Fix from Airspace	NISOR	MANDATORY
Time at Exit Fix	4:01 (or 0401)	MANDATORY
Flight Level at Exit Fix	330	MANDATORY
Assigned Mach number at Exit Fix	M0.77	OPTIONAL
First Fix Within the Airspace OR First Airway Within the Airspace	MESOK OR G582	OPTIONAL
Time at First Fix	02:25 OR 0225	OPTIONAL
Flight Level at First Fix	330	OPTIONAL
Second Fix Within the Airspace OR Second Airway Within the Airspace	MEVAS OR G577	
Time at Second Fix	02:50 OR 0250	OPTIONAL
Flight Level at Second Fix	330	OPTIONAL
(Continue with as many Fix/Time/Flight-Level entries as are required to describe the flight's movement within the airspace)		OPTIONAL

Information Required for a Flight in Traffic Sample

APPENDIX G

Letter to State authority requesting clarification of the State PBN Approval Status of an Operator

When the PBN approval status shown in filed flight plan is not confirmed in an SMA's database of State approvals, a letter similar to the following should be sent to the relevant State authority:

<STATE AUTHORITY ADDRESS>

1. The (SMA name) has been established by APANPIRG to support safe implementation and use of the PBN based separation in (airspace where the SMA has responsibility) in accordance with guidance published by the International Civil Aviation Organization.

2. Among the other activities, the (SMA name) conducts a comparison of the State PBN approval status notified by an operator to an air traffic control unit to the records of State PBN approvals available to us. This comparison is considered vital to ensuring the continued integrity of PBN-based separation.

3. This letter is to advise that an operator which we believe is on your State registry provided notice of State PBN approval which is not confirmed by our records. The details of the occurrence are as follows:

Date:
Operator name:
Aircraft flight identification:
Aircraft type:
Registration mark:
Notified PBN Approval type:
ATC unit receiving notification:

4 We request that you advise this office of the PBN approval status of this operator. In the event that you have not granted a PBN approval to this operator similar to that notified by the operator as above, we request that you advise this office of any action which you propose to take.

Sincerely,

(SMA official)

APPENDIX H

Description of Models Used to Estimate Risk

Include material from Working Paper 14 to the RASMAG/9 meeting (May 2008)

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 datalink 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 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:

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

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

c) Oversee the implementation of new procedures; and

d) Report to the appropriate State regulatory authorities and to the appropriate ATS coordinating group.

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 process monthly end-to-end system performance reports from air traffic 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.

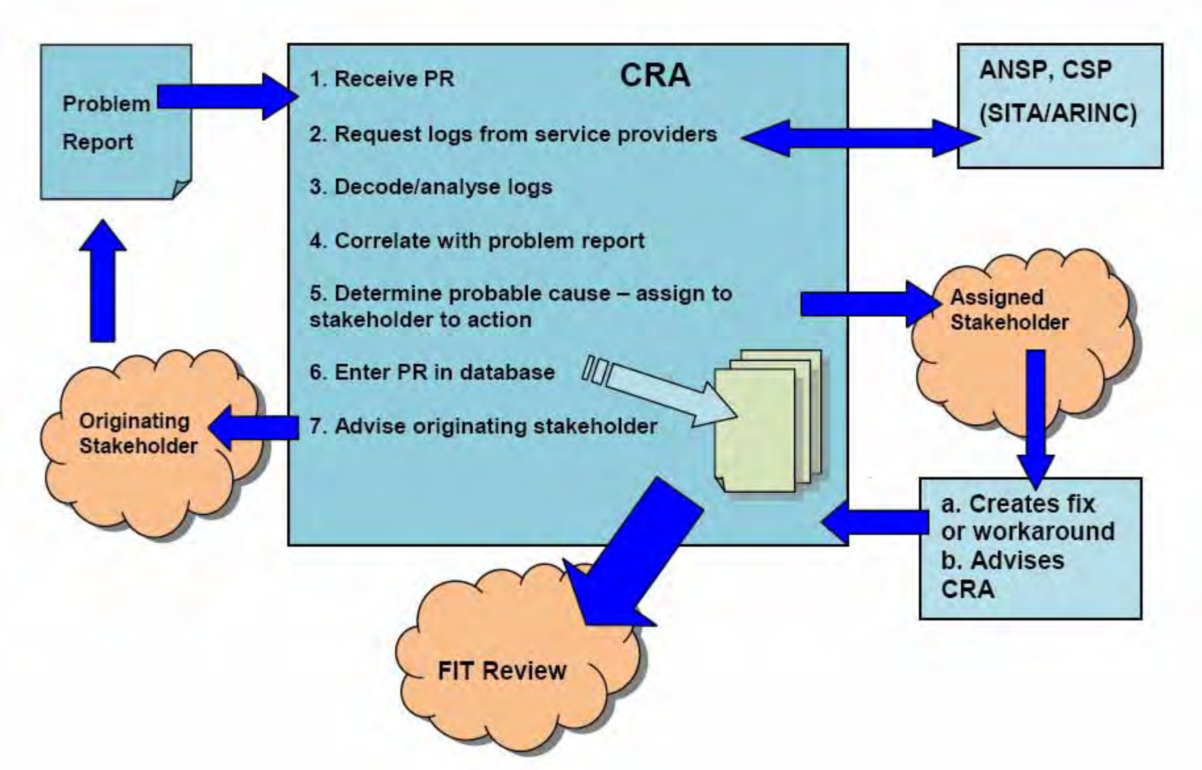
Confidentiality Agreements

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 and 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 of the 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 lab 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, then 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. As part of that activity, and because a considerable period may elapse while software updates are applied to all aircraft in a fleet, procedural methods to mitigate the problem may have to be developed while the solution is being coordinated. 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 Safety Monitoring Agency (SMA) 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 does not include uplink message composition or reviewing of the downlink message response by the Controller.*

> ***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 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.

- 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.
- 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.

7.27 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.

7.28 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.

7.29 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

7.30 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.

7.31 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

7.32 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.

7.33 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

7.34 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.

7.35 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 as well as 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

5.1 ANSPs should report the results of AIDC performance monitoring to the RASMAG.

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

MODEL TERMS OF REFERENCE FOR AN INTEROPERABILITY TEAM

Reporting and problem resolution processes

- 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.

System performance and monitoring processes

- 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.

New procedures

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

Reporting

- 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 *RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace* (Oceanic SPR Standard) contains the safety and performance requirements for data link services that need to be met and verified. This does not prevent ATS service providers from negotiating more constraining contractual requirements with their communication service providers if necessary.

Note 1: *For reference purposes the original monitoring requirement, from earlier versions of the FANS-1/A Operations Manual (FOM), are included in Attachment A to Appendix D.*

Note 2: *The Oceanic SPR standard provides an availability requirement for safety of 0.999, however to enable operational efficiency in some environments, the FANS-1/A availability requirement is set at 0.9999. This 0.9999 availability requirement translates on a per ATSP basis to:*

- *No more than 4 outages (affecting a significant portion of aircraft) greater than 10 minutes for any 12 month period;*
- *Failures causing outages for multiple OACs are not counted more than once; and*
- *No more than 50 minutes of total downtime for any 12 month period.*

The tables below summarise the Oceanic SPR Standard requirements.

Performance Criteria	**Definition**	**Values**
RCP 240/D	Normal means of communication for application of 30 NM lateral separation and reduced distance-based longitudinal separation minima	Communication Transaction time (ET) 240 (sec)
Note: *Communication Transaction time is defined as the maximum time for the completion of an operational transaction after which the initiator reverts to an alternative procedure. (ICAO Doc 8689*)		
RCP400/D	Normal means of communication for application of lateral separation greater than or equal to 50 NM and time-based longitudinal separation. Alternative means of communication for application of 30 NM lateral separation and reduced distance-based longitudinal separation minima	ET 400 (sec)
Surveillance **50 NM Longitudinal** **30 NM Longitudinal** **30 NM Lateral**	Normal Surveillance: (position report delivery) Non-normal Surveillance: (Controller initiated position report request)	ET 180 (sec) ET 240 (sec)
Surveillance **>50NM Lateral** **>=10 mins time based**	Normal Surveillance	ET 400 (sec)

Availability	The probability that an operational communication transaction can be initiated when needed (ICAO Doc 8689)	99.99%
Continuity	The probability that an operational communication transaction can be completed within the communication transaction time (ICAO Doc 9869)	99.9%
Integrity	The probability of one or more undetected errors in a completed communication transaction.	10^{-5}/hour

RCP type	**RCP 240/D**		**RCP 400/D**	
Time Parameter	ET	95%	ET	95%
Time Value	240	210	400	350
RCP Time Allocations				
Initiator	30	30	30	30
TRN	210	180	370	320
TRN Time Allocations				
Responder	60	60	60	60
RCTP	150	120	310	260
RCTP Time Allocation				
Aircraft	15	10	15	10
Communication service	120	100	280	240
ATS unit	15	10	15	10
Note 1: Values shown in seconds. *Note 2: Expiration time (ET) is at the continuity requirement, which is 99.9%.*				

Table 1: *50 longitudinal and 30/30 - intervention (DO-306/ED-122, Table 5-6)*

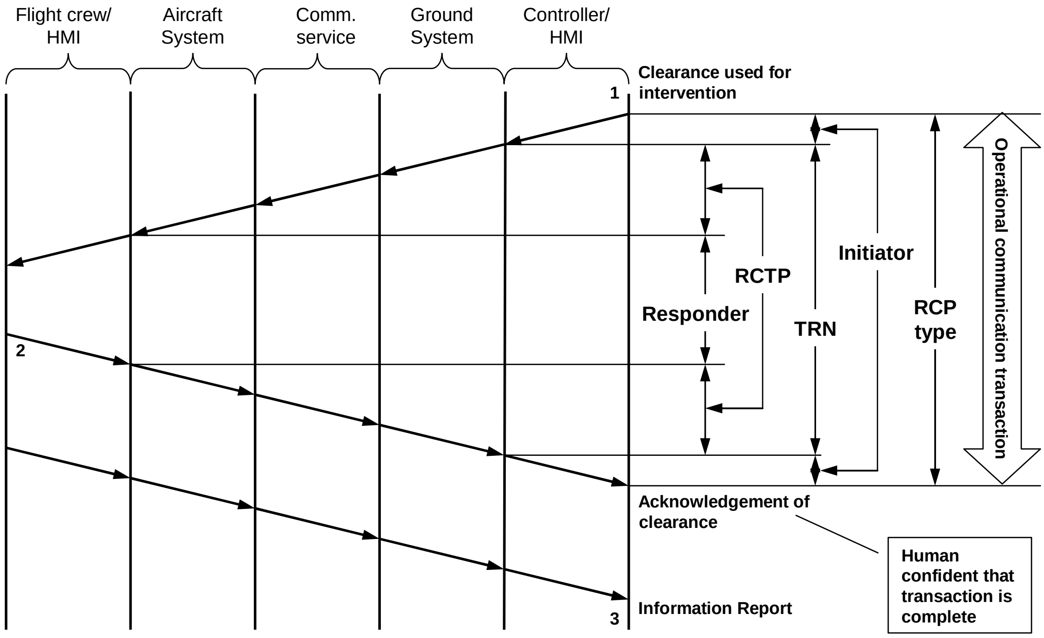


Figure 1: *RCP allocations for intervention capability (DO-306/ED-122, Figure 5-3)*

ATTACHMENT A TO APPENDIX D

FANS-1/A OPERATIONS MANUAL
SYSTEM PERFORMANCE CRITERIA

The table below shows the legacy performance criteria as defined in earlier versions of the FANS-1/A Operations Manual (FOM). These criteria are included for reference purposes only.

Criteria	Definition	Values
Performance	End to end round trip time for uplinks. (sending and reception of MAS)	Round trip time of 2 minutes, 95% of messages. Round trip time of 6 minutes, 99% of messages.
	End to end one way time for downlinks. (comparison of message time stamp and receipt time)	One way time of 1 minute, 95% of messages. One way time of 3 minutes, 99% of messages
	Uplink messages only: Undelivered messages will be determined by: Message assurance failure is received. After trying VHF and, SATCOM Depending on reason code received, the message might, in fact, have reached the aircraft. No message assurance or flight crew response is received by ATSU after 900 seconds	Less than 1% of all attempted messages undelivered
Availability	The ability of the network data link service to perform a required function under given conditions at a given time: The maximum allowed time of continuous unavailability or downtime should be declared MTTR (Mean Time To Repair) ∗	99.9% TBD
Reliability	The ability of a data link application/system to perform a required function under given conditions for a given time interval: it can be expressed in MTBF (Mean Time Between failure) ∗	TBD
Integrity	The probability of an undetected failure, event or occurrence within a given time interval.	10^{-6}/hour

∗ Availability = MTBF x 100/(MTBF+MTTR)

— END —

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

GUIDANCE MATERIAL
FOR THE ASIA/PACIFIC REGION
FOR ADS/CPDLC/AIDC GROUND SYSTEMS
PROCUREMENT AND IMPLEMENTATION

Version 2 – May 2008

Issued by the ICAO Asia/Pacific Regional Office, Bangkok

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CHAPTER 1 INTRODUCTION

This material has been developed under an initiative of the Regional Airspace Safety Monitoring Advisory Group (RASMAG) of the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to assist air navigation service providers (ANSP) with the implementation of data link-based air traffic management (ATM) systems. The material was adopted as Asia/Pacific regional guidance material by APANPIRG/18 (3-7 September 2007) under the provisions of Conclusion 18/5. The RASMAG retains editorial responsibility for the document.

For the purposes of this document, a data link-based ATM system is one which supports automatic dependent surveillance (ADS), controller-pilot data link communications (CPDLC) and air traffic service (ATS) interfacility data link communications (AIDC).

Integrated data link systems are playing an increasingly important role in air traffic management. Data link operations support reduced separation minima and so directly contribute to increased airspace capacity. Controller and pilot workload is reduced, and operational safety enhanced, by the automation enabled by data link systems. As the use of these systems spreads, so more ANSPs must equip with the appropriate facilities.

The material covers two main aspects of implementation: specification and deployment.

Technical systems must be carefully specified from both the technical and operational aspects, and at the right level of detail: enough to ensure that the requirements are met, but not so much that good solutions may be excluded.

The deployment of a new system involves a number of vital steps, such as testing, training, integrating and commissioning.

This material offers guidance, rather than solutions, with the emphasis on specifying systems supporting ADS, CPDLC and AIDC. It is not the intention of this document to provide the detailed technical information required to specify data link applications: this information may be found in the various ICAO and other documents referenced.

1.1 OBJECTIVE

The objective of this document is to provide guidance on the specification, procurement and implementation of data link systems for States and service providers unfamiliar with these systems.

1.2 SCOPE

The material is divided into three sections. The first covers the generalities of procuring and implementing a new system, the second is concerned with the requirements of a data link-based ATM system, and the third gives guidance on specifying a system.

For the purposes of this material, it is assumed that the ANSP is the organisation setting out to procure a system.

1.2.1 Procurement and Implementation

Procurement and implementation includes:

- Planning and contracting
- Supervision and inspection
- Preparation for operation
- Operational transfer

1.2.2 Requirements

The Requirements section covers general requirements for data link systems and specific requirements for:

- Data link Initiation Capability (DLIC)
- ADS
- CPDLC
- AIDC

1.2.3 Specification

The Specification section offers guidance on the specification of:

- System configuration
- Interfaces
- Functionality
- Human-Machine Interface
- Capacity and parameters
- Recording and data analysis

1.3 SYSTEMS OVERVIEW

A key objective of data link systems is to support reduced separation minima: any new data link system should be capable of supporting 30NM lateral and 30NM longitudinal reduced separation minima based on PBN RNP 4.

1.3.1 ADS

Automatic Dependent Surveillance is a surveillance technique in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position, and additional data as appropriate. There are two forms of ADS: broadcast ADS (ADS-B) and contract ADS (ADS-C). With ADS-B, aircraft broadcast positional data up to twice per second; the data may be used by ground systems (and other aircraft). With ADS-C, aircraft report directly to one or more ground systems with specified data at predetermined intervals (usually tens of minutes).

Note: Throughout this document, the abbreviation ADS refers to ADS-C.

The ADS data link application allows the implementation of reporting agreements, or “contracts”, which, with the exception of an aircraft in an emergency situation, are established exclusively by the ground. An ADS contract is an ADS reporting plan which establishes the conditions of ADS data reporting (i.e. the data required by the ATC system and the frequency of the ADS reports which have to be agreed upon prior to the provision of the ADS services). ADS information may be exchanged between the ground system and the aircraft by means of a single contract or a series of contracts. An ADS contract specifies under what conditions an ADS report will be initiated, and what data groups will be included in the reports.

There are three types of contract:

- *Periodic contracts* provide a report at a regular periodic interval determined by the ground system.
- *Event contracts* provide a report when or if a specified event or events take place.
- *Demand contracts* provide a single report when requested by the controller.

1.3.2 CPDLC

Controller Pilot Data Link Communications (CPDLC) is a data link application that provides a means of communication between controller and pilot, using data link for ATC communications.

Sending a message by CPDLC consists of selecting the addressee, selecting and completing, if necessary, the appropriate message from a displayed menu or by other means which allow fast and efficient message selection, and executing the transmission. The messages include clearances, expected clearances, requests, reports and related ATC information. A “free-text” capability is also provided to exchange information not conforming to defined formats. Receiving the message will normally take place by display and/or printing of the message.

CPDLC overcomes a number of the shortcomings of voice communication, such as voice channel congestion, misunderstanding due to bad voice quality and/or misinterpretation, and corruption of the signal due to simultaneous transmissions.

1.3.3 AIDC

ATS Interfacility Data link Communications is a data link application that provides the capability to exchange data between ATS units in support of critical ATC functions.

AIDC defines messages which are related to three phases of coordination as perceived by an ATSU.

- *Notification*, in which the aircraft trajectory and any changes may be conveyed to an ATSU from the current ATSU prior to coordination.
- *Coordination*, in which the aircraft trajectory is coordinated between two or more ATSUs when the flight approaches a common boundary.
- *Transfer*, in which communications and executive control authority is transferred from one ATSU to another.

Other AIDC messages support ancillary ATC data changes between ATSUs, including the exchange of free-text messages.

Other than the formal international communication protocol standards, internet protocol (TCP/IP) as a flexible and low cost de-fact industry standard is recommended.

CHAPTER 2 PROCUREMENT

2.1 GENERAL

2.1.1 System Quality

The overall quality of a system, the Total System Quality, is the product of three main elements: the quality of the design, the quality of production and the quality in operation.

The ***Design Quality*** is a measure of how well the design process has translated the operational requirements into user specifications and the user specifications into product specifications. The design quality depends upon both the definition of operational requirements and development of user specifications by the ANSP and the system design skills of the vendor. If the operational requirements are not well defined, the specification will be compromised and the system design cannot be expected to be meet the real requirements. Similarly, if the specification does not correctly reflect the operational requirements, neither will the system design.

The ***Production Quality*** is a measure of how exactly the products match the specifications, and applies to the hardware, the software and the integration of these to form the system as a whole. In general, the vendor is responsible for production quality.

The ***Operational Quality*** is a measure of how the actual operation of the system realizes the operational objectives. This depends primarily on the way the system is operated: a badly operated system is not a good system. The operational quality is mainly influenced by the operational management of the ANSP.

The ***Total System Quality*** is the product of design quality, production quality and operational quality. To achieve high total system quality is clearly necessary to maintain the highest possible quality in each of the three areas.

Cooperation between the ANSP and the vendor is essential to achieve a high total system quality.

2.1.2 Roles and Responsibilities of the ANSP

The ANSP is ultimately responsible for successful implementation of the system. It is therefore vital that the ANSP takes a positive and active role throughout the system procurement and implementation.

The vendor is only responsible for developing and integrating a system to the ANSP's specific requirements.

Air traffic controllers, as the end-users of the system, must play a positive and active role throughout the procurement and implementation activities. The clear and complete definition of operational requirements and the final testing in an operational environment are both critical and are unlikely to be completed successfully without significant controller input. Clearly defined system requirements and specifications are vital in order for potential vendors to be able to offer a suitable system.

Controllers should also be able to contribute to the design, development and integration activities, and must be directly involved in the testing and commissioning processes.

2.1.3 Relationships: Requirements, Specification and Test/Evaluation

The figure below shows the relationships between the operational requirements, the system requirements, the specification, the design and the test and evaluation process. Only the combination of a complete and feasible definition of the requirements, consistent design, quality assured development and adequate review, testing and evaluation at each stage can provide a quality system.

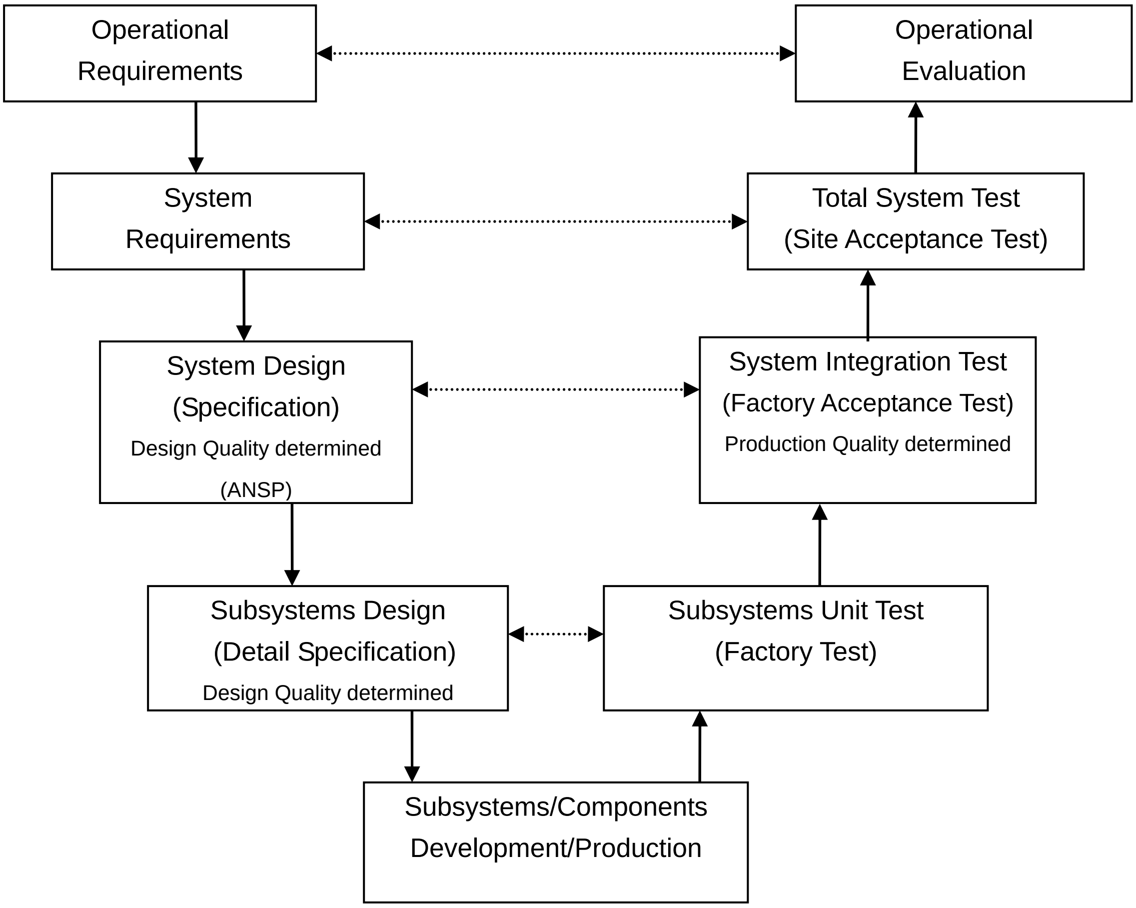

Figure1. Relationship between Requirement, Specification and Test/Evaluation

2.2 PROJECT MANAGEMENT

A project manager should be appointed as early as possible in the project. The basic role of the project manager is to ensure that the project proceeds within predetermined time, resource and cost boundaries. Project management requires a range of special skills, and serious consideration should be given to employing a professional project manager for the duration of the project.

The project manager must be given appropriate levels of financial and organisational authority so that he or she can make project decisions without constant recourse to higher management. It is essential that the terms of reference of the project manager are clearly documented and that they detail these authorities.

The project manager will be responsible for managing all aspects of the project, with particular emphasis on scheduling the many activities of ANSP personnel to match those of the system supplier. He or she will also play a major role in keeping the project within the time and budget constraints by determining what, if any, changes are made to the scope of the contract.

2.3 PLANNING AND CONTRACTING

2.3.1 Operational Requirements

The first, and perhaps most critical, stage of the planning and contracting phase is the definition of the ATS Operational Requirements; these must clearly define precisely what the system is to do. Operational requirements should not define how the results are to be achieved – that can be done in the specification.

There is no place for choice in a requirement, and the wording must reflect this; “must”, “shall” and “will” make requirements mandatory. The use of words such as “may”, “should” and “could”, “maximum” and “minimum” and “if”, “except” and “unless” make a requirement imprecise, because the reader does not know exactly what is required. “There should be 10 sectors” or “there should be at least 10 sectors” is vague. “There will be 10 sectors” is precise and leaves no doubt as to what is required.

The operational requirements should be established by a team of experienced controllers whose professional knowledge and experience encompasses all aspects of the ATS operation; the team should also include engineers and, as necessary, other specialists.

2.3.1.1 Studies of Existing Systems

The operational requirements team must have an appreciation of how data link systems work in the operational environment; this is best achieved by studying existing systems and talking to experienced controllers, engineers and managers in other ATS facilities. The study should cover operational and technical practices and should pay particular attention to problems encountered and lessons learnt.

Controllers using these systems will be well aware of any features that do not work well or are not user-friendly, and will have suggestions for how the system could be improved. This is valuable information that should be considered when developing the specification and during the contract negotiation phase; in the latter case, a supplier could be invited to change such features in an otherwise satisfactory system.

2.3.1.2 Confirmation of Service Environments

The operational requirements team should establish the current ATS environment as the baseline, taking into account:

- Airspace structure and major airports.
- Sector configuration and VHF/radar coverage.
- The required separation minima (30/30NM horizontal separation or better)

- Traffic flows (routes, number, flight levels, etc.).
- ATS procedures.
- Related ATS facilities.

2.3.1.3 Operational Requirement Analysis

From the baseline, the team should analyse trends to determine the likely changes in the operational environment over the projected life of the system. The operational requirements can then be determined, if necessary using the projected environment at several points during the projected system life, and should detail, at the very least:

- The anticipated peak and mean traffic levels.
- The number of sectors, based on the traffic levels.
- Specific services for each sector.
- Inter-sector services.
- Inter-ATSU services.

Once these are established, the specific requirements to provide these services, such as displays and communications, can be determined.,

2.3.2 Design and Review

The next stage is for the team to define the system concept in terms of both operational requirements and technical feasibility, perhaps using other facilities as a base reference. The concept should be reviewed by controllers and managers who are not part of the team; any changes proposed should be discussed with the team and the concept modified accordingly.

2.3.2.1 Conceptual Design

The conceptual design must be documented clearly and should include the following:

- ATS functions needed (e.g. ADS reports, traffic display).
- Performance goals for the targeted airspace.
- Sector configuration.
- Physical configuration and layout.
- System operation (e.g. redundant parallel operation, automatic recovery, etc.).
- Standards to be applied (e.g. ARINC-745, RTCA DO-258A).
- Interface requirements for related ATS facilities.
- Communications Service Provider (CSP) and interface.

- Human Machine Interface (e.g. display size, use of colour, input devices).

The document should also identify any new operational procedures that may be required, both for new techniques, such as the use of ADS, CPDLC and AIDC, and for other changes.

2.3.2.2 Technical Feasibility Study

The team may then determine the technical feasibility of meeting the operational requirements, particularly in terms of the functionality required, the characteristics and performance of existing systems and the available budget. Preliminary information from vendors will give an indication of the systems and capabilities that are available, so that the team can decide on the most appropriate procurement option:

- A standard “off-the-shelf” system.
- A customized off-the-shelf system.
- A custom-built system.

The criteria to be used in evaluating systems in the market will include:

- Functionality meeting the requirements.
- Adequate performance and capacity to handle future traffic.
- User-friendly and intuitive operation.
- High reliability under all anticipated service conditions.
- Simple connection with related systems and facilities.
- Required standards are met.

2.3.2.3 Specification

When the operational requirements and the feasibility studies have been completed the specification can be developed. This is discussed in detail in CHAPTER 5.

2.3.2.4 Design Review

The purpose of this design review is to ensure that the conceptual design meets each and every one of the operational requirements and that it is technically achievable and attainable.

The design review team should be independent of the requirements team but should also comprise controllers, engineers and managers. The review may take the form of a walk-through of the conceptual design documents or a desk-top simulation.

The design review report should cover:

- Compliance with operational requirements.
- Connectivity with related systems and adjoining facilities.
- Flexibility and expandability in the future.
- Any operational or technical issues.

2.3.3 Request for Proposal (RFP)

A fully-documented and approved Request for Proposal (RFP) should be submitted to prospective vendors.

2.3.3.1 Objective

The objective of the RFP is to secure fully compliant proposals from a number of competent vendors.

2.3.3.2 Content

The RFP should contain all the information required for prospective vendors to make a complete and compliant proposal. Any omissions will result in enquiries from vendors, which will take time and effort to respond to. The RFP should contain:

- The specification.
- Operating environment, including:
  - External temperature and humidity ranges.
  - Temperature and humidity ranges in the equipment area and operational area.
  - Mains power supply voltage and frequency.
- Acceptance testing requirements.
- Maintenance support requirements.
- Training requirements.
- Warranty requirements.
- A draft contract, to allow vendors to see what contract requirements they will have to meet, and what arrangements they may have to make to meet them.
- Bidding conditions, including:
  - Submission of separate technical and financial bids.
  - Confidentiality.
  - The enquiry process.

        - The closing date for enquiries.
        - The closing date for bids.
        - Notification of short-listed bidders.
        - Notification of preferred bidder.
    - Financial conditions, including
        - Bid bonds (if required).
        - Requirements for financing (if necessary).
        - Proposed payment schedule.
    - The proposal evaluation process, including the evaluation criteria.

2.3.3.3 Enquiry Process

It is inevitable that some bidders will ask for clarification of details or for additional information. To avoid giving advantage to any particular bidder, there should be a formal process to ensure that all bidders receive the same information. This may be done by issuing a bulletin to all bidders containing each question received and the response. This should be done at frequent intervals so that vendors have time to adjust their proposals if necessary.

2.3.4 Evaluation of Proposals

Proposals must not be opened before the stated final date for bids.

The evaluation of proposals must be, and be seen to be, fair and traceable. All stages of the evaluation process should be clearly documented and the reasons for each decision recorded.

Ideally, the evaluation team will include all the members of the team that drew up the specification, complemented by other personnel as necessary. It is good practice to isolate the evaluation of the financial proposal from the rest of the process. Besides maintaining the confidentiality of the financial bids, this avoids any influence of the technical evaluation on the financial and *vice versa*.

The evaluation process and criteria stated in the RFP must be strictly followed: this should avoid any protest by unsuccessful bidders.

Proposals are not always perfect, nor do they always fully cover every item of the RFP, and so there may be a need for clarification during the evaluation phase. It may be necessary to request additional technical or financial information in order to complete the evaluation; this should take the form of a simple request for the specific information required. However, there should be no negotiation at this stage, of either technical or financial elements.

Once the preferred bidder has been selected, the other bidders should be informed that they may be invited to negotiate if a contract cannot be concluded with the preferred bidder.

2.3.5 Contract Negotiation

There should be no negotiation with bidders before the selection process has been completed. Once the preferred bidder has been determined, negotiations on the detailed conditions are acceptable. Negotiations may be by correspondence or face-to-face, and should involve the appropriate experts from the ANSP.

It is important that the negotiations cover all aspects of the contract, including the vendor's schedule. The negotiating advantage is with the purchaser until the contract is signed; it then passes to the vendor. Changes made after the contract has been signed are inevitably costly and often time-consuming.

The negotiations must be clearly documented.

If a satisfactory contract cannot be concluded, the next preferred bidder may be invited to negotiate a contract; alternatively, the tender process may be started again, but this is a costly process and is unlikely to produce a better outcome.

When the contract has been signed, the other bidders should be informed.

CHAPTER 3 IMPLEMENTATION

The implementation phase begins when the contract is signed.

Typically, the vendor's activities during the implementation phase include design review, manufacture, factory testing, documentation, training, delivery, installation, site acceptance testing and handover.

The ANSP is involved in all these activities to some degree, except manufacture; but the ANSP must also prepare for the operation of the system. This will involve developing test requirements, planning training, organising staff deployment, developing procedures and planning the operational transfer from the existing to the new system.

3.1 IMPLEMENTATION SCHEDULE

The project manager can now use the vendor's schedule as the basis for finalising the overall project schedule. The project schedule should detail all anticipated activities, including system design reviews, factory and site acceptance tests, training (both vendor training and internal training), commissioning and operational transfer. The schedule should also show related activities such as development of operational and technical procedures and preparation of operational material such as charts.

3.2 CONTRACT SUPERVISION

The project manager is normally responsible for supervision of the contract works. This can generally be achieved by monitoring the vendor's progress reports, at least until the vendor starts work on site.

It is likely that desirable changes to the specification or the contract will be identified during design reviews or factory testing. However, careful management of change is essential. Every change will incur costs and delays.

A formal change control system should be implemented, with every change being submitted for approval only after costs and delays have been established. The procedure should identify the levels of cost and delay that the project manager can approve.

3.3 SYSTEM DESIGN REVIEW

This review takes place after the vendor has completed the design for the system, and, as with the concept design review, is intended to ensure that the design meets all the operational and technical requirements. The design review is the point at which the design quality is determined It is also the last stage at which design changes should be made; however, changes made at this stage are likely to incur costs and delays.

3.4 FACTORY ACCEPTANCE TEST

The factory acceptance test is the last opportunity for the ANSP to identify problems before the system is shipped out from the factory and is the point at which the production quality is determined. It is also usually the first opportunity for ANSP personnel to examine and try out the system, and is often combined with factory-based training. It is important that operational as well as technical personnel attend the factory acceptance: it should be a test of operational features as well as of technical compliance.

The vendor should produce a detailed test schedule well before the beginning of the test, so that the ANSP can consider whether the tests meet the requirements and whether any additional tests should be included.

The results of any tests performed by the vendor before the acceptance test should be made available at the start of the acceptance test.

Any problems that are encountered during the factory test should result in agreed corrective actions to be undertaken by the vendor. These may be carried out before shipping or on site, according to the nature of the problem. The results of the factory test form an important part of the contract documentation, as they record the performance of the system and the agreed corrective actions.

3.5 PREPARATION FOR OPERATION

There are a number of items that the ANSP must address in preparation for operation of the new system. These include:

- Development of operational procedures.
- Development of system management procedures.
- Preparation of system data (for maps, etc).
- Establishment of system parameters.
- Development of internal training courses for controllers, system operators and technical staff.
- Development of operational transfer plan.
- Safety assessment.

The ANSP is responsible for carrying out these tasks, although some assistance and information from the vendor will be necessary to complete them. Some of the work can be carried before the installation begins, but it may be more convenient to leave some until the vendor’s specialists are on site.

While it is not appropriate for this guidance material to address each item in detail, some items do merit discussion.

3.5.1 Operational Procedures

The FANS 1/A Operations Manual (FOM) has been adopted for Regional use and contains the procedures for the use of the data link applications.

The ANSP may need to develop other procedures.

3.5.2 System Management Procedures

Procedures for managing the system must be developed. These should cover such topics as system start, changeovers between "main" and "standby" systems, contingency operations, map data management, data recording and monitoring,

3.5.3 Preparation of System Data

The ANSP will be required to provide data to define, for example, FIR boundaries for hand-off processing and airspace maps for the display system. The vendor will provide details of the information required and may either process the data into the system or, preferably, train and assist the ANSP staff to do so.

The preparation of this type of data can be a very detailed and time-consuming process, and due allowance should be made in the project plan.

3.5.4 Establishment of System Parameters

System parameters are used to set values for a number of variables used in the software. These parameters can be changed, but normally only by software specialists. Typical system parameters include timer intervals, for example to set the default interval between ADS periodic contracts, standard range settings, display colours, etc.

The vendor will detail the system parameters and will be able to suggest suitable values; however, the ANSP must make the final decision on each parameter. The parameters should be set before site acceptance testing, so that their effect can be determined. The parameter values should be finalised before operational transfer and changes avoided during the initial period of operation.

3.5.5 Development of Training Courses

It may not be practical or appropriate for the vendor to provide initial training for all personnel, and future training requirements must also be considered. The ANSP must develop its own training courses to complement the initial training by the vendor and to meet its future training requirements.

3.5.6 Operational Transfer Plan

The operational transfer plan should detail each step of the transfer, particularly with regard to contingency measures to recover from system problems or unexpected operational difficulties.

For each step, the plan should give details of the timing, the people involved and any other resources that may be required. It is important to clearly define the measures or events that determine that each step has been satisfactorily completed.

It is also important that the plan is made widely available so that everyone involved understands what will happen.

The operational transfer process is discussed in 3.8 below.

3.5.7 Safety Assessment

It is most important that a safety assessment (or safety case) is prepared for the introduction and operation of the system. The purpose of the safety assessment is to identify all the risks associated with the introduction and operation of the system, to establish the level of each risk and to determine how those risks can be removed or reduced to an acceptable level.

Examples of risks are ADS link failure, workstation failure, inadequate controller training, and failure to close a CPDLC message sequence.

The resulting safety assessment document will list all the risks that have been identified, the associated risk levels and the measures adopted to remove or mitigate each risk.

Safety assessments are described in detail in ICAO Doc 9859, Safety Management Manual.

3.6 TRAINING

Comprehensive training is vital so that controllers, system operators and maintenance personnel must all be able to carry out their tasks competently and effectively as soon as the system becomes operational. A comprehensive training plan is a prerequisite for a successful training programme.

Training is perhaps the most important of all the preparatory tasks.

3.6.1 Controller Training

While the separation standards that controllers apply will probably not change, at least not immediately on introduction of the new system, the tools they use will have changed significantly. The training must cover both the operation of the new workstations and the associated tools and, equally importantly, the procedures for using the data link applications.

Training on the manipulation of the displays and controls should be provided initially by the vendor, and the ANSP's training staff should be included in the first courses. The training staff can then develop and deliver that training.

The procedures for the use of data link applications have been developed within the Region and are laid out in regional documents. The vendor cannot be expected to provide training on data link procedures; this is a task that must be performed by professional training controllers. The training modules must be developed well in advance, ideally in cooperation with the training sections of other ANSPs that have experience of data link operations.

The timing of the training is important. There will almost certainly be several courses to train all controllers, and all training should be completed before operational transfer. The controllers on the earliest courses may have difficulty remembering what they have been taught; one solution is to provide short refresher courses shortly before operational transfer.

3.6.2 System Operator Training

The operation of the system includes starting and stopping the system, switching between operational and standby units, rebooting, system recovery, changing system parameters, loading data for maps, etc, and installing software changes.

The vendor must provide the first training courses for system operators. The syllabus must include the items identified above, with sufficient background to allow the operators to understand the implications of the various actions that they will be expected to perform. They should also be given a good understanding of the various functions of the system.

The training should include practical sessions using the full system, so that the operators experience the various tasks at first hand.

3.6.3 Maintenance Training

The first training courses for maintenance technicians must also be carried out by the vendor. With systems of this type, technicians must be able to diagnose faults down to circuit board level. However, as these systems include a number of computers, technicians must have an understanding of the general software structure. They should also be trained to differentiate between hardware and software faults, and to undertake simple software recovery activities.

3.6.4 Simulator Based Training

If simulator facilities are provided as part of the system, a large proportion of the training can be carried out using these facilities. Simulators are particularly valuable in allowing controllers to experience unusual or exceptional conditions, such as traffic overloads, weather deviations, route changes, emergency descents, conflictions and system failure.

3.7 SITE ACCEPTANCE TEST

The site acceptance test is the last stage before handover by the vendor. This test is crucial. It is the last opportunity to identify problems while the system remains the responsibility of the vendor and should be resolved at the vendor's expense. Once the acceptance documents are signed, the vendor can fairly claim that any new problems are the responsibility of the ANSP and will seek costs if asked to rectify them.

The vendor should produce a test schedule well before the tests are due to start, but it is unlikely that the schedule will contain tests that exercise operational procedures. The ANSP, in consultation with the vendor, should develop operational scenarios that will test a wide range of procedures and functions and add these to the schedule.

3.7.1 Physical Checks

The first stage is typically a physical inspection and inventory check to ensure that all items are present and serial numbers recorded accurately. It is important to inspect the physical condition of all units and record any defects.

3.7.2 Technical Tests

This is generally followed by the technical tests which establish whether the system is correctly set up and is working properly. The system parameters are usually set during these tests, though some may need to be adjusted during the operational tests. System start-up, changeover and shut-down procedures, as well as contingency degradation and recovery processes, must also be tested.

3.7.3 Operational Tests

The operational tests determine whether the operational characteristics are correct, the controls function as expected and the system handles incoming and outgoing data correctly. There should also be tests to ensure that the system operates correctly under the specified maximum load.

These tests will typically take several days to complete as all functions must be tested from all workstations. A number of typical scenarios should be prepared in advance so that the tests can be carried out in a realistic environment.

It is essential that live testing of the data link functions takes place. Tests of ADS and CPDLC will require the cooperation of either one or more airlines or alternatively an aircraft manufacturer with a suitable test-bench. If airlines are used, it must be quite clear that ATS instructions passed are for test purposes and are not to be complied with.

3.7.4 Results

As with the factory test, it is most important to record, in detail, all problems and unusual occurrences.

The outcome of the test should include an list of corrective actions to be undertaken by the vendor within an agreed timescale.

3.8 OPERATIONAL TRANSFER

The most usual ways of transferring operation to a new system are the phased transfer and the parallel operation transfer.

3.8.1 Parallel Operation Transfer

The parallel operation transfer starts with old system being used operationally and the new system running in parallel with its controllers going through their tasks as though that system was operational. When the time comes to switch over to the new system, the old is system is operated in parallel for a short time as a fall-back in case of unforeseen problems. Operation of the new system need not be full-time until shortly before transfer: for example, it would be appropriate to start parallel operations during low traffic periods and work up to busy periods. H24 parallel operation is not necessary until immediately before and after transfer.

The parallel operation transfer is generally preferable as it allows the new system to be run, in its entirety, in an environment that is as close as possible to fully operational before actually taking over the operational load. However, it does require full staffing of both systems during periods of parallel operation.

3.8.2 Phased Transfer

In the phased approach, operations are transferred bit by bit, typically one sector at a time, until the whole operation is running smoothly on the new system. This type of transfer may be more appropriate where the space available dictates that only one or two positions can be transferred at a time or where limited staff numbers mean that it is impossible to operate both systems simultaneously.

In this type of transfer, it is good practice to keep at least one sector available on the old system as a contingency position.

3.8.3 Preparation for Transfer

The transfer must be carefully planned; in particular, there must be close coordination with external ATS units that may be affected. Staff must be thoroughly briefed before the start of the transfer process and must be kept informed of any changes to the plan.

The criteria for deciding when operations can be transferred to the new system must be clearly defined in advance. If a phased transfer is planned, transfer criteria should be set for each phase.

It is quite possible that problems will arise and it may be necessary to return the operation to the current system or to the last successful step, as appropriate. The reversion process should be established in advance – if contingencies have not been planned for, it is very likely that mistakes will be made and the problem compounded.

After the transfer has been successfully completed, it is useful to hold a debriefing to determine what went well and what did not. This can identify potential problems and possible areas of concern with both the technical and the operational aspects of the system and the new procedures.

CHAPTER 4 REQUIREMENTS

4.1 GENERAL REQUIREMENTS

The integrated ATS data link system will incorporate AFN, ADS, CPDLC and AIDC.

The system will be linked with other automated systems. The FDP system provides flight plan data, such as the flight identification and flight path. The ATS operation will be enhanced if the system has the ability to feedback current aircraft positions to the FDP system to update the flight data.

The system will be linked to aircraft by a communications service provider (CSP).

The system will be capable of transmitting and receiving AFN, ADS and CPDLC messages complying with RTCA/DO258A-EUROCAE/ED-100 and AIDC messages complying with the Asia/Pacific Regional Interface Control Document for AIDC (ICD).

The system will include the ACARS Convergence Function (ACF) to convert messages between the character-oriented data of ACARS and the bit-oriented data used in ADS and CPDLC.

The system will provide air traffic controllers with:

- Display of message exchanges.
- Display of updated aircraft positions and maps.
- Tools for measuring separation in distance or time.
- Tools for measuring angles between aircraft flight paths.
- Information on aircraft flight status.
- HMI tools for composing ADS and CPDLC messages.
- Alerts for exception conditions (e.g. expected message not received, coordination overdue).
- Conflict probe capability.
- Electronic flight progress strips, and paper strips if required.
- Presentation of emergency status.
- Other information pertinent to ATS operations.

The system capacity will be determined from:

- Traffic density at the peak hours.
- Frequency and size of messages per aircraft.
- Airspace size and number of waypoints.

- Number of FANS capable aircraft operating in the airspace.
- Anticipated growth of FANS operation.
- Number of displays.
- Number of connections for terminal systems.

4.1.1 Notification of Error Messages

The system will be capable of performing the cyclic redundancy check (CRC) on each message.

The system will be capable of format and validity checks appropriate to each message.

Controllers will be notified when the system detects:

- A message error.
- A message sequence error.
- A duplicate message identification number.
- Message non-delivery.
- An expected response not received.

4.1.2 Time Stamps and Timers

All time sources used in data link communications must be accurate to within 1 second of UTC in accordance with Annexes 2 and 11.

It is important to note that 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.

CPDLC and AIDC messages will be time-stamped; however, the form of some timestamps is actually set differently from that specified in Doc 9694.

By setting and/or deactivating various timer values for the messages received in response to transmitted messages, the system will monitor whether or not aircraft responses arrive within a specified time limit.

Timers are generally based on the operational requirements of each ATSU. However, the timers for sending messages relating to the automatic transfer of CPDLC connection and to AIDC will be set according to bilateral agreements with adjacent ATSUs concerned.

A timer file will be provided in the system for:

- Timeout settings for delayed response.
- Timing to initiate actions in ADS/CPDLC operations for:

  - Connection request (CR).
  - ADS periodic, event and demand requests.
  - Automated transfer of connection to the next ATSU.
  - Sending Next Data Authority (NDA) message.
  - Sending AFN Contact Advisory (FN_CAD): at least 30 minutes prior to FIR boundary message.
  - Sending End Service message prior to the aircraft crossing the FIR boundary (e.g. 5 minutes before).
- Timer to trigger actions for sending AIDC messages.
- Timer for re-transmission of the message when no response is received within a specified time.

4.1.3 Applicable Documents

4.1.3.1 ICAO Documents

Annex 10, Volume III, Communication Systems

Manual of Technical Provisions for the Aeronautical Telecommunication Network – Doc 9750

Manual of Air Traffic Services Data Link Applications – Doc 9694

Regional Supplement to the ASTERIX Interface Control Document (ICD) for the Asia/Pacific Region

Asia/Pacific Regional Interface Control Document (ICD) for ATS Inter-facility Data Communications (AIDC)

Guidance Material for End-to-End Safety and Performance Monitoring of ATS Data Link Systems in the Asia Pacific Region

4.1.3.2 Industry Standards

The industry standards for ATS data link systems are described in the latest versions of the following documents.

- ARINC 622: ATS Data Link Applications over ACARS Air-Ground Network (end-to-end).
- RTCA DO-258/EUROCAE ED-100: Interoperability Requirements for ATS Applications Using ARNC 622 Data Communications.
- ARINC 620: Data Link Ground System Standard and Interface Specification (ground-to-ground).
- ARINC 619: ACARS Protocols for Avionics End Systems (Airborne).

- ARINC 429: Mark 33 Digital Information Transfer System (DITS).
- FANS 1/A Operations Manual (FOM)
- RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data Link Services in Oceanic and Remote Airspace *(Oceanic SPR Standard)*

Note: It should be noted that some message parameters for avionics are categorized as 'option' data, but provide information useful for ATS operations.

4.1.4 Data Recording

The contents and timestamps of all messages will be recorded by the system. There will be a facility to retrieve, display and printout the recorded data.

4.1.5 System Performance Monitoring Tool

The Central Reporting Agencies (CRAs) perform safety assessments of data link performance, and to support this function, in accordance with the FOM, ATSUs are required to produce monthly statistics of end-to-end system performance in daily operations. The system performance criteria from the RTCA DO-306/EUROCAE ED-122 Oceanic SPR Standard are reproduced at APPENDIX C. The system should have appropriate tools for monitoring and analysing the performance data for reporting to the appropriate monitoring agency.

4.2 DATA LINK INITIATION CAPABILITY

4.2.1 AFN Logon Functions

The AFN logon functions provide the necessary information to enable ADS and CPDLC communications between the system and aircraft avionics systems for:

- Logon.
- Forwarding logon information to the next ATSU.

Note: Details of Data Link Initiation Capability (DLIC) functional capabilities are provided in Doc 9694 Part 2.

The required capacity for AFN logons will be determined from the operational requirements, such as estimated number of FANS aircraft at the peak hours and anticipated growth of FANS traffic.

The system must be capable of accepting or rejecting AFN logon requests.

The system will be linked with the FDPS to correlate the AFN logon data automatically with the aircraft flight plan.

The controller's workstation should be capable of displaying the following data:

- Address and version number of the aircraft applications, if required.
- Response from the aircraft with timestamp.
- Status of correlation of the aircraft with its stored flight plan.
- Indication of ‘Acceptance’ or ‘Rejection’ to the logon request from aircraft.

When an aircraft downlinks its supported applications and their version numbers in an FN-CON message, the ground system response must indicate whether or not it supports those version numbers.

The system must be capable of sending the Acceptance message or the Rejection message with reason, as appropriate.

4.2.2 Use of AIDC for Forwarding AFN Message

The ATS system should be capable of sending the FANS application message (FAN), in accordance with the ICD. When possible, the system should use the AIDC FAN message for address forwarding in preference to the AFN application.

4.3 CPDLC

4.3.1 General

The required capacity of the CPDLC function will be determined by taking account of the operational policy and procedures and the airspace characteristics, such as the number of FANS-capable aircraft, airspace size and number of waypoints, the communications necessary in ATS operations, and of the estimated future growth of data link operations.

The system will be capable of processing the specified number of message exchanged with each of the aircraft.

Down-linked CPDLC messages will be displayed to controllers. Tools must be provided to allow simple and intuitive initiation of, or response to, CPDLC messages.

Note: The size of the free text field is limited to 80 characters (instead of 256) for some specific aircraft types.

CPDLC position reports should be used to display aircraft positions when no ADS report is available.

The system will have the capability of terminating CPDLC connection with the aircraft.

4.3.2 Transfer of CPDLC between ATC Sectors

The system will allow transfer of CPDLC between sectors of an ATSU without changing the data authority and with the same CPDLC link.

4.3.3 CPDLC Message Exchange Requirements

The system will be capable of handling the message set and the standardized free text messages defined in the RTCA DO-306/EUROCAE ED-122 Oceanic SPR Standard and the FOM, as well as free text.

The system will allow controllers to review uplink messages prior to sending.

4.3.4 Message Handling Order

Messages will be handled in order of priority.

Messages with the same priority will be processed in the time order of receipt.

The controller will be alerted to unsuccessful receipt of the required response in the specified time or receipt of Message Assurance Failure (MAF).

4.3.5 Responses

The system will allow controllers to send any response messages linking with the reference number of the message received. The relationship between the message and its intent and the response requirement is defined in the FOM.

4.3.6 Message Closure

A CPDLC dialogue will not be closed until an appropriate closure response for that message with same reference number is received.

When the closure response message is sent, the dialogue is closed and the system will reject any further attempt to send a response message.

The capability of closing a CPDLC dialogue, independent of CPDLC closure message receipt, will be provided.

4.4 ADS

4.4.1 General

The capacity of the ADS function will be determined from the operational policy and procedures and the airspace characteristics, including number of FANS capable aircraft, periodic reporting rate, airspace size, waypoint event report frequency, usage of event and demand contracts, and projected traffic growth.

The system will be capable of initiating periodic, event and demand contracts.

The system will be able to support a demand, an event and a periodic contract simultaneously with each aircraft.

The system will apply validation checks to incoming data by reference to flight plan data in relation to time, altitude, direction and position.

The system will be capable of processing ADS reports to display aircraft positions, tracks and altitude. Between ADS reports, aircraft positions will be extrapolated and displayed automatically at specified intervals.

The data link system should have the capability of supporting 30NM lateral and 30NM longitudinal distance based separation standards.

Air and earth reference data of ADS reports will be provided for controllers if required.

The types of ADS contract are described at 5.3.1 ADS.

4.4.2 Message Handling

ADS messages will be processed by the system in the following order:

1. ADS emergency mode.
2. Demand/event reports.
3. Periodic report.

Within these categories, messages will be handled in the order received.

The following errors will be notified to controllers:

- Message validation error.
- Message sequence error detected with time stamp.
- Time-out of ADS report in response to request.
- Periodic and waypoint event report failure.

4.5 AIDC

4.5.1 General

General descriptions of AIDC applications, requirements, functional capabilities, and message contents are provided in the latest version of the ICD.

The AIDC application exchanges ATC coordination information between ATSUs.

Bilateral agreements between ATSUs are necessary to determine the operational and system requirements for both ATSUs, and should be made before developing the system. These agreements should cover:

- The ICD to be applied – Asia/Pacific or other ICD.
- message set to be used.
- usage of messages (e.g. timing of transmission).

The AIDC application requires that:

- messages are generated and sent in time-ordered sequence.
- messages are delivered in the order in which they are sent.

When an ATSU queues received messages, messages with the highest urgency type will be placed at the beginning of the queue. Messages will be assigned one of the following urgency attributes:

- Normal.
- Urgent.
- Distress.

The time used in the AIDC application will be accurate to within 1 second of UTC.

A timestamp will be generated when the message is dispatched and will consist of the date (YYMMDD) and time (HHMMSS).

Where an AIDC message is linked to a previously sent message, the message will contain reference information, including the ID of the referenced message.

4.5.2 Asia/Pacific Interface Control Document (ICD)

The Asia Pacific ICD for AIDC provides the standardized procedures for inter-facility message exchanges.

(The purpose of the ICD is to ensure that inter-facility message exchanges between ATSU equipped with automated ATS systems in the Asia/Pacific Region are harmonized to a common standard.)

Until ATN becomes available, the engineering details needed to implement the exchange of messages described in Appendix A of the ICD will need to be agreed to bilaterally.

4.5.3 Message Header

Every message will contain an AFTN header. The AFTN IA-5 message header, including the use of the Optional Data Field defined in Annex 10, will be employed for the exchange of data. AFTN priority indicator FF will normally be used for all data exchanges.

A message header consists of the optional data field (ODF), addressing, message/data identification number, reference information, time stamp and cyclic redundancy check (CRC).

4.5.4 ATS Coordination Messages

AIDC provides the means by which data is exchanged between and within ATSUs for the notification of flights approaching FIR boundary, the coordination of boundary crossing conditions and the transfer of ATC services.

AIDC messages are also used to exchange emergency, track definition, and application management information as well as for transfer of surveillance data.

4.5.5 Detailed Information Provided in ICD

The appendices to the ICD describe:

- ATS coordination messages (Appendix A).
- Error codes (Appendix B).
- ATM application naming conventions (Appendix C).
- Implementation Guidance Material – IGM (Appendix D).
- Relationship to ICAO AIDC messages (Appendix E).

4.5.6 Performance Requirements

The performance requirements for the trip time of messages need to be specified and agreed to with neighbouring ATSUs to ensure effective use of AIDC. Recommended performance figures are specified in Appendix D of the ICD.

The methodology for monitoring AIDC performance is provided in Appendix A of the Guidance Material for End-to-end Safety and Performance Monitoring of ATS Data Link Systems in the Asia/Pacific Region.

CHAPTER 5 SPECIFICATION

The development of the specification should, wherever possible, be a team effort, with operational and technical personnel working together to achieve the optimum result. System specifications should be based primarily on operational requirements; the technical specifications should be framed to support those requirements.

In developing a specification for any technical system, it is important to achieve the right level of detail. Too little detail leaves the purchaser at the mercy of potential suppliers, while too much may preclude suppliers from offering very suitable equipment. In general, it is probably appropriate to specify requirements in great detail only where those requirements are essential to the operation, and otherwise to leave the supplier a reasonable amount of freedom. An off-the-shelf system can be expected to be less expensive than one that is custom-designed.

It is also important to get the specification right. Proposals will be priced on the specification, and any changes required later, particularly after the contract is signed, will be costly in terms of price and completion time.

This section on specification covers the system configuration, its interfaces with other systems, its functionality, the operator interface, system capacity, and recording and data analysis.

5.1 SYSTEM CONFIGURATION

The system configuration depends upon the operational environment. In specifying the configuration, a number of issues must be considered:

- Is it to be a stand-alone ADS/CPDLC/AIDC system, is it to be part of an integrated system or is it to be interfaced with a separate ATM system?
- How many sectors are required?
- How many workstations are required per sector? If more than one, why?
- What contingency configuration is required?
- Is complete duplication of the system required?
- What are the requirements for main/standby computers and independent contingency workstations?
- Will there be duplication of communications bearers? If so, which ones?
- Assuming the normal operational configuration is one workstation per sector, how many contingency workstations are required?

5.2 INTERFACES

The System must have a number of interfaces to send and receive data; some of these are essential, others may be useful or just nice to have. This section concentrates on the essential and the useful.

5.2.1 Data Link Communications Service Provider

In the current FANS 1/A environment, ADS and CPDLC messages are passed between aircraft and the System using the ACARS data messaging system. ACARS was developed by the data link communications services providers (CSPs) to pass information between the airline operating centre (AOC) and the aircraft. ADS and CPDLC required an air-ground data link and, in the absence of the Aeronautical Telecommunication Network (ATN), the ACARS system was used.

Access to the ACARS data link is available only from the CSPs; ARINC and SITA are the major CSPs; they provide global coverage and complete management of the signal between the ATSU and the aircraft, including selection of most appropriate data link path (VHF, satellite or HF). There are also some national or regional CSPs, such as AVICOM Japan.

It is essential therefore to specify the appropriate interface port(s) to connect to the chosen CSP. This is typically an RS232 serial port, but the exact requirement should be confirmed with the CSP.

5.2.2 ATN

It is intended that the ADS and CPDLC functions will eventually be carried by the ATN. The purpose of the ATN is to "provide data communication services and application entities in support of the delivery of air traffic services (ATS) to aircraft; the exchange of ATS information between ATS units; and other applications such as aeronautical operational control (AOC) and aeronautical administrative communication (AAC)." [Annex 10, Vol III, 3.3]

It is important, therefore, that any new system should either include provisions for, or have a defined upgrade path to provide, interfacing with the ATN.

ICAO Doc 9705 - Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN) is the appropriate source of interface data for the ATN.

At present, the ATN is under development and trials are being carried out in several ICAO Regions.

5.2.3 AFTN/AMHS

The AFTN is currently the carrier for ground-ground messaging between ATC units and carries AIDC messages in the FANS 1/A environment. The AHMS (Aeronautical Message Handling System) is the ground-ground messaging application of the ATN. The AMHS is also referred to as the ATSMHS (ATS Message Handling System).

AIDC messages will be passed via the AFTN until the ATN is operational. However, AFTN/AMHS gateways will increasingly be used to provide a transition between the AFTN and ATN. These gateways transpose AFTN messages into AMHS format and vice versa.

Any new system should include at least one AFTN/AMHS gateway. AIDC messages generated in AMHS structure can then be transmitted via the AFTN and incoming messages from the AFTN will be transposed to AMHS structure. After the ATN becomes operational and the AFTN is no longer used, the gateway can be removed.

5.2.4 ATS systems

In many cases, interfaces to other ATS systems will be necessary. This may be because an ADS/CPDLC system will use the flight data or other processing capability of another system or because the new system will be directly connected to another system.

5.2.4.1 Flight Data Processing System

Where an ADS/CPDLC system is to rely on an existing system to provide flight data, the interface required will depend on the data to be passed. The ADS/CPDLC system may have no flight data processing capability and merely require flight plan information for identification purposes, or it may have some capability to up-date flight plans received from the other system and return the up-dated information.

In either case, the interface may need to transform data formats between the 2 systems. It is therefore essential that the data formats used by the existing system are detailed in the specification so that they are allowed for in proposals; otherwise, costly contract variations may be required.

5.2.4.2 Radar Data Processing System

Data imported from a separate radar data processing system will take the form of track data or possibly plot data. As with interfaces for flight data, it is most important to detail the radar data formats in the specification.

If ADS data is to be exported to a separate radar data processing system or display system, the formats required by those systems also must be detailed.

5.2.4.3 Direct Connection between Systems

When a full system (with FDPS and perhaps RDPS as well as ADS/CPDLC/AIDC) is to be connected directly to an existing system for full data interchange, details of all the data formats of the existing system should be included in the specification.

5.2.5 Radar Data

If the System is to receive direct radar feeds from existing radars, the output data format of each radar must be detailed.

Most new systems are designed around the ASTERIX surveillance data formats; specifying ASTERIX where possible will allow the greatest flexibility for the future. The ASTERIX Standard was adopted as the ICD for surveillance data exchange for the Asia/Pacific Region in 1998. Information on ASTERIX may be found at: http://www.eurocontrol.int/asterix/public/subsite_homepage/homepage.html

The "Regional Supplement to the ASTERIX Interface Control Document for the Asia/Pac Region" gives details of location-specific ASTERIX coding.

Inputs from military radars may be non-standard or require additional processing; any available details should be included.

5.2.6 ADS-B Data

Where ADS-B data is available or anticipated, the system should be capable of accepting and processing such data.

5.2.7 Meteorological Data

Many modern systems make provision for the use of meteorological data for updating predicted waypoint times in near-real time. However, this type of prediction may require very large amounts of data and may not be justified if experience shows that weather variations have very little effect on the routes concerned or where the weather patterns are such that occasional manual input would suffice.

If there is a requirement for regular automatic data input, the available sources of data should be investigated and the appropriate formats should be specified.

5.3 FUNCTIONALITY

This section covers the core applications of the system, ADS, CPDLC and AIDC, and their supporting functions, AFN and ACF.

5.3.1 ADS

ADS is a means of surveillance in which an aircraft reports its current position, intent and other pertinent information via the data link function to an ATSU. ADS is detailed in ARINC 745-2.

The ADS reporting rate and the types of data to report are determined by ADS contract requests from an ATSU. An aircraft can report to up to four ATSUs simultaneously.

There are three types of ADS contract: the periodic contract, the event contract and the demand ("one-shot") contract.

5.3.1.1 Periodic Contract

The ATSU sets up a periodic contract with the aircraft to obtain regular position reports; the contract specifies to the aircraft the reporting rate, any optional data groups be added to the basic ADS report, and the frequency at which the optional groups are to be included in the reports.

Only one periodic contract can be established between an ATSU end system and a particular aircraft at any one time. The periodic contract normally remains in effect until the contract is cancelled by the ATSU.

The system must be capable of pre-defining the reporting rate as a system parameter and of allowing the controller to change the rate, on a case by case basis, to meet operational requirements.

The system must also allow the controller to include any of the permissible additional data groups in a periodic contract request.

Some systems have the capability of automatically changing the reporting rate from one area to another; however, this could increase system cost and complexity.

5.3.1.2 Event Contract

An event contract specifies a request for reports whenever a defined 'event' occurs. Only one event contract can be established between a ground system and a particular aircraft at any one time; however, the event contract can contain multiple event types. There are four event types.

The **Vertical Rate Change Event** is triggered when the aircraft's vertical rate is either less than or greater than a parameter defined in the contract.

The **Lateral Deviation Change Event** is triggered when the aircraft's actual position exceeds a lateral distance parameter from the aircraft's expected position on the active flight plan in the FMC.

The **Altitude Range Change Event** is triggered when the aircraft's altitude exceeds the altitude ceiling or floor defined in the contract by the ground system.

Once a vertical rate, lateral deviation or altitude range event trigger has occurred, a recurrence of this event no longer triggers an event report. If required, a new event contract must be initiated each time one of these specific events occurs.

The **Waypoint Change Event** is triggered by a change to the next or the next-plus-one waypoints. Such a change normally occurs due to routine waypoint sequencing. However, it will also be triggered by occurrences such as a change to a non-ATS waypoint entered by the pilot for operational reasons, or execution of a new route affecting the next or next-plus-one waypoints. Unlike the other event contracts, the waypoint change event trigger remains in effect for all waypoint changes.

Once an event contract has been established, it remains in effect until the specific event requests are fulfilled, or it is cancelled by the ground system.

The system must be capable of pre-defining the event trigger parameters and of allowing the controller to change the event parameters as required.

5.3.1.3 Demand Contract

The demand contract is a "one-off" request from the ground system for an ADS report containing specific data as defined in the request. A demand contract can be requested by the ground system at any time. The demand contract request does not affect any existing contracts.

The system must allow the controller to initiate a demand contract, including optional data fields.

5.3.1.4 Emergency Mode

The emergency mode can only be activated by the pilot and is normally cancelled by the pilot. While it is possible for a ground system to cancel the emergency mode status, most ground systems do not have this capability; however, some ground systems allow the controller to modify the "display" of the emergency mode status.

The system must recognise the emergency flag and display the emergency status to the controller.

5.3.2 CPDLC

CPDLC provides a two-way message system between controller and pilot. It comprises an number of pre-defined up-link and down-link messages, some of which are complete in themselves, while others require data (such as time, flight level, etc) to be added. There are also two free-text messages available in each direction, one reserved for emergency use.

To send a message, the controller selects the required message and enters any required data. (Options for selecting messages and entering data are discussed below under Human-Machine Interface.) The system then automatically codes the message in bit-oriented format and presents it for transmission.

On reception of a down-link message, the CPDLC application decodes the message and presents it to the controller.

The current message set is detailed in the RTCA DO-306/EUROCAE ED-122 Oceanic SPR Standard and the FOM, and the system must provide the complete up-link message set and be capable of accepting and decoding the complete down-link message set.

Some message sequences require “closure”:

- A message requiring a response remains open until a referenced response is received.
- A message is closed when either a response is not technically required, or after a referenced response other than STANDBY or REQUEST DEFERRED has been received.

The system must manage message closure protocols in accordance with the requirements of the RTCA DO-306/EUROCAE ED-122 Oceanic SPR Standard and the FOM.

5.3.3 ACF

ADS and CPDLC both operate on bit-oriented data, while ACARS is character-oriented. The ACARS Convergence Function (ACF) converts the bit-oriented data of ADS and CPDLC to the character-oriented data used by ACARS, and vice versa.

If the system is to operate over ACARS, the ACF must be specified as an essential requirement.

(The ACF is not required where the ATN is the carrier.)

5.3.4 AFN

The AFN function provides the transfer of information required to support the initiation of data link connectivity between an aircraft and an ATSU. The AFN is a character-oriented application.

Because it is essential to ADS and CPDLC operation over ACARS, the AFN function as detailed in ARINC 622-4 must be a requirement of the system specification.

5.3.5 AIDC

The AIDC application supports information exchanges for notification, coordination, and the transfer of communications and control functions between automated ATS systems located at different ATSUs.

The AIDC message set is defined in the ICD. This message set was based on ICAO agreed methods and messages wherever possible; elsewhere, new messages used existing ICAO field definitions to the extent possible.

5.4 OPERATOR INTERFACE

5.4.1 Human Factors

Human factors play a major part in the success or failure of a system to meet its operational objectives. A system that is uncomfortable to use will lead to controller dissatisfaction, which as controllers are an essential part of the overall system, can only degrade the overall system performance.

Displays and keyboards that are poorly designed from a human factors aspect will be inefficient and may cause actual harm to the users. Bad display design can affect the eyes and bad keyboard design may result in occupational overuse syndrome (repetitive strain injury). The human factors implications of the system specification should be very carefully considered, and it may be appropriate to get specialist advice.

5.4.2 Displays

One or more displays are required to handle the ADS, CPDLC and AIDC messages. Many systems incorporate message handling in the situation display.

Modern displays use LCD technology and may be as large as 600 x 600mm, with typical resolution of 2048 x 2048 pixels. Smaller displays may be more appropriate for some uses, particularly if there are 2 displays at a controller position: a second display is often used for flight data handling. However, the arrangement of displays will largely depend on the extent to which the new system is to be integrated with existing systems.

While colour displays offer great advantages in differentiating between different categories of data, the choice of colours for the various categories can be very contentious. It is essential that colour allocation is not arbitrarily decided, but is based upon sound human factors principles. Inappropriate colour choices can contribute to fatigue, confusion and errors. To avoid these problems, a human factors expert should be engaged to advise on the use of colour.

Different symbols should be used for radar tracks, ADS-B tracks, ADS-C tracks and tracks generated from flight plan information. The track symbol should be that of the source of the highest quality information. At the current stage of development of ADS-B systems, radar is generally accepted as the best surveillance data, followed by ADS-B and then by ADS-C. Flight plan tracks are the lowest quality.

The status of the CPDLC connection is important information for the controller and is best displayed in the track label.

5.4.3 Message Handling

Message handling for ADS, CPDLC and AIDC messages is usually achieved by some form of menu access for generating messages and by pop-up windows for replying to incoming messages. Most systems now offer access via the track label.

For CPDLC, there are two elements to generating most messages: selection of the specific message and entry of necessary data. The message selection should be simple: there are about 180 uplink messages available. Some systems present a selection of appropriate messages – for example, by offering only height-related messages if the height field in the track label is selected. ADS contract messages are more simple and infrequently required, so that a simple menu-type operation is normally adequate. AIDC messages can usually be generated automatically form flight plan data.

If a particular message handling method is required, it should be clearly stated in the specification.

The language for all menus and message sets should be English: English is the de facto language for radiotelephony within the Asia-Pacific Region. While it may seem attractive for menus and CPDLC messages to be displayed in a local language, this will inevitably lead to loss of English language proficiency and so will work against the ICAO language proficiency provisions in Annexes 1, 6, 10 and 11. These provisions require that from March 2008, pilots, aeronautical station (radio) operators and air traffic controllers shall demonstrate the ability to speak and understand the language used for radiotelephony communications to specified levels.

5.4.4 Input Devices

The controller input devices include the text input device and the pointing device.

The text input device is normally a keyboard and there are various types of keyboard (standard, ergonomic, etc). The type should be specified if it is considered important; however, it is worth noting that controllers do not have to input large amounts of text in an ADS/CPDLC system. Touch panels may be offered instead of keyboards.

The mouse is the most common and probably most flexible pointing device; others include the track-ball and the light pen. It is difficult to locate a track-ball and keyboard so that they are well-placed for both left- and right-handed people, and light pens have been poorly received by many controllers.

Wireless connections for the input devices will reduce the clutter on the workstation working surface and allow more freedom of movement for the pointing devices. However, electro-magnetic compatibility with nearby equipment must be carefully considered.

5.5 CONTROLLER TOOLS

Controller tools include such items as:

- Conflict probe
- Temporary maps
- Bearing-distance lines
- Velocity vectors
- Label overlap avoidance

5.5.1 Conflict Probe

Conflict Probe is a tool to determine whether a proposed flight plan will come into conflict with another during a specified period.

The Conflict Probe is normally initiated by the controller for a particular aircraft. The probe compares the proposed trajectory with the current planned trajectories of other aircraft information and displays the position and time of calculated conflicts to the controller. The period covered by the probe is typically fairly long (up to several hours), as the main use of Conflict Probe is when a routing change is proposed under a flexible track regime.

Conflict Probe is a very complex function, requiring considerable computer power, and consequentially can be expected to be expensive.

5.5.2 Temporary Maps

Temporary maps allow controllers to depict on the display areas of interest on a temporary basis. Temporary maps should be simple both to construct – a few straight lines is usually adequate – and to switch on or off on the display.

5.5.3 Bearing-Distance Line

As its name suggests, a bearing-distance line allows a controller to measure the bearing and distance between 2 points on a display. The points might be an aircraft track symbol and a reporting point or 2 aircraft track symbols.

Some systems allow one or both ends of the line to lock on to an aircraft track symbol, so that the bearing and distance information displayed is updated as the aircraft move.

Multiple bearing distance lines, if available, can be useful.

5.5.4 Velocity Vectors

Velocity vectors display a vector from the track symbol showing the calculated position of the track after a specific time. The time is normally preset to a default value (typically 2 minutes); most systems allow the controller to set a different value.

Some systems also allow velocity vectors to be shown for all tracks or for a selected track only.

5.5.5 Label Overlap Avoidance

Label overlap avoidance allows the track labels to be moved to avoid labels overlapping one another. This is done by rotating some labels to new positions relative to the track symbol or by changing the distance of some labels from their symbols. The process is normally automatic, but should allow the controller to set selected labels to a preferred position.

5.6 SYSTEM CAPACITY

The required system capacity is directly related to the number of ADS, CPDLC and AIDC messages, the number of radar tracks, the number of active flight plans, the number of workstations and so on. These, in turn, are directly related to the volume of traffic, particularly the peak traffic volume.

The system capacity is normally expressed as the number of active flight plans that the system can handle at one time; in this context, “active” means that the system is using or processing the flight plan information in some way.

It is clearly important that the system capacity should allow for traffic growth over the projected life of the system, which for modern systems is typically 5 to 7 years between major upgrades or replacement. The anticipated growth should therefore be carefully assessed using the best projections available, and should allow for daily and seasonal traffic peaks.

However, it is also important not to set the capacity requirement too high, as this will almost certainly result in increased cost.

Some growth rates over those periods are shown below to give an indication of future capacity requirements based on current traffic:

Anticipated Annual Growth	Total Growth over		
	5 years	6 years	7 years
5%	28%	34%	41%
7.5%	44%	54%	66%
10%	61%	77%	95%

5.7 RECORDING AND DATA ANALYSIS

The system should record all incoming and outgoing ADS, CPDLC and AIDC messages for use in incident and accident investigations. It is imperative that all recordings are time-stamped. Messages are typically recorded onto a tape cartridge or DVD, and the system should allow change-over of the cartridge or DVD with no interruption to the recording.

Annex 10 Vol II and Annex 11 require communications, including AIDC and CPDLC, to be recorded and the recordings to be retained for at least 30 days for accident/incident investigation purposes. Chapter 3 of the FOM details some specific recording requirements for both safety investigation and performance monitoring.

The recording system should allow replaying of the situation and identification of messages were sent or received by the system.

Provision should also be made to record data for use by the agencies monitoring reduced horizontal separation (lateral and longitudinal) being applied in accordance with ICAO Performance Based Navigation (PBN) provisions, RVSM and data link performance. These are the Safety Monitoring Agency (SMA), the Regional Monitoring Agency (RMA) and the Central Reporting Agency (CRA) respectively. Generally, the data required by RMAs and SMAs is captured by the FDPS.

Increasingly, the requirements associated with reduced separation minima will include a specified Required Communication Performance (RCP) parameter to be met (e.g. RCP240, RCP400) and data link performance will also need to be monitored against the technical elements of RCP. Therefore, arrangements should be made to also record appropriate data to enable RCP analysis to be conducted.

To meet CRA requirements, the specification should include a requirement for data link performance monitoring tools and analysis software. The analysis software should, at the least, be capable of extracting time-stamps, addressees and message types from all incoming and outgoing messages.

The table below summarises the FOM data link monitoring requirements for ANSPs.

Requirements	Monitor/Record
Operational Procedures	Time stamped ATS messages with identification and reference numbers
	Message Assurance
	Anomaly event report
Performance	End-system availability
	Transit times
Safety (i.e. operational, performance and interoperability requirements which are used to mitigate the effect of a failure condition)	Time stamped ATS messages with identification and reference numbers/MAS
	Anomaly event reports
Interoperability	Time stamped ATS messages with identification and reference numbers/MAS

APPENDIX A GLOSSARY

ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Aircraft Collision Avoidance System (ICAO
ADS	Automatic Dependent Surveillance
AEEC	Airline Electronic Engineering Committee
AFN	ATS Facilities Notification
AFTN	Aeronautical Fixed Telecommunication Network
AIDC	ATC Inter-Facility Data Communications
AIP	Aeronautical Information Publication
AMHS	Aeronautical Message Handling System
ANSP	Air Navigation Service Provider
AOC	Airline Operational Communications
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
ARINC	Aeronautical Radio Incorporated
ATC	Air Traffic Control
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSMHS	ATS Message Handling System
ATSU	ATS unit
AVICOM	AVICOM Japan Co. LTD
CAA	Civil Aviation Authority
CNS	Communications, Navigation, Surveillance
CPDLC	Controller Pilot Data Link Communications
CRA	Central Reporting Agency (for data link)
CRC	Cyclic Redundancy Check
CSP	Communications Services Provider
DL	Downlink message
DSP	Data Link Service Provider
EUROCAE	European Organization for Civil Aviation Equipment
FANS	Future Air Navigation System
FIR	Flight Information Region
FIT	FANS Interoperability Team (IPACG, ISPACG) FANS Implementation Team (FIT-BOB, FIT-SEA)
FMC	Flight Management Computer
FMS	Flight Management System
GES	Ground Earth Station (satellite)
GPS	Global Positioning System (USA)
HF	High Frequency (3-30 MHz)
IATA	International Air Transport Association

ICAO	International Civil Aviation Organisation
IFATCA	International Federation of Air Traffic Controllers Associations
IFALPA	International Federation of Air Line Pilots' Associations
IPACG	Informal Pacific ATC Coordinating Group
ISPACG	Informal South Pacific ATS Coordinating Group
MAS	Message Assurance (data message)
MCDU	Multipurpose Control Display Unit (ACARS & FMC)
MU	Management Unit (ACARS)
NDA	Next Data Authority
NOTAM	Notice To AirMen
PBN	Performance Based Navigation
RASMAG	Regional Airspace Safety Monitoring Advisory Group of APANPIRG
RCP	Required Communication Performance
RMA	Regional Monitoring Agency (for RVSM)
RNP	Required Navigation Performance
RTCA	RTCA Inc.
RVSM	Reduced Vertical Separation Minima
SATCOM	Satellite Communication
SATVOICE	Satellite Voice Communication
SITA	Société Internationale de Télécommunications Aéronautiques
SMA	Safety Monitoring Agency (for RNP)
SR&O	System Requirements and Objectives (FANS-1 document)
TCAS	Traffic Alert and Collision Avoidance System (USA)
TMU	Traffic Management Unit
UL	Uplink message
VHF	Very High Frequency (30-300 MHz)

APPENDIX B REFERENCES

Annex 10, Volume III, Communication Systems		ICAO
Procedures for Air Navigation Services, Air Traffic Management	Doc 4444	ICAO
Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN)	Doc 9750	ICAO
Basic Air Navigation Plan – Asia and Pacific Regions	Doc 9673	ICAO
Manual on Airspace Planning Methodology for the Determination of Separation Minima	Doc 9689	ICAO
Manual of Air Traffic Services Data Link Applications	Doc 9694	ICAO
Safety Management Manual	Doc 9859	ICAO
Asia/Pacific Regional Plan for the new CNS/ATM Systems		ICAO Asia Pacific Office
Regional Supplement to the ASTERIX Interface Control Document (ICD) for the Asia/Pac Region		ICAO Asia Pacific Office
Asia/Pacific Regional Interface Control Document (ICD) for ATS Inter-facility Data Communications (AIDC)		ICAO Asia Pacific Office
Guidance Material for End-to-End Safety and Performance Monitoring of ATS Data link Systems in the Asia Pacific Region		ICAO Asia Pacific Office
FANS 1/A Operations Manual		
Interoperability Requirements for ATS Applications using ARINC 622 Data Communications	DO-258A / ED-100A	RTCA and EUROCAE
Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace (Oceanic SPR Standard)	DO-306 / ED-122	RTCA and EUROCAE
Air-Ground Character-Oriented Protocol Specification	618-5	ARINC
Data Link Ground Systems Standard and Interface Specification (DGSS/IS)	620-5	ARINC
ATS Data Link Applications Over ACARS Air-Ground Network	622-4	ARINC
Aircraft Communications Addressing Reporting System (ACARS)	724B-5	ARINC
Air Traffic Services Systems Requirements & Objectives (ATS SR&O)		Boeing

APPENDIX C PERFORMANCE CRITERIA

SYSTEM PERFORMANCE CRITERIA

The *RTCA DO-306/EUROCAE ED-122 Safety and Performance Standard for Air Traffic Data link Services in Oceanic and Remote Airspace* (Oceanic SPR Standard) contains the safety and performance requirements for data link services that need to be met and verified. This does not prevent ATS service providers from negotiating more constraining contractual requirements with their communication service providers if necessary.

Note *The Oceanic SPR standard provides an availability requirement for safety of 0.999, however to enable operational efficiency in some environments, the FANS-1/A availability requirement is set at 0.9999. This 0.9999 availability requirement translates on a per ATSP basis to:*

- *No more than 4 outages (affecting a significant portion of aircraft) greater than 10 minutes for any 12 month period;*
- *Failures causing outages for multiple OACs are not counted more than once; and*
- *No more than 50 minutes of total downtime for any 12 month period.*

The Tables and Figure below summarise the requirements of the Oceanic SPR Standard

Performance Criteria	Definition	Values
RCP 240/D	Normal means of communication for application of 30 NM lateral separation and reduced distance-based longitudinal separation minima	Communication Transaction time ET 240 (sec)
***Note**: Communication Transaction time is defined as the maximum time for the completion of an operational transaction after which the initiator reverts to an alternative procedure. (ICAO Doc 8689*)		

RCP400/D	Normal means of communication for application of lateral separation greater than or equal to 50 NM and time-based longitudinal separation. Alternative means of communication for application of 30 NM lateral separation and reduced distance-based longitudinal separation minima	ET 400 (sec)
Surveillance **50 NM Longitudinal** **30 NM Longitudinal** **30 NM Lateral**	Normal Surveillance: (position report delivery) Non-normal Surveillance: (Controller initiated position report request)	ET 180 (sec) ET 240 (sec)
Surveillance **>50NM Lateral** **>=10 mins time based**	Normal Surveillance	ET 400 (sec)
Availability	The probability that an operational communication transaction can be initiated when needed (ICAO Doc 8689)	99.99%
Continuity	The probability that an operational communication transaction can be completed within the communication transaction time (ICAO Doc 9869)	99.9%
Integrity	The probability of one or more undetected errors in a completed communication transaction.	10^{-5}/hour

RCP type	**RCP 240/D**		**RCP 400/D**	
Time Parameter	ET	95%	ET	95%
Time Value	240	210	400	350
RCP Time Allocations				
Initiator	30	30	30	30
TRN	210	180	370	320
TRN Time Allocations				
Responder	60	60	60	60
RCTP	150	120	310	260
RCTP Time Allocation				
Aircraft	15	10	15	10
Communication service	120	100	280	240
ATS unit	15	10	15	10
Note 1: Values shown in seconds.				
Note 2: Expiration time (ET) is at the continuity requirement, which is 99.9%.				

Table 1: *50 longitudinal and 30/30 - intervention (DO-306/ED-122, Table 5-6)*

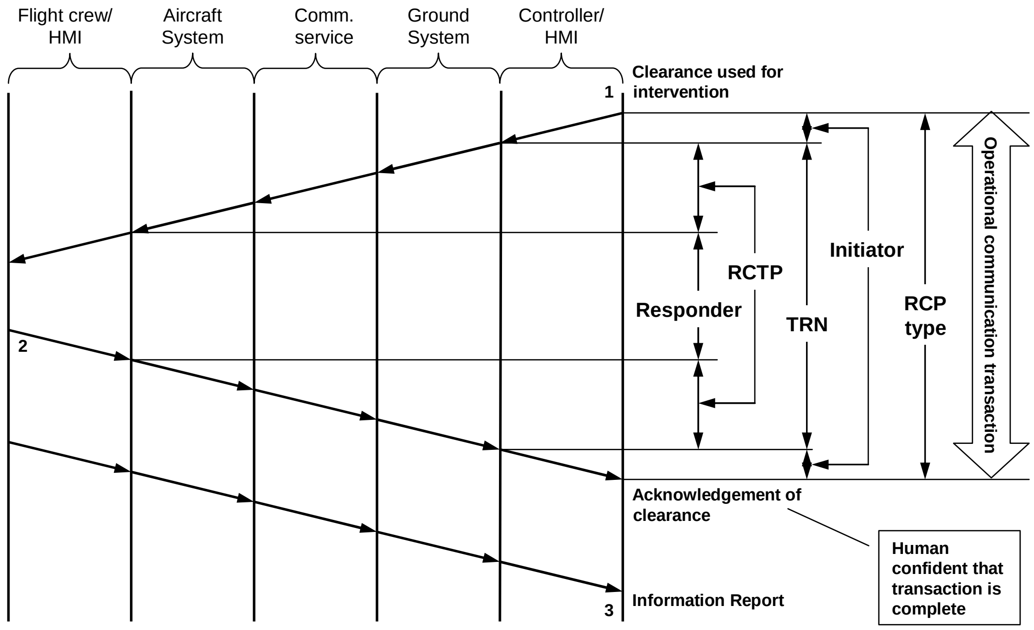

Figure 1: *RCP allocations for intervention capability (DO-306/ED-122, Figure 5-3)*

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);
- SMA – Safety Monitoring Agency – safety assessment and monitoring in the horizontal plane (i.e. RHSM, 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 30 May 2008)

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed (FIRs)
Australian Airspace Monitoring Agency (AAMA) - Airservices Australia Mr Robert Butcher, Manager Human Factors and Analysis, Safety Management Group, email robert.butcher@airservicesaustralia.com	Australia	APANPIRG RMA	Current	Brisbane, Honiara, Jakarta, Melbourne, Nauru, Port Moresby and Ujung Pandang FIRs.
		SMA	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)** Mr. Tang Jinxiang, Engineer of Safety and Monitoring Technical Group, ATMB e-mail: tangjx@adcc.com.cn	China	RMA *(**note:** RASMAG/9 recommended that APANPIRG/19 [September 2008] approve China as Asia/Pacific RMA*	Current	Beijing, Guangzhou, Kunming, Lanzhou, Shanghai, Shenyang, Urumqi and Wuhan FIRs and Sector 01 (airspace over Hainan Island) of the Sanya FIR.
JCAB RMA - **Japan Civil Aviation Bureau** Mr. Masao Kondo, Special Assistant to the Director, Flight Procedures and Airspace Program Office, email kondou-m2pd@mlit.go.jp	Japan	APANPIRG RMA	Current	Fukuoka FIR
		SMA	Available second quarter – 2009	Fukuoka FIR
Monitoring Agency for the Asia Region (MAAR) – Aeronautical Radio of Thailand LTD Mr. Nuttakajorn Yanpirat, Executive Officer, Systems Engineering,Aeronautical Radio of Thailand Ltd. Email: nuttakajorn.ya@aerothai.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, Sanya FIR, 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) Mr. Dale Livingston, Manager, Separation Standards Analysis Team, FAA, email: dale.livingston@faa.gov	USA	APANPIRG RMA	Current	Anchorage Oceanic, Auckland Oceanic, Incheon, Nadi, Oakland Oceanic, Tahiti FIRs
		SMA	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	Monitoring Authority for Gross Navigational Error (GNE)	Current	Hong Kong, Ho Chi Minh, Manila, Sanya and Singapore FIRs
		SMA for South China Sea	From 1st July 2008	Hong Kong, Ho Chi Minh, Manila, Sanya and Singapore FIRs
FIT - SEA (ICAO Regional Office email icao_apac@bangkok.icao.int & **CRA Japan** Mr. Masahisa Hayashi, Deputy Director, Air Traffic Control Association Japan, email:hayashi@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. Masahisa Hayashi, Deputy Director, Air Traffic Control Association Japan, email:hayashi@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/9 – WP/14
26/05/08

International Civil Aviation Organization

The Ninth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/9)

Bangkok, Thailand, 26 − 30 May 2008

Agenda Item 5: Airspace safety monitoring activities/requirements in the Asia/Pacific Region

**Assessment of the Safety of Implementing
50NM Lateral and Longitudinal Separation Standards
On RNAV Routes L642 and M771**

(Presented by Singapore)

SUMMARY

This working paper presents the results of an assessment of the risk associated with introducing 50NM lateral and longitudinal separation standards on South China Sea RNAV routes L642 and M771. The safety assessment was conducted using internationally applied ICAO collision risk methodology, making use of relevant results developed in other portions of the Asia and Pacific Region where appropriate. Principal sources of data used in the safety assessment are information extracted from the December 2007 Traffic Sample Data collection, radar-based measurements of position obtained from the Singapore Area Control Center, and the results of monitoring navigational performance on the routes – a process which has been underway on a continuous basis since November 2001. The risk associated with the 50NM lateral separation standard is estimated, with high statistical confidence, to be in compliance with the Regional Target Level of Safety (TLS). Examination of the risk associated with the 50NM longitudinal separation standard also indicates that the TLS is satisfied with high confidence. In light of favorable risk estimates and the ongoing program for monitoring navigational performance, the safety assessment supports introduction of 50NM lateral and longitudinal separation standards on L642 and M771.

1. Introduction

1.1 In March 2006, the First Meeting of the ICAO Required Navigation Performance Task Force (reference 1), RNP/TF-1, agreed that there was a need to increase the capacity of the RNAV routes in the South China Sea. The meeting agreed to introduce 50NM longitudinal separation as a capacity-enhancement option, with initial use of this reduced standard on RNAV routes L642 and M771. The meeting agreed, further, that any introduction of reduced separation minima would be subject to the satisfactory outcome of an assessment of the safety of proposed changes.

1.2 In July 2007, the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) Air Traffic Management/Aeronautical Information Services/Search and Rescue Sub-Group held its Seventeenth Meeting (ATM/AIS/SAR/SG/17). At that meeting, the International Air Transport Association emphasized the need for implementation of Required Navigation Performance 10 (RNP 10) based 50NM lateral and longitudinal separation on L642 and M771 in order to meet capacity demands, which were becoming critical (reference 2, paragraphs 4.57 through 4.60).

1.3 At ATM/AIS/SAR/SG/17, Singapore agreed to host a Special Coordination Meeting in September 2007 to address these capacity problems. That meeting agreed (reference 3) to implement RNP 10-based 50NM lateral and longitudinal separation standards on L642 and M771 on 3 July 2008, subject to a favorable outcome of a safety assessment of the change.

1.4 Singapore informed the Special Coordination Meeting that it would arrange for conduct of the necessary safety assessment.

1.5 Arrangements were completed in January 2008; a preliminary safety assessment (reference 4) was presented to the task force fostering implementation of the separation changes, now called the ICAO South-East Asia Required Navigation Performance Implementation Task Force (RNP-SEA/TF), at its Second Meeting (RNP-SEA/TF/2).

1.6 The purpose of this working paper is to present the final assessment of the safety of implementing 50NM lateral and longitudinal separation minima on L642 and M771.

2. Background

2.1 This section summarizes the characteristics and infrastructure of South China Sea airspace, and presents an overview of airspace use based on a recent sample of traffic. The section also describes the operational concept which will guide application of 50NM lateral and longitudinal separation standards to L642 and M771 and reviews the current program for monitoring lateral errors in South China Sea airspace.

2.2 Description of South China Sea Airspace

2.2.1 As is shown in figure 1, South China Sea airspace is organized into six flight information regions (FIRs): Ho Chi Minh, Hong Kong, Kota Kinabalu, Manila, Sanya, and Singapore.

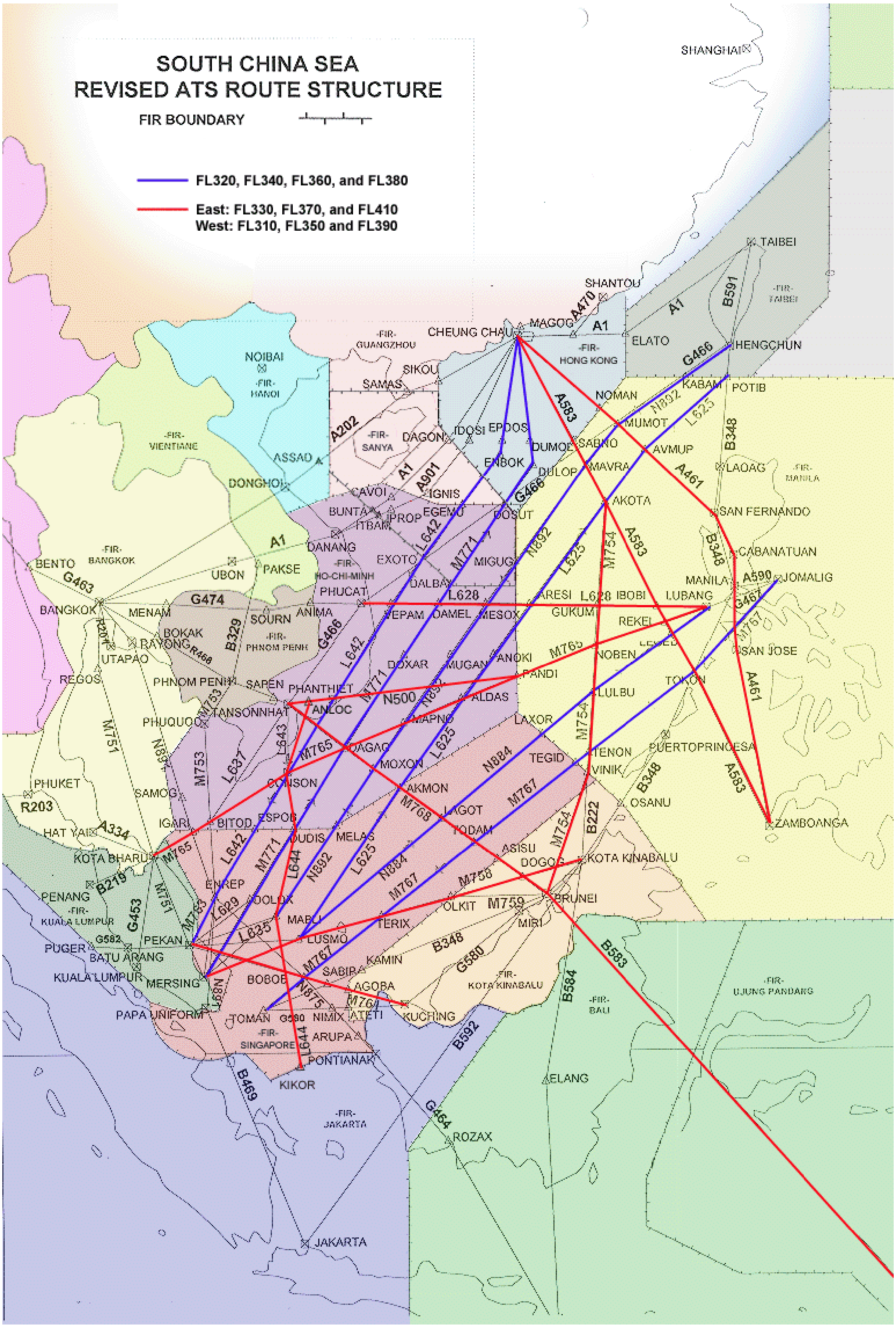

Figure 1. South China Sea Airspace

2.2.2 In response to increased demand for capacity, air navigation service providers revised use of South China Sea airspace in November 2001. The principal change was introduction of six major trunk routes to accommodate the three major northeast-southwest flows in the airspace, as shown in figure 1. These routes, termed “RNAV routes,” are configured as three sets of route-pairs, with a minimum lateral separation of 60NM between the members of a pair. The minimum longitudinal separation between two co-altitude aircraft on one of the routes is either 10 minutes with Mach number technique (MNT) or 80NM if RNAV separation rules apply. All flights at or above flight level (FL) 290 on these routes must be State-approved for RNP 10 operations.

2.2.3 The three route-pairs serve heavy-traffic flows in the airspace: Hong Kong/Singapore and Kuala Lumpur (routes L642 and M771), northeast Asia and Taiwan/Singapore (N892 and L625) and Manila/Singapore (N884 and M767). Routes crossing the RNAV routes in figure 1 accommodate traffic between other important origin-destination pairs in the States bordering the South China and beyond.

2.2.4 The flow on any of the six RNAV routes is unidirectional. Each of the two members of a route-pair provides one-way traffic flow between the origin-destination sets served. Flight-level use on the South China Sea routes is restricted in order to enhance provision of separation between operations on the RNAV and crossing routes. At present, no-pre-departure-coordination (No-PDC) flight levels on the RNAV routes are 300, 320, 340, 360, 380 and 400; No-PDC flight levels available on crossing routes are 330, 370 and 410 for eastbound flights, and 310, 350 and 390 for westbound operations. Effective 2100 UTC on 2 July 2008, as the result of work (reference 5) by the Western Pacific/South China Sea RVSM Scrutiny Working Group (WPAC/SCS RSG), No-PDC flight levels on the RNAV and crossing routes will change. The No-PDC flight levels available on the RNAV routes will be 310, 320, 350, 360, 390 and 400; No-PDC flight levels on the crossing routes will vary by route.

2.2.5 Table 1 summarizes this information concerning South China Sea airspace.

RNAV Route	Principal Service	Direction of Flow	No-PDC Flight Levels Prior to 2 July 2008	No-PDC Flight Levels After 2 July 2008
L642	Hong Kong/Singapore-Kuala Lumpur	Northeast-southwest	300, 320, 340, 360, 380, and 400	310, 320, 350, 360, 390 and 400
M771	Hong Kong/Singapore-Kuala Lumpur	Southwest-northeast	Same as L642	Same as L642
N892	Northeast Asia-Taiwan/Singapore	Northeast-southwest	Same as L642	Same as L642
L625	Northeast Asia-Taiwan/Singapore	Southwest-northeast	Same as L642	Same as L642
N884	Manila/Singapore	Southwest-northeast	Same as L642	Same as L642
M767	Manila/Singapore	Northeast-southwest	Same as L642	Same as L642
Crossing Routes	Various	Bidirectional	Eastbound: 330, 370, and 410 Westbound: 310, 350, and 390	Dependent upon route

Table 1. Characteristics of Air Traffic Service Routes in South China Sea

2.3 South China Sea Airspace Infrastructure

2.3.1 The South China Sea air-ground communications network is a combination of very high frequency (VHF) voice radio, high frequency (HF) voice radio and controller-pilot data link communications (CPDLC). The medium for data link may be VHF, HF or satellite.

2.3.2 The air traffic surveillance function is accomplished in the airspace with a combination of ground-based radars, HF voice reports and data-link-based automatic dependent surveillance-contract (ADS-C) position reports.

2.3.3 Figure 2 presents the South China Sea radar coverage shown in Appendix E of reference 6. As will be noted, there is virtually complete radar coverage of L642 and M771, with the exception of the northern portion of M771. Discussions at RNP-SEA/TF/2 indicated that the radar coverage shown in figure 2 requires updating (reference 7, paragraph 4.6) to reflect the fact that radar coverage of M771 in the Ho Chi Minh, Sanya and Hong Kong FIRs is complete. Further, the same discussions summarized in reference 7 indicated that there is a portion of both L642 and M771 within the Singapore FIR, between the boundary and the required reporting point closest to the boundary, where controllers must rely on voice or ADS position reports since there is no Singapore Area Control Center (ACC) radar coverage of the routes in this region. Radar-based aircraft position measurements from the Singapore ACC automation system, to be presented later in this paper, indicate that the distance of non-radar coverage on L642 is about 100 NM, or about 13 minutes of flying time. Finally, reference 7 indicates that VHF coverage is complete along L642 and M771, with the exception of the region within the Singapore FIR where no radar coverage exists.

2.4 Operations on L642 and M771

2.4.1 At its Sixteenth Meeting (August 2005), the APANPIRG agreed that each FIR where the Reduced Vertical Separation Minimum (RVSM) is applied would collect a sample of traffic movements during the month of December each year. Termed “traffic sample data,” or TSD, the traffic movement data for each flight consists of identifying information (aircraft call sign, aircraft type, origin and destination) and flight progress information (entry fix into RVSM airspace with associated route, time and flight level; and exit fix from RVSM airspace with associated route, time and flight level). Optionally, fix/route/time/flight-level information may be provided for fixes within the RVSM airspace of the FIR.

2.4.2 Reference 8 presents an examination of operations on L642 and M771 based on the December 2007 TSDs provided by the four FIRs – Ho Chi Minh, Hong Kong, Sanya and Singapore - having control responsibility for the routes. This reference notes that 61 individual operators were observed to use one or the other of the routes; these operators, as a group, used 37 unique aircraft types. Of particular interest is that 15 types taken together account for 97 percent of the operations, and that the type accounting for the highest percentage of operations (19 percent) is the A320.

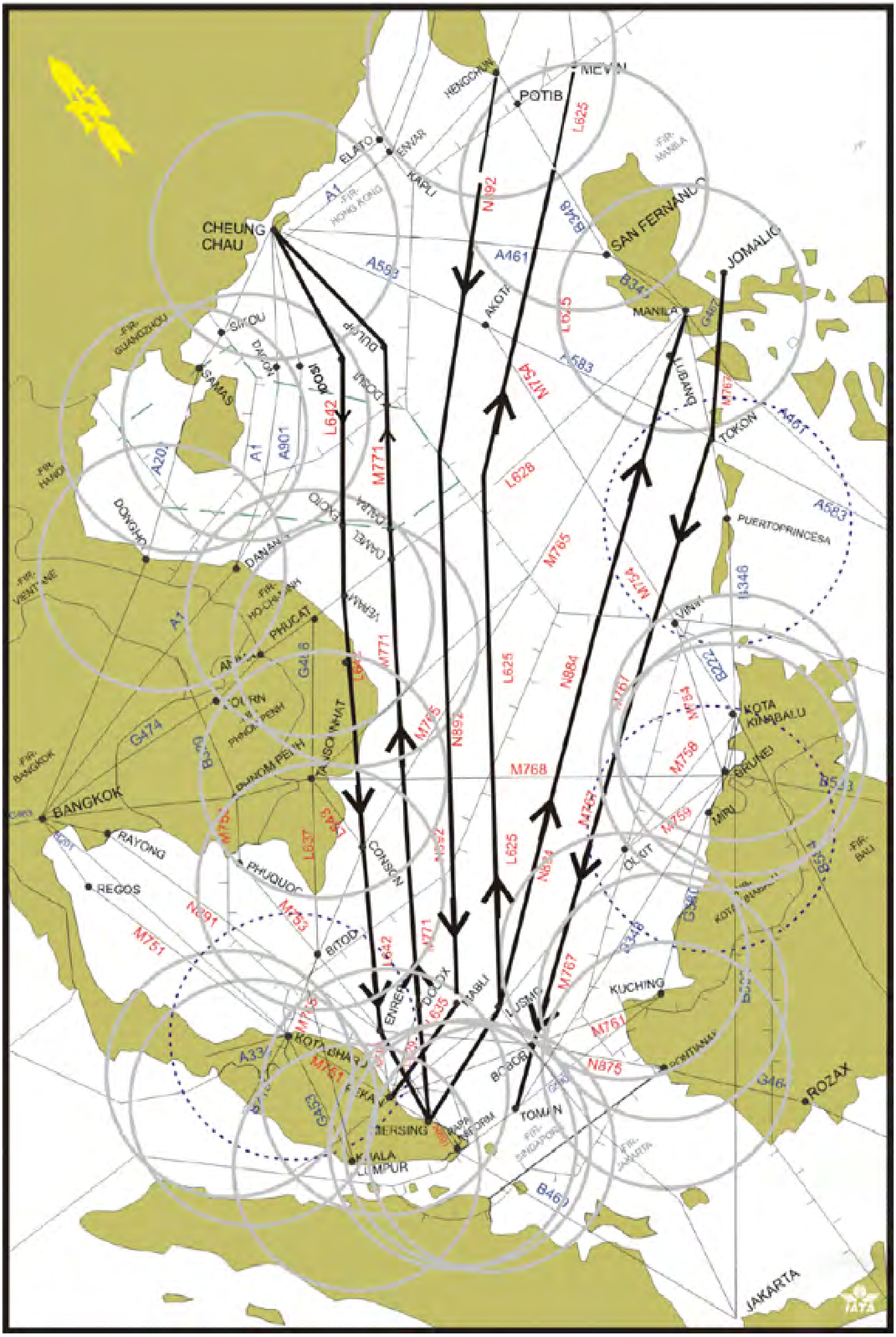

Figure 2. South China Sea Radar Coverage

2.4.3 Requirements for application of 50NM longitudinal separation (reference 9, section 5.4.2.6) include the availability of Direct Controller-Pilot Communications (DCPC) to enable position reports at least every 24 minutes from RNP 10-approved aircraft, if reports are by voice, and every 27 minutes if by ADS-C. Regional experience to date with use of the 50NM longitudinal standard has been limited to Pacific FIRs. Reference 10 lists the aircraft types observed in one such application of the longitudinal standard, none of which are the A320. Further examination of the summary of aircraft types observed in the December 2007 TSD indicates that roughly 38 percent of the operations were conducted by aircraft types which have not evidenced, typically, the ability to employ CPDLC and ADS, the systems which reference 10 describes as having been used to satisfy the DCPC requirement.

2.5 Operational Concept Underlying Planned Application of 50NM Lateral and Longitudinal Separation Standards on L642 and M771

2.5.1 As noted, the current lateral separation standard between the three pairs of RNAV routes is 60 NM. Also as noted, planning calls for introduction of the 50NM lateral separation standard on 3 July 2008.

2.5.2 The application of the 50NM lateral separation standard will not result in any change to the current locations of L642 and M771. Rather, the concept of operation for application of the 50NM lateral separation standard is that air traffic control will have the flexibility to clear an aircraft to deviate up to 10 NM from route centerline – to accommodate a pilot request for a weather-related deviation, for example – without the need for action to ensure maintenance of safe lateral separation from aircraft on the adjacent route.

2.5.3 The concept of operation for application of 50NM longitudinal separation takes advantage of the nearly complete radar and VHF voice radio coverage of the two routes, calling for use of the 50NM standard between any two co-altitude aircraft on either route. The concept of operation does not rely on CPDLC and ADS being fitted to an aircraft; rather, advantage is taken of the highly developed ground communications and surveillance infrastructure. Aircraft not equipped with CPDLC or ADS will be required to provide HF voice position reports during the roughly 13 minutes of flying time where VHF voice and radar are not available in the Singapore FIR.

2.6 Monitoring of Navigational Performance in South China Sea Airspace

2.6.1 A program to monitor the lateral and longitudinal deviations of aircraft assigned to the RNAV routes was implemented when the routes became operational in November 2001. Through a letter of agreement (LOA) signed by the air navigation service providers of the five South China Sea FIRs, there has been uninterrupted radar monitoring of both individual-aircraft lateral and longitudinal errors, and also unexpected changes in longitudinal separation between aircraft pairs, at fixes near the end of flight on routes M771, L625, N884 and N892 since introduction of the RNAV routes. A revised LOA (reference 11) adds, formally, Singapore’s surveillance of L642 and M767 to the monitoring program. In fact, Singapore has been monitoring these routes since November 2001.

2.6.2 Under the LOA, all instances of 15NM or greater magnitude lateral errors observed on any of the RNAV routes are reported to Singapore, which has acted as the monitoring program coordinator since introduction of the RNAV routes. To date, two instances of such larger lateral errors have been reported. Neither error occurred on either L642 or M771.

2.6.3 If time-based separation is being applied to a pair of co-altitude aircraft, monitoring of longitudinal errors under the LOA requires that a report be sent to Singapore if: (a) the 10-minute minimum is infringed, (b) the expected time between the pair varies by 3 minutes or more, even if the separation standard is not infringed, or (3) a pilot estimate varies by 3 minutes or more from that advised in a routine position report. If RNAV distance-based separation pertains, a report is to be sent if: (a) the separation standard is infringed, or (b) the expected separation between a pair of aircraft varies by 10 NM or more, even if the separation standard is not infringed.

3. Discussion

3.1 The safety assessment reported in this working paper 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.

3.2 The APANPIRG has adopted the value 5×10^{-9} fatal accidents per flight hour as the TLS for each separation dimension – lateral, longitudinal and vertical – in the Asia and Pacific Region.

3.3 Reference 4 presents a non-mathematical description of the collision risk model applied in this safety assessment. As necessary, descriptions of technical aspects of the model forms and parameters will be presented below, with an invitation to examine reference 4 for more detail.

3.4 The working paper first reviews some overall factors which decision makers may wish to take into account in the interpretation of results presented in the safety assessment.

3.5 Factors Affecting the Risk of Collision in South China Sea Airspace

3.5.1 A horizontal-plane safety assessment addresses separately the risk that a typical pair of aircraft operating at the same flight level loses: (a) all planned lateral separation if assigned to laterally adjacent routes, (b) all planned longitudinal separation if operating on the same route, and (c) all planned horizontal separation if operating on intersecting routes. As described in the previous section, traffic flows on routes intersecting the South China Sea RNAV routes are restricted to operating at flight levels not available to traffic on the RNAV routes. Thus, the risk that a typical pair of aircraft loses all planned horizontal separation if operating on intersecting routes is zero. As a result, the safety assessment addresses only the risk arising from application of the planned lateral and longitudinal separation standards.

3.5.2 As noted in reference 4, an important factor in assessing the risk associated with the lateral separation standard is the packing of aircraft at the same flight level on adjacent routes, termed "lateral occupancy." Estimation of this risk-model parameter relies on data describing traffic movements in the airspace. The planned July 2008 change in flight levels allocated to RNAV route traffic will likely result in a change to this parameter value. In order to take the uncertainties associated with this change into account, the safety assessment reflects a cautious (that is, higher) value of lateral occupancy than might have been suggested from processing of the combined December 2007 TSDs.

3.5.3 One of the assumptions made in developing the collision risk model is that there is no independent surveillance of aircraft position. As a result, there is no allowance made for the value of air traffic control intervention to reduce the risk that a pair of aircraft loses planned separation. As noted in the previous section, radar surveillance of L642 and M771 is virtually complete. As a result, the risk estimates presented in this working paper should be considered conservative, that is, higher than is likely the case in the airspace. Further detail in this regard will be provided below.

3.5.4 The previous section noted that monitoring of separation-related aircraft performance on South China Sea RNAV routes has been continuous since their 2001 introduction. To date, no 15NM or greater magnitude lateral errors and no longitudinal-error events covered in the monitoring LOA have been reported on L642 and M771. During the interval since monitoring began, it is reasonable to assume there have been several hundred thousand flight operations on these two routes.

3.5.5 With respect to analysis of the proposed 50NM lateral separation standard, the description of the operational concept presented in the preceding section leads to a cautious estimate of lateral risk. This is so since the model-estimation process assumes that all co-altitude operations on L642 and M771 will be conducted with planned lateral separation of 50 NM, when, in fact, this standard will be applied only to those aircraft pairs where one member of the pair is on an approved deviation in the direction of the laterally adjacent route. All normal route operations will be conducted with the current 60NM lateral separation standard unchanged.

3.5.6 Operators and aircraft flying at or above FL 290 on the South China Sea RNAV routes require State RNP 10 approval, as noted above. Compliance with this requirement is equivalent to stating that 95 percent of lateral deviations from route centerline are 10 NM or less. In turn, under the assumptions made in development of the RNP 10 standard, this containment percentage is equivalent to requiring that the standard deviation of lateral errors is roughly 5 NM. Radar-based measurements of the positions of aircraft operating on L642, to be described in more detail in this working paper, indicate that the standard deviation of lateral errors is on the order of 0.5 NM. These results should pertain for M771 operations as well, since the same operators and aircraft use both routes. As a result, decision makers should have high confidence that RNP 10 requirements for lateral navigational performance are being met. This estimate of standard deviation would seem to support the reported results of monitoring lateral errors: there has been no report of a 15NM or greater magnitude lateral error since the November 2001 introduction of the South China Sea RNAV routes. Based on the radar-based evidence, it would seem that, if a 15NM or greater magnitude error were to occur in the future, it would not be the result of typical navigational performance in the airspace.

3.6 Collision Risk Modeling

3.6.1 For nearly 40 years, collision risk modeling has been used as support by decision makers considering changes in separation standards. Technical analysis forming the basis for most en route separation minima – 50NM lateral separation based on RNP 10, the 60NM lateral separation standard applied in North Atlantic airspace, reduced horizontal-plane separation minima and the RVSM – contains a risk-model component.

3.6.2 As noted in reference 4, several assumptions underlie the mathematical development of the model. Principal among these are:

. an aircraft is considered to have the shape of a box, with length, height and width of the box equal, respectively, to the metallic length, wingspan and height from the underside of the fuselage to the top of the vertical tail of a typical aircraft in the system under study

. individual-aircraft navigational errors are independent in the three dimensions

. errors in the three dimensions made an aircraft are independent of the corresponding errors of any other aircraft in the system

. there is no collision-risk mitigation due to collision avoidance based on visual or electronic surveillance

3.6.3 The overall result of these assumptions is that collisions result from flying errors which occur independently among aircraft without the possibility of beneficial intervention.

3.7 Form of the Collision Risk Model

3.7.1 There are slightly different forms of the collision risk model used to assess the safety of separation minima in the three separation-standard dimensions. Reference 12 provides a summary of the derivation and use of the lateral and longitudinal collision risk model forms. The form of the lateral collision risk model is:

$$N_{ay} = P_y(S_y)P_z(0)\frac{\lambda_x}{S_x}\left\{E_y(same)\left[\frac{\overline{|\dot{x}|}}{2\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]+E_y(opp)\left[\frac{\overline{V}}{2\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]\right\} \tag{1}$$

The form of the longitudinal collision risk model is:

$$N_{ax} = P_y(0)P_z(0)\frac{2\lambda_x}{\overline{|\dot{x}|}}\left[\frac{\overline{|\dot{x}|}}{2\lambda_x}+\frac{\overline{|\dot{y}|}}{2\lambda_y}+\frac{\overline{|\dot{z}|}}{2\lambda_z}\right]\times\int_m^M\left(\int_s^M f(s,l)dl\right)ds \tag{2}$$

3.7.2 The mathematical symbols on the left of the two equations are the lateral and longitudinal risks, respectively. Each has the unit of fatal accidents per flight hour. This is the same unit in which the TLS is expressed.

3.7.3 The symbols on the right of the equations are termed "model parameters," the values of which are, typically, estimated from data taken in the airspace system under study. Reference 4 presents a description of each. In the following, those descriptions will be summarized.

3.8 Data Used in the Safety Assessment

3.8.1 The general data sources used in estimating the parameters are four: (1) information on traffic movements, (2) measurements of navigational performance, (3) records of weather deviations and other operational factors with potential influence on separation maintenance, and (4) archives of errors made by flight crews or air traffic control in following or granting clearances, or in transferring control responsibility between air traffic control units. Global experience has demonstrated that the last of these data sources is vital in estimating the risk associated with the RVSM and in developing remedial actions to reduce risk.

3.8.2 A principal source of information used in the safety assessment is the combined form of the December 2007 TSDs collected in the Ho Chi Minh, Hong Kong, Sanya and Singapore FIRs.

3.8.3 Eight days of radar-based position measurements of aircraft operating on L642, extracted from the automation system at the Singapore ACC, provided the basis for examining actual navigational performance on the RNAV routes. This sample was composed of 245 flights, after excluding radar tracks of aircraft which appeared to be on direct clearances to fixes other than ENREP on L642. Using only the first position of an aircraft after entry into radar coverage, the computed mean and standard deviation of lateral deviations from L642 centerline were -0.88NM and 0.67NM, respectively. It is common practice to use the first position measurement after entry into radar coverage to estimate lateral error in order to diminish the prospect of sampling aircraft navigational performance influenced by ground-based navigational aids. The disadvantage of using the first position measurement is that it is likely to be most influenced by radar error. Using all radar position measurements available between ESPOB and ENREP, the computed mean and standard deviation were -0.79NM and 0.46NM, respectively.

3.8.4 The details of the safety assessment will now be presented.

3.9 Explanation of Model Parameters and Corresponding Estimated Values Used In the Safety Assessment

3.9.1 Parameters Common to the Lateral and Longitudinal Risk Models

Aircraft Length, Wingspan and Height: λ_x, λ_y *and* λ_z

3.9.1.1 Table 2 of reference 8 presents the 20 aircraft types observed most frequently in the December 2007 TSDs. The most frequently occurring type is the A320, accounting for roughly 19 percent of the observations. The second most frequently observed type is the B-777-200. Of the four most frequently observed types –accounting for 58 percent of the aircraft recorded in the TSD – three are wide-body aircraft, including both the B-777-200 and B-777-300. Based on the results concerning aircraft types presented in reference 8, the safety assessment used the B-777-300 as the typical aircraft. The length, wingspan and height of this aircraft type are 0.0399NM, 0.0329NM and 0.0099NM, respectively.

Probability That Two Aircraft Assigned to the Same Flight Level Are at the Same Geometric Height: $P_z(0)$

3.9.1.2 The value of this parameter depends on the accuracy of height-keeping in the airspace and on the height of the aircraft type chosen to represent the typical aircraft. For purposes of standardization with other risk modeling within the Region, the safety assessment proceeded with the commonly used value of this parameter, 0.538, which is associated with the B-747-400.

The Average Relative Vertical Speed of Two Aircraft Assigned to the Same Flight Level: $\overline{|\dot{z}|}$

3.9.1.3 As has been the case in all recent safety assessments conducted in the Asia and Pacific Region, the value used in this document is 1.5 knots.

3.9.2 Parameters Used Only in Estimation of Lateral Risk

Same- and Opposite-Direction Lateral Occupancies: $E_y(same)$ *and* $E_y(opp)$

3.9.2.1 As noted above, the lateral occupancy parameter reflects the relative density of co-altitude traffic on adjacent routes. Lateral occupancy provides quantitative insight into the likelihood that two co-altitude aircraft on laterally adjacent routes will be in the same relative along-track position - and, thus, subject to the risk of midair collision - should all lateral separation be lost.

3.9.2.2 It should be noted that occupancy is not expressed in a unit of traffic flow, such as the number of aircraft per year using a route. Rather, occupancy is a dimensionless number, like a probability, and increases with an increase in the number of pairs of aircraft on laterally adjacent routes which are at or near the same along-track positions. Insofar as an increase in airspace traffic volume results in an increase in these proximate aircraft pairs, occupancy increases with increasing flights using the airspace.

3.9.2.3 Co-altitude aircraft on adjacent routes may be operating on the same or reciprocal headings. In the expression of the lateral risk model (equation (1), above), there are two parameters, representing the relative density of same- and opposite-direction pairs on adjacent routes, E_y(same) and E_y(opp), to account for these differences in headings.

3.9.2.4 Since L642 and M771 are each unidirectional-flight routes, with flights on the two routes in opposite directions, E_y(same) has the value zero. Because of this, the expression for lateral risk reduces to:

$$N_{ay} = P(S_y) \bullet P_z(0) \bullet (\lambda_x/S_x) \bullet E_y(opp) \bullet [\;]$$

where the "[ ]" refers to the sum of ratios of relative speeds to aircraft dimensions in equation (1).

3.9.2.5 The December 2007 TSDs provided traffic movement data for estimation of opposite-direction occupancy at several locations along the L642/M771 pair. For example, estimates of opposite-direction occupancy at the northern fixes on L642 and M771 (EPKAL and DOSUT) and southern fixes (ESPOB and DUDIS), were 0.457 and 0.452, respectively. As expected, occupancy values were highest for the most heavily used flight levels: 340, 360 and 380. Estimates at other fix-pairs produced somewhat higher results.

3.9.2.6 The Monitoring Agency for the Asia Region (MAAR) presented a safety assessment of the South China Sea RNAV routes in reference 13. The value for opposite-direction lateral occupancy used in that assessment was 0.78, which was a cautious estimate based on the entire December 2006 TSD for the South China Sea FIRs. To accommodate a possible increase in opposite-direction lateral occupancy resulting from the July 2008 change to flight-level allocation on L642 and M771, the safety assessment employed the MAAR-derived value.

Speed of the Typical Aircraft in the System: $\overline{V}$

3.9.2.7 This parameter represents the speed of the typical aircraft in the system. The combined December 2007 TSD provided information to estimate the value of this parameter. All flights on L642 with reported times over both the EPKAL and ESPOB fixes and all M771 flights with reported times over both the DUDIS and DOSUT fixes were used to produce separate estimates of the parameter for the two routes. The results are shown in table 2.

Route	Fix-Pair	Distance Between Fixes of Fix-Pair (NM)	Number of Flights Used to Compute $\overline{V}$	Estimate of $\overline{V}$ (kts.)	Standard Deviation of Estimate (kts.)
L642	EPKAL – ESPOB	783.6	1970	470.0	17.6
M771	DUDIS – DOSUT	725.5	2125	483.9	17.6

Table 2. Average Aircraft Speeds on L642 and M771 Estimated From December 2007 TSD

Relative Across-Track Speed of Two Aircraft on Parallel Tracks As They Lose All Planned Lateral Separation: $|\dot{y}|$

3.9.2.8 This parameter describes the relative speed of two aircraft as they lose all planned lateral separation. Global experience has shown that the basic track-keeping accuracy of RNP-10-approved aircraft makes it highly unlikely that the loss of 50NM lateral separation would be due to normal navigational performance. The most reasonable circumstance associated with such a separation-loss event is a waypoint insertion error. Monitoring of lateral navigation performance on the South China Sea RNAV routes since their November 2001 introduction has not recorded one such event. Nevertheless, a cautious approach to lateral risk estimation should include use of a value for $|\dot{\bar{y}}|$ which corresponds to the loss of 50NM lateral separation. Reference 13 contains such a value, 75 kts., which has been used in the safety assessment.

Probability of Lateral Overlap: $P_y(50)$

3.9.2.9 This parameter describes the chance that two aircraft assigned to laterally adjacent routes which are separated by 50 NM will lose all planned lateral separation. Two approaches to treating $P_y(50)$ are possible in lateral collision risk assessment:

(1) Collecting sufficient lateral navigational performance data to estimate the value of $P_y(50)$ directly, and then using this value in equation (1) with the other necessary parameter values to estimate lateral risk for comparison to the TLS, or

(2) Using all the other necessary parameters in risk model, determining that value of $P_y(50)$ which will satisfy exactly the TLS, and then demonstrating from data that this value of $P_y(50)$ is not exceeded in the airspace

3.9.2.10 The first approach requires, typically, many years of recording lateral errors in a parallel-track system in order to demonstrate with high statistical confidence that the TLS is satisfied.

3.9.2.11The second approach takes advantage of the fact that there is a well-established relationship between the probability that two aircraft with planned 50NM separation will lose all planned separation, $P_y(50)$, and the probability that an individual aircraft will commit a lateral error of 15 NM or more in magnitude. Table B-1 of Attachment B to reference 14 is an example of this approach for the case of planned 30NM lateral separation between parallel routes.

3.9.2.12 In applying this second approach, a competent authority organizes a program to monitor lateral errors and employs a statistical decision-making process to evaluate the monitoring results. The decision-making process incorporates a predetermined level of statistical confidence that the TLS is met and uses the observed frequency of 15NM or greater lateral errors to signal, at any time in the monitoring program, one of three decisions:

(1) the TLS is satisfied,

(2) lateral navigational performance is not sufficiently good to meet the TLS, or

(3) there is not yet sufficient monitoring data available to conclude whether the TLS has been satisfied

3.9.2.13 This second approach to demonstrating compliance with the lateral TLS has been applied successfully in several portions of worldwide airspace, and has been adopted in this safety assessment. Details will be provided after review of the lateral risk model parameter values used in the safety assessment.

Summary of Parameter Values Used in the Preliminary Assessment of the Safety of a 50NM Lateral Separation Standard between L642 and M771

3.9.2.14 Table 3 summarizes the details of parameters used in the lateral safety assessment.

Model Parameter	Description	Value Used in Preliminary Safety Assessment	Source for Value
N_{ay}	Risk of collision between two aircraft with planned 50NM lateral separation	5.0×10^{-9} fatal accidents per flight hour	TLS adopted by APANPIRG for changes in separation minima
S_y	Lateral separation minimum	50NM	Goal of RNP-SEA/TF
$P_y(50)$	Probability that two aircraft assigned to parallel routes with 50NM lateral separation will lose all planned lateral separation	2.69×10^{-9}	Value required to meet exactly the TLS of 5×10^{-9} fatal accidents per flight hour, given other parameter values used in safety assessment.
λ_x	Aircraft length	0.0399NM	Combined December 2007 TSD
λ_y	Aircraft wingspan	0.0329NM	
λ_z	Aircraft height	0.0099NM	
$P_z(0)$	Probability that two aircraft assigned to same flight level will be at same geometric height	0.538	Commonly used in safety assessments
S_x	Length of half the interval, in NM, used to count proximate aircraft at adjacent fix for occupancy estimates	120NM, equivalent to the +/- 15-minute pairing criterion used in safety assessment	Arbitrary criterion which does not affect the value of risk
$E_y(\text{same})$	Same-direction lateral occupancy	0.0	Result of direction of traffic flows on L642 and M771
$E_y(\text{opp})$	Opposite-direction lateral occupancy	0.78	MAAR estimate based on December 2006 TSD (reference 13)
$\overline{V}$	Aircraft along-track speed	483.9 kts.	Combined December 2007 TSD
$\lvert\overline{\dot{y}}\rvert$	Average relative speed of aircraft pair at loss of planned 50NM lateral separation	75 kts.	Reference 13
$\lvert\overline{\dot{z}}\rvert$	Average relative vertical speed of a co altitude aircraft pair assigned to the same route	1.5 kts.	Conservative value commonly used in safety assessments

Table 3. Summary of Risk Model Parameters Used in Lateral Safety Assessment

3.10 Outcome of the Lateral Safety Assessment

3.10.1 As noted, monitoring of lateral deviations has been continuous since the November 2001 introduction of the South China Sea RNAV routes, with the criterion to identify a large lateral deviation set at 15NM in magnitude. Singapore has acted as the coordinator of this monitoring program, collecting records of traffic movements and large lateral deviations from all FIRs where monitoring takes place. To date, there has been no report of a large lateral deviation for aircraft operating on either L642 or M771.

3.10.2 Table 4 of reference 8 indicates that the number of flights observed in the merged December 2007 TSD from the Singapore and Hong Kong FIRs was 5743. Assuming that December 2007 is a month representative of the traffic counts on L642 and M771, it is reasonable to conclude that there would be, in a year, about 70,000 flights available for monitoring on the two routes. The value required value of $P_y(50)$ shown in table 3, 2.69×10^{-9} , implies that it would be necessary to have many years of navigational performance observations from the monitoring program in order to show with high confidence that the TLS is being met.

3.10.3 As noted in the discussion of the required value of $P_y(50)$, taking the approach of demonstrating compliance with the TLS through analysis of 15NM or greater errors overcomes this problem. The approach is based on a statistical technique known as sequential sampling and employs a control chart of the type that is used in monitoring the manufacturing quality of many industrial processes. In such an environment, a manufacturer always wants to know if the product manufactured meets the company's standards for quality. As proposed for application in the case of introducing the 50NM lateral separation standard on L642 and M771, the product is system safety, as demonstrated by compliance of risk with the TLS, and the standard for quality is an acceptably low rate of occurrence of 15NM or greater lateral deviations.

3.10.4 Figure 3 shows a control chart which mechanizes the sequential sampling process using the parameter values shown in table 3, with the assumption that decision-makers want to have 95 percent statistical confidence that the TLS is met. The chart permits plotting of the number of reported 15NM or greater errors on the vertical axis against numbers of flights monitored on the horizontal axis.

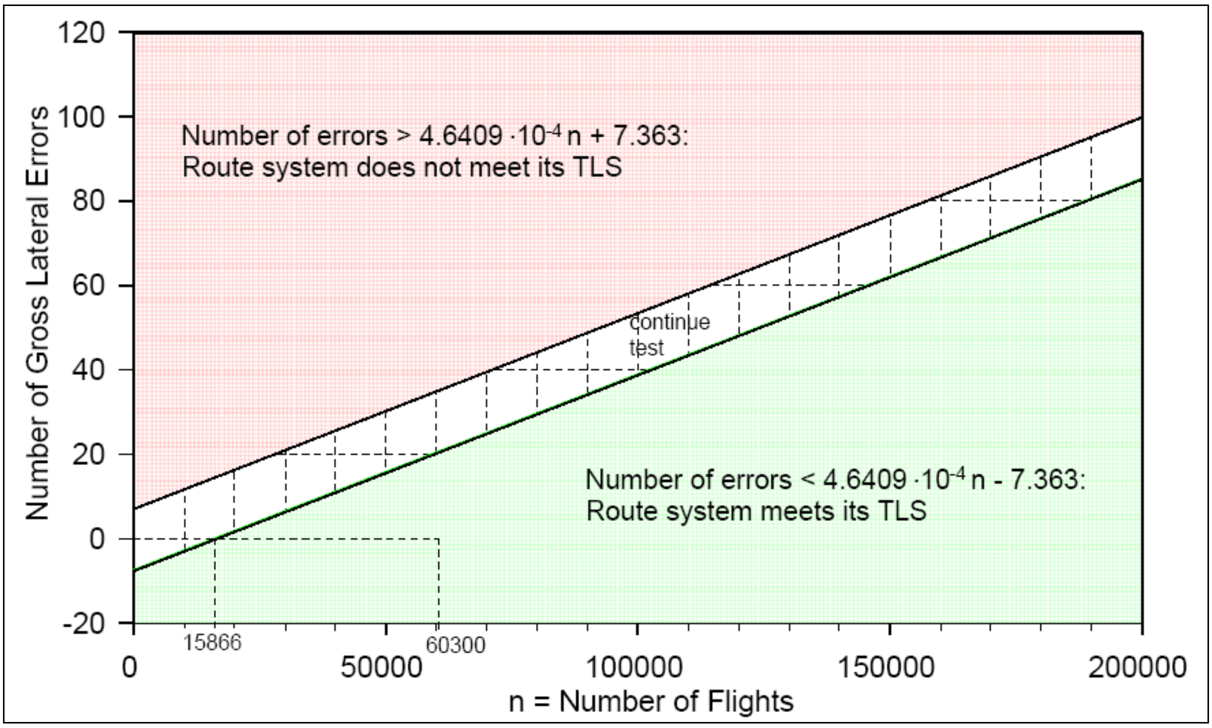

Figure 3. Sequential Sampling Approach to Demonstrating That Lateral Collision Risk for 50NM Lateral Separation Standard Applied to L642/M771 Complies With TLS

3.10.5 The two straight lines of identical slope in the figure divide the chart into three regions, corresponding to the three decisions possible after entering each monitoring observation (number of 15NM or greater errors reported and number of flights monitored) onto the chart:

(1) the number of 15NM or greater errors recorded during observation of the total number of flights monitored leads to the conclusion that the TLS is met (the plot of 15NM or greater errors versus number of monitored flights is within the region below the lower sloped line),

(2) the total number of flights monitored is not yet sufficient to conclude that the TLS is met (the plot of 15NM or greater errors versus number of monitored flights is between the two sloped lines), or

(3) navigational performance, as measured by the number of 15NM or greater errors recorded for the number of flights monitored, is not adequate to meet the TLS and, therefore, investigations must be done to look for any sources of systematic error which, if found, must be eliminated (the plot of 15NM or greater errors versus number of monitored flights enters the region above the upper sloped line).

3.10.6 From the control chart of figure 3, if there are no 15NM or greater magnitude lateral errors reported after roughly 15,900 flights, the plot of 15NM or greater magnitude errors versus number of monitored flights enters the "meets the TLS" region of the chart (the intersection of the horizontal dashed line corresponding to no 15NM or greater magnitude lateral errors and the vertical line corresponding to 15,866 monitored flights). The cumulative total of flights monitored on L642 and M771 for the period 1 January 2007 through 30 April 2008 is roughly 60,300. During this period, no 15NM or greater magnitude errors were reported to Singapore for either route. The location of this point - the intersection of the no-large-lateral-deviation horizontal line and the vertical line corresponding to 60,300 monitored flights - is well within the "meets the TLS" region of the chart, as can be seen from figure 3.

3.10.7 As a result, it can be concluded with 95 percent statistical confidence that the proposed 50NM lateral separation standard for route-pair L642/M771 meets the TLS.

Conclusions and Recommendations from the Safety Assessment Concerning Introduction of the 50NM Lateral Separation Standard on L642 and M771

3.10.8 Use of a sequential-sampling approach in combination with the results of the program to monitor lateral errors in the South China Sea has led to the conclusion that the TLS is met with 95 percent statistical confidence.

3.10.9 As a result, the assessment of the risk of introducing a 50NM lateral separation standard between L642 and M771 supports the decision to proceed with implementation.

3.11 Parameters Used Only In Estimation of Longitudinal Risk

Background Information from the Combined December 2007 TSD Useful for the Estimation of Longitudinal Collision Risk

3.11.1 All flights on L642 with reported times over the EPKAL and ESPOB fixes and all flights on M771 with reported times over the DUDIS and DOSUT fixes were examined to estimate the relative along-track speed of aircraft pairs on the two routes. A pair of aircraft was included in the examination of relative along-track speed if the two aircraft were at the same flight level and passed over the entry fix (EPKAL for M642 flights and DUDIS for M771 flights) within 60 minutes of each other. The same-altitude/close-in-time criteria were intended to minimize the effects of wind on the estimation of relative speeds. Application of these criteria resulted in 650 L642 pairs and 742 M771 pairs available for the examination of relative speed. For any pair, the computed difference in speeds was assigned a positive value if the lead aircraft in the pair was faster and a minus sign if the faster aircraft was the trailing aircraft in the pair. The examination involved computing the average of these signed speeds as well as the average of the speed differences without regard to sign, that is, the average of the absolute value of the speeds.

3.11.2 During the estimation of relative along-track speed, it became apparent that there were clusters of speed differences resulting, it would seem, from the mix of a relatively fast and relatively slow aircraft as members of a pair.

3.11.3 All flights on L642 with times reported over both EPKAL and ESPOB and all M771 flights with reported times over both DUDIS and DOSUT were used to estimate the average transit time between the fix-pairs. There were 1970 such flights identified on L642 and 2125 flights on M771.

3.11.4 Table 4 shows the results of this investigation.

Route	Fix-Pair	Average Signed Relative Speed (kts.)	Standard Deviation of Signed Relative Speed (kts.)	Average Absolute-Value of Relative Speed (kts.)	Standard Deviation of Absolute-Value of Relative Speed (kts.)	Average transit Time (mins.)
L642	EPKAL - ESPOB	-3.34	2.39	16.74	2.40	100.0
M771	DUDIS - DOSUT	-5.89	2.45	14.27	2.51	90.1

Table 4. Average Relative Speeds and Transit Times on RNAV Routes L642 and M771

3.11.5 As can be seen, the average along-track signed speed for each route is negative, indicating that, on the average, a faster aircraft is following a slower one in the pairs used in the examination.

Probability That Two Aircraft Assigned to the Same Route and Flight Level Are in Lateral Overlap: $P_y(0)$

3.11.6 As can be seen from inspection of the longitudinal collision risk model presented in equation (2) above, risk is directly proportional to the value of this parameter. That is, as the value of this parameter increases, longitudinal risk increases.

3.11.7 Experience has shown that use of the Global Positioning System (GPS) produces highly accurate estimates of aircraft position. In turn, these accurate position estimates produce smaller lateral errors from course. Smaller lateral errors produce higher values of $P_y(0)$, thus increasing the risk of losing longitudinal separation, all other things being equal. This "navigation paradox" – improvements in navigation in one dimension increase collision risk in another – is well known.

3.11.8 The ICAO Reduced Vertical Separation Minima Implementation Task Force initiated work to introduce the RVSM into Pacific FIRs in November 1998. Reference 15, presented to the Third Meeting of the Task Force describes analysis of cross track errors exhibited by B-747-400 aircraft known to be using GPS for position-determination. Based on analysis of these errors, reference 15 concluded that, if all Pacific operations were conducted by B-747-400 aircraft equipped with GPS, the estimated value of $P_y(0)$ would be 0.3868. In contrast, if there were no GPS-equipped aircraft in the airspace, the value would be only 0.019. Reference 15 provided evidence that about 27 percent of Pacific operations at the time of the RVSM/TF/3 meeting were conducted by GPS-equipped aircraft. The corresponding value of $P_y(0)$ adopted by the Task Force was 0.052.

3.11.9 Table 2 of reference 8 presents the 15 aircraft types which, taken together, account for 97 percent of the operations on L642 and M771 found in the combined December 2007 TSD. From this table, it is possible to conclude that at least 50 percent of the operations on L642 and M771 were conducted by aircraft types known to be equipped with GPS.

3.11.10 Based on this percentage of GPS equipage, the preliminary safety assessment used a value of 0.20 for $P_y(0)$.

Relative Across-Track Speed of Two Aircraft Assigned to the Same Route and Flight Level - $|\bar{\dot{y}}|$

3.11.11 The effect of GPS in the navigation solution is to reduce aircraft cross-track velocity. Reference 15 provides the value of relative cross-track speed, 1 knot, used in the current estimation of longitudinal risk.

Probability of Longitudinal Overlap: P_x

3.11.12 The remaining terms in the longitudinal risk model shown in equation (2), above, address the estimation of P_x, the probability that a pair of same-route, co-altitude aircraft loses all planned longitudinal separation. While the estimation of this probability is a complex mathematical form in equation (2), involving a double integral, the concept behind the form is relatively straightforward.

3.11.13 If Q(s) is the proportion of aircraft pairs separated initially by s in the longitudinal dimension and $P(S \geq s)$ is the probability of losing at least the separation s, then the probability of losing all longitudinal separation between a pair of aircraft, Px , can be represented by:

P_x = (factor dependent on initial separation s) •
summation of $[Q(s) \cdot P(S \geq s)]$ for all values of s.

3.11.14 The term in “( )” (factor dependent on initial separation) is represented in equation (2) above by (1/T) • $(2\lambda_x / |x|)$, where the relative speed, $|x|$, is that necessary for two aircraft to lose longitudinal separation, s, within a time T. The value of T is usually taken to be the time between successive waypoint reports, under the assumption that air traffic control will intervene to correct the case of a serious loss of longitudinal separation at the next waypoint. In oceanic airspace such as the Pacific, T is roughly 60 minutes.

3.11.15 As noted in table 4, the average transit time on M771 between DUDIS and DOSUT is 90 minutes and roughly 100 minutes on L642 between EPKAL and ESPOB. The principal fixes on each route are on the order of 200 NM apart. Assuming three required reporting points between EPKAL and ESPOB and between DUDIS and DOSUT, T for L642 and M771 would be on the order of 30 minutes. If two aircraft were separated longitudinally by 50 NM at a required reporting point, the relative speed difference required to lose exactly 50 NM within 30 minutes is 100 kts. The data on relative speeds presented in table 4 suggest that such an overtake speed is highly unlikely.

3.12 Estimating the Initial Distribution of Along-Track Separation

3.12.1 In longitudinal risk estimation, the term Q(s) is the distribution of initial separations between co-altitude same-route aircraft pairs on entering the airspace. The term $P(S \geq s)$, the chance of losing all planned longitudinal separation of s or more, is usually estimated from data on longitudinal separation erosion available from airspace records.

3.12.2 It is not possible to know in advance how co-altitude aircraft will be spaced longitudinally when a 50NM longitudinal separation minimum is applied. It is, however, possible to infer something about capacity demand and air traffic control response by examining actual system performance.

3.12.3 The combined December 2007 TSD was used to gain insight into both the distribution of initial along-track separation and also separation decrease or increase during operations on L642 and M771. It will be convenient to use the term "separation loss or gain" to describe the decrease or increase in initial separation, but, in using this term, there should be no misunderstanding that "separation loss" means loss of all initial longitudinal separation between the members of an aircraft pair.

3.12.4 The combined December 2007 TSD was processed to determine pairs of co-altitude aircraft on L642 passing over EPKAL within 60 minutes of each other. Similarly, pairs of co-altitude aircraft passing over DUDIS no more than 60 minutes apart were identified. The pair-separations for the L642 pairs passing over ESPOB and the M771 pairs passing over DOSUT were then computed and the data summarized as counts of initial-separation/separation-change. The combined total of L642 and M771 pairs which contributed to the initial-separation/ separation-change analysis is 1392, the same pairs used to examine relative along-track speed.

3.12.5 The distribution of initial separations is shown in figure 4. As can be seen, there are initial separations well below the 10-minute minimum applied on the routes. Examination of the basic data indicated that such smaller initial inter-aircraft separation values were the result of the lead aircraft being faster than the second member of the pair over the fix. Subsequent separation increased as the flights were conducted.

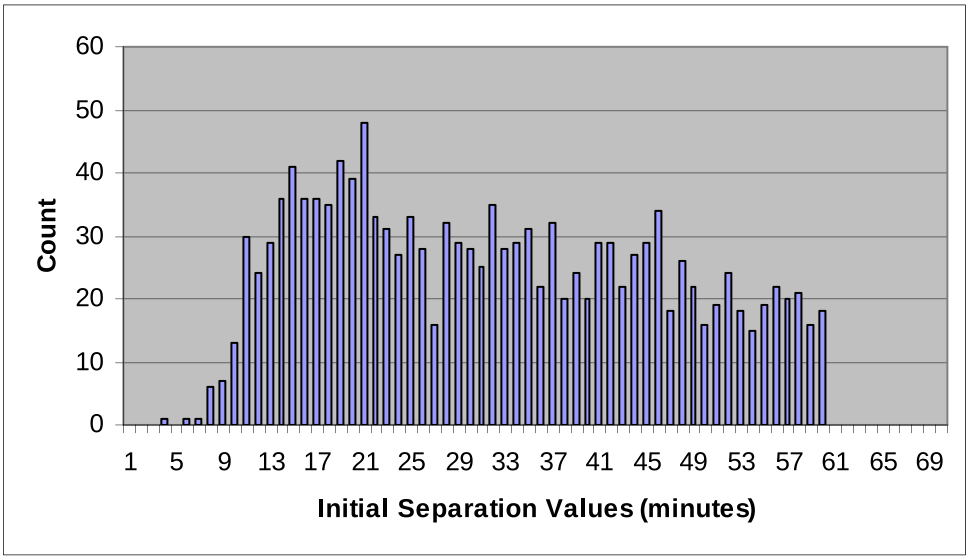

Figure 4. Absolute Frequency of Initial Separation Values

3.12.6 As noted previously, the 10-minute longitudinal minimum is applied with Mach number technique on the RNAV routes. Reference 9, paragraph 5.4.2.4.3, specifies the reduction below minimum which is permissible with this technique. If the preceding aircraft is assigned a speed which is 0.02 units of Mach number higher than the following aircraft, the initial separation may be 9 minutes. For each additional 0.01 unit of difference, the pair may be spaced by 1 minute less, down to a minimum of 5 minutes. Thus, application of Mach number technique explains the apparent anomaly in the data – initial separations well less than the minimum.

3.12.7 Unfortunately, information concerning Mach number is not contained in a TSD. In an attempt to account for the effect of applying Mach number technique, a correction was made to the differences of the 1391 aircraft pairs used to examine longitudinal risk. The details of the correction process are contained in the Attachment.

13.2.8 The results of correcting initial separation for Mach number are shown in figure 5. As will be noted, pairs with apparent initial separations less than 10 minutes in figure 4 have been moved to larger separations, with the exception of a few remaining at 9 minutes. Since the correction process relies on the use of ICAO Standard Atmosphere temperatures, small errors are to be expected. In fact, examination of the initial separations corrected for Mach number shows consistent underestimation of the Mach number difference between a pair of aircraft, with the underestimation growing with increasing difference in groundspeeds between the members of a pair. If a correction of, roughly, 0.01 unit of Mach number is added to the initial separations of figure 5 in order to account for the underestimation of Mach number difference, there are no pairs separated by 9 minutes and the number of pairs at separations near the minimum of 10 minutes decreases. This correction was taken into account in estimation of longitudinal risk.

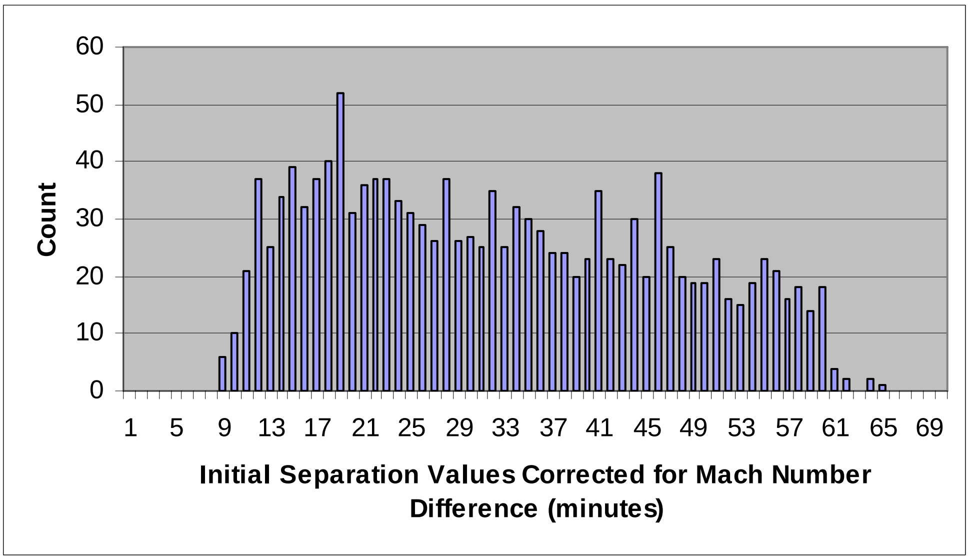

Figure 5. Absolute Frequency of Initial Separation Values Corrected for Mach Number Difference

13.2.9 The form of the distribution in figure 5 suggested that a gamma probability density function might characterize the distribution of initial separations. This distribution is often used to study problems in queuing for service. Since the distribution of initial separations demonstrates the ability of L642 and M771 to respond to demands for service, the gamma distribution is attractive as a means of characterizing the data of figure 5.

13.2.10 Figure 6 presents the data of figure 5 as logarithms of the relative frequency of observed initial separations. The figure likewise suggests that a gamma distribution may fit the data adequately.

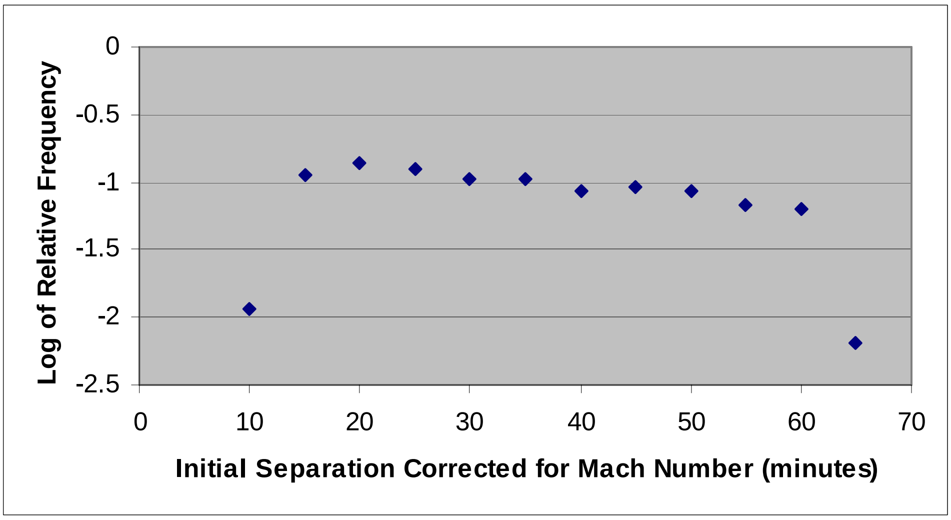

Figure 6. Log of Relative Frequency of Initial Separation Values Corrected for Mach Number

3.13 Estimating the Distribution of Separation Gain or Loss

3.13.1 Figure 7 presents the distribution of separation gain and loss observed for the 1392 aircraft pairs for which initial separations are shown in figure 4. The maximum values of gain and loss were 12 minutes and 12 minutes, respectively. The data of figure 7 need to be treated before use in risk estimation, since there is a clear relationship between separation loss and initial separation.

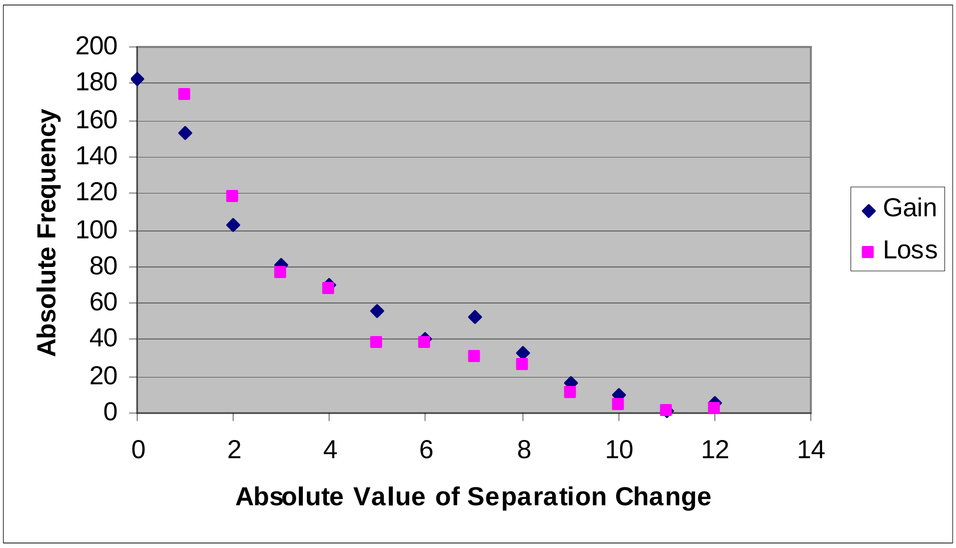

Figure 7. Absolute Frequency Count of Separation Gain or Loss

Separation Gain (+) or Loss (-)	Initial Separation Up to 10 Minutes	Initial Separation Between 11 and 15 Minutes	Initial Separation Between 16 and 20 Minutes	Initial Separation Between 21 and 25 Minutes	Initial Separation Between 26 and 30 Minutes
-12	0	0	0	0	1
-11	0	0	0	0	0
-10	0	0	0	0	2
-9	0	0	1	2	1
-8	0	0	2	3	4
-7	0	0	4	4	6
-6	0	1	3	3	1
-5	0	0	5	2	2
-4	0	4	6	7	11
-3	0	7	12	9	7
-2	0	13	19	14	14
-1	0	18	25	24	17
0	2	32	26	20	15
1	3	24	15	22	13
2	6	12	10	12	13
3	5	9	11	9	6
4	2	10	16	10	5
5	0	8	9	12	3
6	3	6	5	7	5
7	3	6	8	8	2
8	2	5	6	1	3
9	2	2	3	3	0
10	0	3	2	0	0
11	0	0	0	0	1
12	1	0	0	0	0

Table 5. Separation Gain or Loss as Function of Initial Separation

3.13.2 Table 5 shows this relationship. The data of the table are separation gain and loss presented as a function of initial separation. As can be seen, for initial separations up to 10 minutes, there is no separation loss over the course of flight. For initial separations between 11 and 15 minutes, there is some evidence of separation loss. The largest value of loss is 6 minutes, which occurred between a pair separated initially by 15 minutes. One pair with initial separation of 12 minutes lost 4 minutes at the exit fix, producing an 8-minute final separation. Another pair with 13-minutes initial separation also lost 4 minutes, resulting in a 9-minute final separation. As initial separation increases, the data of the table indicate that separation-loss magnitudes increase. None of the separation losses, however, resulted in final separations below 10 minutes.

3.14 Estimation of Longitudinal Risk

3.14.1 Given the values of $P_y(0)$, $P_z(0)$ and other risk model parameters, the value of the summation of $[Q(s) \cdot P(S \geq s)]$ for all values of s needed to meet the TLS is 2.3×10^{-8} for a value of T equal to 30 minutes, the interval between position updates allowing air traffic control to intervene, if necessary, to increase separation.

3.14.2 Implementation of a 50NM longitudinal separation standard will result in the application of a distance-based separation on L642 and M771. All data describing the results of current longitudinal separation practice which were available for the safety assessment are in units of time. As a result, the safety assessment will examine the likelihood that a 6-minute longitudinal separation standard will meet the TLS.

3.14.3 Air traffic controllers focus on maintenance of the applicable separation standards in the airspace. Generally, the term "loss of separation" means that a pair of aircraft is operating below the separation standard being applied.

3.14.4 Collision risk analysis focuses on the loss of all separation, which is equivalent to a collision. Therefore, to meet the TLS, it is necessary to determine whether the summation of $[Q(s) \cdot P(S \geq s)]$ for all values of s is less than 2.3×10^{-8}. From the data in figure 5, initial separation values near the minimum of 10 minutes occur at lower frequencies and increase in frequency up to about 20 minutes. After that point, the frequencies of larger initial separations decrease.

3.14.5 In the safety assessment, this same characteristic of initial separation values is assumed to pertain when 6 minutes is the minimum longitudinal separation standard on 3 July 2008.

3.14.6 From the data of table 5, separation losses for smaller initial separation values were observed to be small relative to the current longitudinal separation standard of 10 minutes. This same characteristic is assumed to apply when the 50NM, or 6-minute, minimum longitudinal separation standard is in effect.

3.14.7 The data of table 5 demonstrate the effectiveness of applying the Mach number technique. As a result, a larger separation loss, 6 minutes or more, between the two aircraft of a pair would require that the at least one of the aircraft exhibit an unexpected change in separation of three minutes or more for which Mach number technique did not account. It would seem that such a significant change would have to be the result of substantial wind gusts affecting only one member of the pair, or some aircraft system failure resulting in a major change in true airspeed since the last position update.

3.14.8 Results from the South China Sea monitoring program are that there was no unexpected change in longitudinal separation of three minutes or more observed for pairs of aircraft during the period 1 January 2007 through 30 April 2008. These results indicate, further, that there was no instance of a significant individual-aircraft longitudinal error – defined as a 3-minute or greater unexpected deviation between a pilot forecast of next waypoint and the actual report at that fix – reported for any of the 60, 300 flights monitored on L642 or M771 during the period.

3.14.9 The fact that there were no individual-aircraft unexpected changes in longitudinal position reported in 60, 300 flights does not mean that the rate at which such errors occur is 0.0. Rather, the conclusion to be drawn from the monitoring data is that the true rate of occurrence of significant individual-aircraft longitudinal errors is so small that none were produced in slightly more than 60,000 operations.

3.14.10 Given the monitoring program results showing that they are rare events, the probability of occurrence of significant individual-aircraft longitudinal errors can be described by a Poisson distribution, where it is assumed that the rate of significant longitudinal errors decreases as the number of flights increase in a way that keeps the product of the two constant. Assuming that each flight is an independent opportunity for a significant individual-aircraft longitudinal error, no occurrence of this event in 60,300 operations is, with 95 percent statistical confidence, consistent with a true rate of occurrence of 8.51×10^{-7} significant longitudinal errors per flight, or less. It is not possible for a pair of aircraft to lose

6 minutes of separation, the equivalent of 50 NM, unless there is an unexpected change in longitudinal position of 3 minutes or more associated with at least one aircraft. As a result, this monitoring-program finding can provide insight into the value of $P(S \geq s)$, the probability that an aircraft pair loses at least as much as longitudinal separation as it has on entering a route.

3.14.11 Given the sparse data on unexpectedly large individual-aircraft longitudinal errors from the monitoring program, it is not possible to propose a probability distribution that characterizes the occurrence of 3-minute or greater individual-aircraft longitudinal errors, that is, the probability of a 3-minute error, 4-minute error, 5-minute error and so on. In attempting to estimate $P(S \geq s)$, it will be assumed that a significant individual-aircraft longitudinal error is equally likely to contribute to an unexpected gain or loss of separation between an aircraft pair. Taking a conservative view, it will be assumed that it is possible to have a significant individual-aircraft longitudinal error as large as 6 minutes, which would require a 100-knot unexpected speed difference from that used by air traffic control to plan separation with other aircraft. Again to be conservative, it will be assumed that 3-minute, 4-minute, 5-minute and 6-minute significant individual-aircraft longitudinal errors are equally likely. As a result:

P(3-minute significant individual-aircraft longitudinal error) = $0.25 * 8.51 \times 10^{-7}$
$= 2.13 \times 10^{-7}$
= P(4-minute error) = P(5-minute error) = P(6-minute error)

3.14.12 Again, to be conservative, it will also be assumed that the probability of a zero-minute, 1-minute and 2-minute unexpected losses or gains in separation due to significant individual-aircraft longitudinal error will be identical and equal to $(0.2 - 8.51 \times 10^{-7}) \approx 0.2$. In contrast, it will be recalled from the data of table 5 that only 3 of the 1392 pairs examined in the December 2007 TSD evidenced final separations below 10 minutes, with the smallest final separation being 8 minutes.

3.14.13 Finally, it will be assumed that, because of the lack of information to correct adequately the initial separations for Mach number, the frequency of 9-minute separations presented in figure 4 can be added to the 10-minute initial separations count. As a result, when considered to represent the distribution of initial separations for L642 and M771 after 50NM separation is applied, the frequency values of initial separations of 5 minutes or less will all be 0.0.

3.14.14 With these assumptions, 12 minutes is the maximum initial longitudinal separation value which can be lost due to unexpected individual-aircraft longitudinal errors, and would result only when the lead aircraft of a pair loses 6 minutes and the other gains 6 minutes. Because individual-aircraft longitudinal errors are assumed independent between aircraft, the probability that this would happen is the product of the probabilities that each aircraft would have a significant longitudinal error of 6 minutes, or,

$$P(S \geq 12) = P(S = 12) = (2.13 \times 10^{-7}) \bullet (2.13 \times 10^{-7}) = 4.5 \times 10^{-14}$$

This probability is so small that it can be neglected. Likewise, the contribution to summation of $[Q(s) \cdot P(S \geq s)]$ for all values of s made by initial separation values, s, of 11 minutes, 10 minutes and 9 minutes can be disregarded.

3.14.15 As a result, only 8 minutes, 7 minutes and 6 minutes initial separation values require examination in light of unexpected losses or gains in separation due to significant individual-aircraft longitudinal error. Assuming that Aircraft 1 is following Aircraft 2, the combinations of unexpected losses or gains in separation necessary for two aircraft to lose 8 minutes of initial separation are shown in table 6:

Aircraft 1 Unexpected Gain (+) or Loss (-) (minutes)	Aircraft 2 Unexpected Gain (+) or Loss (-) (minutes)	Resulting Separation (minutes)
+6	-2	0
+5	-3	0
+4	-4	0
+3	-5	0
+2	-6	0

Table 6. All Combinations of Unexpected Separation Loss and Gain Resulting in Loss of Exactly 8 Minutes Initial Separation

3.14.16 The value P(S = 8 minutes) is the sum of the products of the probabilities of separation loss and gain in the rows of the table. For example, the contribution to P(S = 8) of the first row is:

$$(2.13 \times 10^{-7}) \bullet (0.2) = 4.26 \times 10^{-8}$$

The contribution of the last row is also 4.26×10^{-8}. The contribution of the products of the probabilities in the other rows is the negligible value 4.5×10^{-14}. Thus, the value of P(S = 8 minutes) is $2 \bullet 4.26 \times 10^{-8}$, or 8.52×10^{-8}.

3.14.17 The value of P(S = 7) can be determined in a similar manner and is $4 \bullet 4.26 \times 10^{-8} = 1.7 \times 10^{-7}$. The value for P(S = 6) is $8 \bullet 4.26 \times 10^{-8} = 3.41 \times 10^{-7}$.

3.14.18 Using the relative frequencies of initial separation values determined from the data shown in figure 5, it is now possible to calculate the quantity summation of [Q(s) · P(S ≥ s)] for all values of s. Table 7 shows the results.

Initial Separation, s (minutes)	Proportion of initial separations, corrected for Mach number, with separation s, Q(s)	P(S ≥ s)	Q(s) • P(S ≥ s)
6	0.011	$(3.41 \times 10^{-7} + 1.7 \times 10^{-7} + 8.52 \times 10^{-8})$	6.85×10^{-9}
7	0.015	$(1.7 \times 10^{-7} + 8.52 \times 10^{-8})$	3.85×10^{-9}
8	0.027	8.52×10^{-8}	2.26×10^{-9}
9 and beyond	0.018	0.0	0.0
Sum Q(s) • P(S ≥ s)			1.30×10^{-8}

Table 7. Computation of the Summation of Q(s) • P(S ≥ s) for All Values of Initial Separation, s

3.14.19 The resulting value for summation of [Q(s) • P(S ≥ s)] for all values of s, 1.30×10^{-8}, is less than the required value of 2.3×10^{-8} required to meet the TLS.

3.15 Conclusions and Recommendations from the Safety Assessment Addressing Introduction of the 50NM Longitudinal Separation Standard on L642 and M771

3.15.1 When the summation value computed in table 7 is substituted into the expression for P_x and used in the model, the resulting value of longitudinal collision risk is 2.8 x 10^{-9} fatal accidents per flight hour, which satisfies the TLS.

3.15.2 In light of the imminent change to the flight level allocation scheme in the South China Sea, decision makers should consider the possibility of collecting a sample of system use similar in content to the TSD. Such a sample would indicate whether assumptions made during conduct of the safety assessment need refinement.

3.15.3 The monitoring program has shown considerable value as source material for the safety assessment. It would be valuable to re-emphasize its importance to all signatories of the monitoring program LOA.

4. Action by the Meeting

4.1 The meeting is invited to

a) Note that the safety assessment supports the implementation of RNP10 (50/50NM) horizontal separation on L642 and M771; and

b) Consider collecting additional traffic movement data after the planned 3 July introduction of the 50NM longitudinal separation.

……………………….

Attachment

Correction to Initial Separation of Aircraft Pairs to Account for Application of Mach Number Technique

Mach number, M, can be computed from true airspeed using the relation

$$V_t = a_0 M \cdot [T_1/T_o]^{1/2} \qquad (A.1)$$

where:

V_t = true airspeed
a_0 = speed of sound at sea level
T_1 = temperature at the altitude flown
T_o = temperature at sea level

It is well-known that true airspeed is related to groundspeed by:

$$V_g = V_t + V_w$$

where:

V_g = groundspeed
V_w = speed of the wind at the altitude being flown

No information was available concerning either true airspeed or the effect of wind in the airspace during December 2007. The aircraft pairs used in the analysis were, however, chosen to be co- altitude and spaced by no more than 60 minutes. Taking the difference of the groundspeeds of a pair should, therefore, remove much of the effect of wind, leaving the difference in true airspeeds, ΔV_t. Using equation (A.1), this results in:

$$\Delta V_g = a_0 \Delta M \cdot [T_1/T_o]^{1/2} \qquad (A.2)$$

Since there were no data available describing temperatures at altitude or sea level in South China Sea airspace during December 2007, the temperatures published in the ICAO Standard Atmosphere were used. This introduced some error into the correction process, since temperatures in the ICAO Standard Atmosphere were determined at 45 degrees latitude where are likely to be temperatures cooler than those at flight levels on the RNAV routes.

The initial separation of each of the 1392 aircraft pairs was corrected for estimated difference in Mach number using relation (A.2).

References

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5. "WPAC/SCS FLAS Comparison Table," Fourth Meeting of the Western Pacific/South China Sea RVSM Scrutiny Working Group (WPAC/SCS RSG/4), Bangkok, 26 – 29 February 2006, WP/6.

6. Report of Thirteenth Meeting of South-East Asia ATS Coordination Group (SEACG/13), Bangkok, 16 – 19 May 2006.

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9. *Procedures for Air Traffic Services Air Traffic Management*, Doc 4444 ATM/501, Fifteenth Edition, International Civil Aviation Organization, Montréal, 2007.

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14. Annex 11 of the Convention on International Civil Aviation, *Air Traffic Services*, Thirteenth Edition, International Civil Aviation Organization, Montreal, July 2001.

15. “Preliminary Estimate of the Probability of Lateral Overlap, $P_y(0)$, Based on the Percentage of non-GPS-equipped Aircraft in the Pacific Ocean Airspace,” Third Meeting of the ICAO Reduced Vertical Separation Minima Implementation Task Force (RVSM/TF3), Honolulu, U.S.A., 10 -13 May 1999, WP/13.

REGIONAL AIRSPACE SAFETY MONITORING ADVISORY GROUP (RASMAG)

TERMS OF REFERENCE OF THE RASMAG

The objectives of the Group are to:

a) facilitate the safe implementation of reduced separation minima and CNS/ATM applications within the Asia and Pacific Regions in regard to airspace safety monitoring; and

b) assist States to achieve the established levels of airspace safety for international airspace within the Asia and Pacific Regions.

To meet these objectives the Group shall:

a) review airspace safety performance in the Asia and Pacific Regions at the regional level and within international airspace;

b) review and develop as necessary, guidance material for airspace safety monitoring, assessment and reporting activities, including the duties, responsibilities and scope of regional monitoring entities;

c) recommend, and facilitate as necessary, the implementation of airspace safety monitoring and performance assessment services;

d) review and recommend on the competency and compatibility of monitoring organizations and recommend to APANPIRG specific airspace responsibility for individual regional monitoring entities;

e) review, coordinate and harmonize regional and inter-regional airspace safety monitoring activities;

f) review regional and global airspace planning and developments in order to anticipate requirements for airspace safety monitoring and assessment activities;

g) address other airspace safety related issues as necessary;

h) facilitate the distribution of safety related information to States, and

i) provide to APANPIRG comprehensive reports on regional airspace safety and coordinate with other contributory bodies of APANPIRG as appropriate.

TASK LIST

To review the safety monitoring programmes in the Asia and Pacific Regions for implementation and operation of:

a) reduced vertical separation minimum (RVSM);

b) reduced horizontal (lateral and longitudinal) separation minima using PBN;

c) aircraft separation applications using data link, e.g. ADS and CPDLC; and

d) ATS Unit to ATS Unit operational messaging using AIDC.

(Last updated APANPIRG/18, September 2007)

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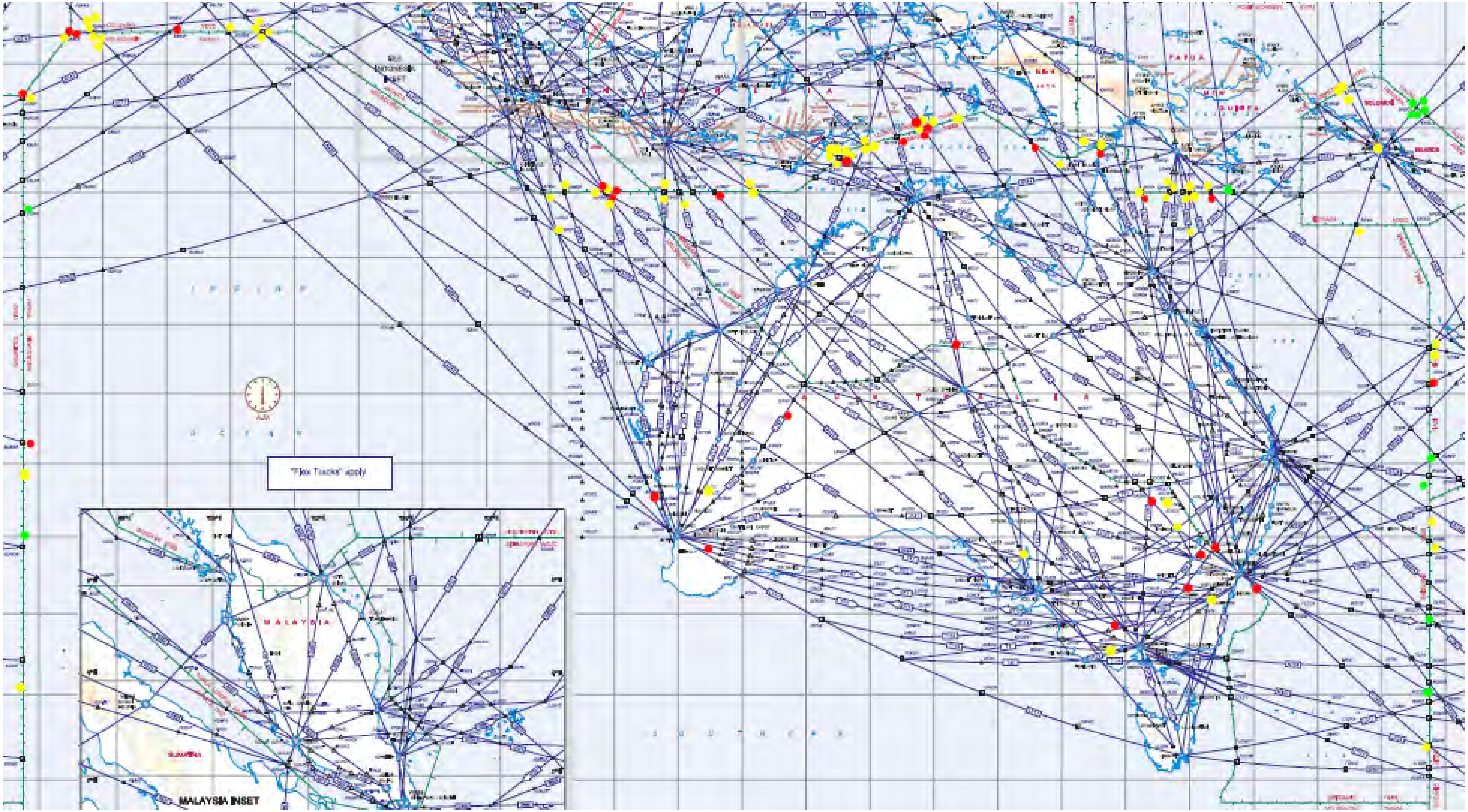
Brisbane and Melbourne FIRs – ATC-to ATC Coordination Errors in RVSM Height Band (Cat E and Cat F)
May 2007-April 2008



Key: Red = Cat E Risk Bearing in Australian FIRs
Yellow = Cat E Non-risk Bearing in Australian FIRs
Green = Cat F Non-risk Bearing in Australian FIRs

Cat E = Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of human factors issues (e.g. late or non-existent coordination, incorrect time estimate/actual, flight level, ATS route etc not in accordance with agreed parameters).
Cat F = Coordination errors in the ATC-to-ATC transfer of control responsibility as a result of equipment outage or technical issues

RASMAG — TASK LIST

(last updated 30 May, 2007)

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
2/4	Develop SMA Handbook.	Report Progress to RASMAG/10	Chairman (R. Butcher), All members Secretariat	Open	Significant work undertaken by RASMAG/8, final draft available for adoption by RASMAG/9. Feedback to Chairman (Mr. Butcher) before RASMAG/9 RASMAG/9 considered advanced draft, noted that reduced horizontal separation required consideration of communications and surveillance aspects in addition to navigation performance. Ongoing work, expect final draft to be available to RASMAG/10 for endorsement.
3/1	Provide guidance to States in respect of the issues surrounding quantum and application of Target Levels of Safety (TLS).	Report Progress to RASMAG/8	RASMAG members Secretariat	Open	Referred to RMAs by RASMAG/5 for discussion/action. Additional guidance material included in Amendment 44 to Annex 11, effective November 2006.
5/5	Regional Office to coordinate with the RNP-SEA/TF to ensure inclusion of safety assessment requirements in the Task Force TOR	Report progress to RASMAG/8	Regional Office	Open Completed	Next RNP-SEA/TF meeting scheduled March 2007 late 2007 or early 2008 from 4 to 7 March 2008 Secretariat paper submitted, and TOR amended to include safety assessments requirements
7/6	Define and promulgate a standardised process under which a safety monitoring organisation could gain approval by APANPIRG for regional activity	Report progress to RASMAG/10	RASMAG, RMAs, SMAs	Open	RASMAG adopted interim process using Annex 11, RVSM Manual and RMA Handbook requirements for endorsement of JCAB RMA and China RMA. Consideration of SMA credentialing required by RASMAG/10.

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
7/7	Asia/Pacific RMAs communicate collectively prior to the next RASMAG meeting with the objective of providing some guidance on regional issues/impacts resulting from the implementation of global long term height monitoring provisions for RVSM operations.	Report progress to RASMAG/10	Asia/Pacific RMAs	Open	RASMAG/8 reviewed work so far and adopted 6 Long Term Height Monitoring (LTHM) actions in Asia/Pacific area for dissemination RASMAG/9 informed no progress made due to priority workloads for all RMAs and Regional Office. Small drafting team formed, to submit advanced draft to RASMAG/10, Task List item 9/1 refers.
~~8/1~~	~~Review RASMAG TOR to ensure capability to support regional PBN implementation~~	~~RASMAG/9~~	~~RASMAG/9~~	~~Open Completed~~	~~RASMAG/9 reviewed TORs, no change required.~~
~~8/2~~	~~Present paper describing roles and responsibilities to PBN/TF/1 in January 2008~~	~~January 2008~~	~~Secretariat~~	~~Open Completed~~	~~Secretariat presented RASMAG paper to PBN/TF 9-11 January 2008~~
~~8/3~~	~~RMAs to coordinate prior to the next meeting to implement a process which enables the efficient sharing of LHD data relevant to one or more RMAs, e.g. LHDs occurring at an FIR boundary shared between RMAs~~	~~RASMAG/10~~	~~Asia/Pacific RMAs including China RMA~~	~~Open Completed~~	~~AAMA is sharing data with MAAR, other RMAs actioning as required.~~
8/4	Include the following question re AIDC on LHD reporting template for Asia/Pacific RMAs in relation to Category 'E' LHDs: *Was an automated capability (e.g. AIDC) used for the coordination of the flight?*	February 2008	Asia/Pacific RMAs including China RMA	Open	RASMAG/10 to confirm status
8/5	Include additional note to RASMAG LHD Categorization 'M' (Others), as follows *Note: this includes situations of flights operating (including climbing/descending) in airspace where flight crews are unable to establish normal air-ground communications with the responsible ATS Unit.*	January 2008	Asia/Pacific RMAs including China RMA	Open	RASMAG/10 to confirm status

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
8/6	Take action to implement LTHM Actions 1-6 as described in RASMAG/8 report In particular, ensure arrangements for regional cooperation between RMAs	First quarter 2008	Asia/Pacific RMAs including China RMA	Open	Update RASMAG/9 about progress RASMAG LTHM Actions promulgated by State Letter AP018/8 of 31 January 2008. RASMAG/9 informed no progress made due to priority workloads for all RMAs and Regional Office.
~~8/7~~	~~Asia/Pacific RMAs, including China, to attend Global RMAs meeting to finalize RMA Manual at ICAO Montreal from 13-15 May 2008 as part of SASP meeting.~~	~~May 2008~~	~~Asia/Pacific RMAs including China RMA~~	~~Open~~ ~~Completed~~	~~Global RMA meeting conducted in Montreal 13-15 May 2008. Representatives from all RMAs attended, including all Asia/Pacific RMAs including China.~~
~~8/8~~	~~Circulate letter to APANPIRG members and Asia/Pacific RMAs advising JCAB RMA has been approved as APANPIRG RMA.~~	~~December 2007~~	~~Secretariat~~	~~Open~~ ~~Completed~~	~~Regional Office State Letter AP019/08 dated 31 January circulated to APANPIRG members and Asia/Pacific RMAs.~~
~~8/9~~	~~Prepare submission supporting advancement of China RMA to APANPIRG RMA status for consideration by RASMAG/9. Submission from China to address provisions of Annex 11, RVSM Manual (Doc 9574) and RMA Manual in respect of requirements for establishment and operation of an RMA – as described in IP08 to RASMAG/7~~	~~Submit to RASMAG/9~~	~~China, assisted by MAAR, PARMO & Regional Office~~	~~Open~~ ~~Completed~~	~~China submitted required documentation to RASMAG/9, RASMAG/9 recommended to APANPIRG/19 that China RMA be approved as Asia/Pacific RMA.~~
~~8/10~~	~~Contact Vietnam and request urgent submission of LHD data for 2007 for Hanoi and Ho Chi Minh FIRs~~	~~December 2007~~	~~Secretariat~~	~~Open~~ ~~Completed~~	~~Secretariat transmitted Letter Ref.: T3/10.0, T3/10.1.17 – AP-ATM0016, dated 1 February 2008 RASMAG/9 commended Vietnam for providing all required data.~~

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
8/11	Prepare a paper for RASMAG/10 that summarises regional initiatives for AIDC including APANPIRG requirements and status of regional AIDC implementation	RASMAG/10	Secretariat	Open	
~~8/12~~	~~Transmit State Letter on behalf of RASMAG to all States and Asia/Pacific RMAs describing outcomes of RASMAG/8 in terms of LTHM Actions 1 – 6 and request assistance from States in complying with LTHM Actions.~~	~~January 2008~~	~~Secretariat~~	~~Open~~ ~~Completed~~	~~RASMAG LTHM Actions promulgated by Regional Office State Letter AP018/8 of 31 January 2008 to all States and CC to Asia/Pacific RMAs~~
8/13	United States to investigate AIDC implementations and compile comparison between numbers of ATC coordination errors before and after AIDC implementation	RASMAG/10	United States	Open	United States presented WP/25 to RASMAG/9 using interim data, further investigations will be submitted to RASMAG/10
9/1	Prepare advanced draft of Asia/Pacific Regional Impact Statement regarding the implementation of long term global height monitoring in accordance with APANPIRG Conclusion 18/4 for consideration by RASMAG/10 in December 2008. Task List item 7/7 refers.	RASMAG/10	Small drafting team comprising members from all Asia/Pacific RMAs including China, keep Bangkok Secretariat informed of progress.	Open	RMA Technical meeting on first day of RASMAG/10 will finalise the draft document for presentation to the RASMAG/10 plenary meeting.
9/2	Constitute small drafting team to prepare draft Section 9 (Safety monitoring matters etc) of the PBN Regional Implementation Plan being prepared by the PBN Task Force.	30 June 2008	Representatives from Australia, New Zealand, Singapore, United States and IFALPA, with the RASMAG Chairman as the primary coordinator.	Open	Submit to Bangkok Secretariat by end of June to enable submission to PBN/TF/3 meeting 15-18 July 2008.
9/3	Include estimate of annual hours flown and standardise reporting across RMAs – graphs, and bar graphs using WP/18 from AAMA to RASMAG/9 as the basis	RASMAG/10	All Asia/Pacific RMAs including China RMA.	Open	

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
9/4	Japan to attempt to capture and analyse data in relation to implementation of AIDC with Republic of Korea during late 2008. Attempt to show Category E LHD performance before and after implementation of AIDC	RASMAG/10	JCAB RMA	Open	

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Global Aviation Safety Plan and Global Safety Initiatives

The first version of the ICAO Global Aviation Safety Plan (GASP) was developed in 1997 by formalizing a series of conclusions and recommendations developed during an informal meeting between the ICAO Air Navigation Commission and Industry. The GASP was used to guide and prioritize the technical work programme of ICAO was updated regularly until 2005 to ensure its continuing relevance.

In May 2005, another meeting between the Air Navigation Commission and Industry identified a need for a broader Plan that would provide a common frame of reference for not only ICAO but all stakeholders. Consequently, a new Global Aviation Safety Plan which included, *inter alia*, a set of Global Safety Initiatives (GSIs) was developed and published during 2007.

The 2007 GASP defines twelve GSIs, as described below, that support the implementation of the ICAO safety Strategic Objective. Each GSI relies on a set of best practices, metrics and maturity levels defined in the GASP to ensure that implementation makes full use of the collective experience of the aviation community and that progress is measured in a transparent and consistent way.

GSI-1 Consistent Implementation Of International Standards And Industry Best Practices

Scope: Full implementation of applicable ICAO SARPs and industry best practices. Compliance with ICAO Standards is considered internationally essential and sound application of ICAO Recommendations and best practices is accepted as the effective way to achieve consistent implementation worldwide:

GSI-2 Consistent Regulatory Oversight

Scope: Each State is in a position to objectively evaluate any given safety critical aviation activity within its jurisdiction and require that the activity adhere to standards designed to ensure an acceptable level of safety. States ensure their Regulatory Authority is independent in the conduct of its safety functions, competent and adequately funded.

GSI-3 Effective Errors And Incidents Reporting

Scope: A free flow of data exists that is required to assess aviation system safety on a continuous basis and to correct deficiencies when warranted.

GSI-4 Effective Incident And Accident Investigation

Scope: The accident or incident investigations provide the opportunity for an in-depth examination of both the causal factors leading up to the particular event and the broader questions concerning the underlying safety of an entire operation.

GSI-5 Consistent Coordination Of Regional Programmes

Scope: While regional differences will dictate different implementations of best practices at different levels of maturity, there is much benefit that can be gained by sharing the experience between regions.

GSI-6 Effective Errors And Incidents Reporting And Analysis In The Industry

Scope: The development and maintenance of a "Just Culture" is one of the primary means available to industry to understand where the hazards and risks lie within an organization.

GSI-7 Consistent Use Of Safety Management Systems

Scope: A systematic management of the risks associated with flight operations, aerodrome ground operations, air traffic management and aircraft engineering or maintenance activities is essential to achieve high levels of safety performance.

GSI-8 Consistent Compliance With Regulatory Requirements

Scope: The attainment of a safe system requires that industry complies with State regulations. The main responsibility for compliance rests with industry, which has a legal, commercial and moral obligation to ensure that operations are conducted in accordance with the regulations.

GSI-9 Consistent Adoption Of Industry Best Practices

Scope: Best practices, which represent the application of lessons learned globally by industry, are adopted by individual organizations in a timely manner.

GSI-10 Alignment Of Industry Safety Strategies

Scope: The efforts of all industry stakeholders to improve aviation safety at the local, State, and regional levels are more effective at a global level if they are well aligned and based on shared goals and methods.

GSI-11 Sufficient Number Of Qualified Personnel

Scope: Industry and the regulatory authorities have access to a sufficient number of qualified staff to support their activity.

GSI-12 Use Of Technology To Enhance Safety

Scope: Technology advances which contribute significantly to improvements in safety are implemented.

……………… End ……………..