INTERNATIONAL CIVIL AVIATION ORGANIZATION

REPORT OF THE SIXTH MEETING OF THE REGIONAL AIRSPACE SAFETY MONITORING ADVISORY GROUP (RASMAG/6)

BANGKOK, THAILAND, 6 – 10 NOVEMBER 2006

Adopted by the RASMAG
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Page

HISTORY OF THE MEETING

1. Introduction

1.1 The Sixth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/6) was held in Bangkok, Thailand from 6 to 10 November 2006 at the Kotaite Wing of the ICAO Asia/Pacific Office.

2. Attendance

2.1 The meeting was attended by 26 participants from Australia, Hong Kong China, India, Japan, New Zealand, Singapore, Thailand, United States, IATA and IFATCA. 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 and was assisted by Mr. Polawat Chootai, Regional Officer ATM.

4. Opening of the Meeting

4.1 The meeting was opened by Mr. Andrew Tiede on behalf of Mr. Lalit Shah, Regional Director of the Asia/Pacific Regional Office. Mr. Tiede welcomed the participants to Bangkok and the Sixth meeting of the RASMAG. He highlighted the work that had been completed by RASMAG/5 (June 2006) in preparing submissions for APANPIRG in relation to the funding of safety monitoring, provision of safety related data by States and the ongoing safety concerns in the Western Pacific/South China Sea relating to RVSM operations and the horizontal safety assessment which was still to be updated. APANPIRG/17 (August 2006) had valued the submissions from RASMAG and had taken action in raising appropriate Conclusions and Decisions to ensure that the work was progressed. These matters would have to also be addressed by this meeting.

4.2 In his opening remarks the Chairman, Mr Butcher, welcomed participants to the meeting. He noted that many of the members had traveled some distance to attend the meeting and thanked them for their time in progressing the valuable safety work undertaken by RASMAG. Specifically Mr. Butcher informed the meeting of a number of work items that needed attention during the week. These included reviewing the conclusions resulting from the recent APANPIRG meeting; the review of funding arrangements for Regional safety assessment activities and support for the proposed funding Task Force; considering the reports from the Regional RMAs in relation to RVSM safety assessments; and further development of the SMA handbook and other considerations in relation to monitoring requirements of reduced horizontal separation minima.

5. Documentation and Working Language

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

5.2 Seventeen (17) Working Papers and Twelve (12) 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 of outcomes of APANPIRG/17

Agenda Item 3: Funding of Regional Safety Monitoring Activities

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

Agenda Item 5: Review the airspace safety monitoring arrangements in the Asia/Pacific Region and the activities of regional airspace safety monitoring agencies

Agenda Item 6: Review of regional safety assessment activities/requirements

Agenda Item 7: Review and update RASMAG Task List

Agenda Item 8: Any other business

Agenda Item 9: Date and venue of the RASMAG/7 Meeting

Agenda Item 2: Review of outcomes of APANPIRG/17

Outcomes of APANPIRG/17 in relation to RASMAG

2.1 The 17th meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/17) was held at Bangkok, Thailand, from 21-25 August 2006. The meeting reviewed extracts from the Report of APANPIRG/16, noting that APANPIRG/16 had endorsed a total of 55 Conclusions and Decisions, of which the 3 Conclusions and 2 Decisions in the table below were of direct relevance to the work of RASMAG and are discussed elsewhere in this report.

APANPIRG/17 Conclusions and Decisions relevant to RASMAG

Conclusion 17/4	Long Term Monitoring of RVSM Height Keeping Performance
Conclusion 17/6	Completion of the horizontal safety assessment for the South China Sea route structure
Conclusion 17/48	Funding of Pacific RMA & CRA
Decision 17/5	Establishment of the WPAC/SCS RVSM Scrutiny Working Group
Decision 17/47	Task Force to establish Regional Airspace Safety Monitoring Committees

ALLPIRG/5 Follow Up

2.2 The meeting was informed that the fifth meeting of the ALLPIRG/Advisory Group (ALLPIRG/5) was held at ICAO Headquarters in Montreal from 23 to 24 March 2006 and had developed eighteen conclusions covering a wide range of issues.

2.3 Taking into account the comments of the Air Navigation Commission, during June 2006 the Council of ICAO considered and approved the follow-up to the report of ALLPIRG/5. The Council called upon all planning and implementation regional groups (PIRGs) to initiate follow-up action on specific conclusions. APANPIRG/17 had subsequently formulated Decision 17/1 and Conclusions 17/2 and 17/3 following the intent of the Council and allocating responsibility for follow up of the ALLPIRG/5 outcomes to APANPIRG, States and international organizations, respectively.

2.4 The meeting reviewed the ALLPIRG/5 outcomes for matters within the purview of RASMAG, noting the relevance of Conclusion 5/11 in relation to ATM Safety Management and Conclusion 5/12 relating to coordination between Regional RMAs.

Conclusion 5/11 - ATM Safety Management

2.5 In noting that this Conclusion called for support for the development of sufficient levels of expertise through formal training in ATM safety issues and implementation of "just-culture" reporting environments, the meeting reviewed the recent history of ATS safety training in the region. As reported in Agenda Item 6, two SMS Courses had been conducted at the Regional Office during September 2006 by accredited staff from ICAO Headquarters. Also during September 2006, an ATS Safety Management Workshop had been conducted at the Regional Office using the SIP mechanism, incorporating some of the material that had been prepared as part of the RASMAG Safety Management Seminar conducted during RASMAG/3 in June 2005.

2.6 The meeting was informed that ICAO Headquarters would continue to present SMS Courses in accordance with the arrangements promulgated in State Letter AN12/46-06/52, dated 30 June 2006. Additionally, the Regional Office would continue to coordinate arrangements with Hong Kong, China with the intention of running a combined ICAO/CAD ATS SMS Seminar/Workshop in the first half of 2007.

2.7 In light of this ongoing activity in respect to ATS SMS training, the meeting agreed that RASMAG would take no further action at this time but would again review the situation at the next meeting.

Conclusion 5/12- Coordination between RMAs

2.8 Recalling that this Conclusion called for the ICAO EUR/NAT Office to act as the focal point for required coordination between RMAs globally, the meeting was updated that the Separation and Airspace Safety Panel (SASP) Tenth Meeting of the Working Group of the Whole would take place in Australia in late November and early December 2006. Arrangements had been made to ensure that global RMA issues would be considered during this meeting and it was anticipated that representatives from many of the global RMAs would be in attendance.

2.9 The meeting noted that there was some overlap and potential confusion in respect of the roles of the EUR/NAT Office of ICAO and the SASP in relation to RVSM monitoring responsibilities. The SASP had a long history in developing monitoring requirements and had drafted the RMA Handbook, whilst the EUR/NAT Office had assisted in secretarial and coordination arrangements.

2.10 The meeting was informed that the draft RMA Handbook would also be reviewed during the SASP meeting in late November 2006, although it was unlikely that there would be sufficient time for required work on the Handbook to be fully completed and an additional RMA meeting would probably be necessary to finalize the work. In order to ensure that work on the Handbook progressed quickly, the meeting requested that SASP take primary carriage of this work and advise the EUR/NAT Office of progress in this regard. The remaining matters described in ALLPIRG/5 Conclusion 5/12 would be addressed subsequent to the SASP meeting of the Whole in late 2006.

Agenda Item 3: Funding of Regional Safety Monitoring Activities

Task Force to establish Regional Airspace Safety Monitoring Committees

3.1 The meeting recalled that, in pursuing the establishment of feasible and sustainable means to organize and finance the necessary regional safety monitoring mechanisms, RASMAG/5 had prepared a Working Paper for submission to APANPIRG/17 proposing that APANPIRG initiate steps to establish a *Regional Safety Monitoring Board – Asia* and a *Regional Safety Monitoring Board – Pacific* developed from the MID RMA model. This process was to be initiated by inviting the States concerned to meet with the aim of preparing acceptable Memoranda of Agreement and to take the necessary follow-up steps to establish the Boards to support their activities. The Regional Office had circulated the Working Paper via State Letter (Ref:T3/10.1.17 – AP050/06 ATM, dated 13 June 2006) prior to APANPIRG/17 to ensure that APANPIRG members were in a position to study the material prior to the meeting.

3.2 In considering these matters, APANPIRG/17 noted the global consensus that voluntary funding arrangements were not considered to be sustainable in the long-term, that the most appropriate funding mechanism for RVSM RMAs was to establish a multinational (ICAO) facility/service and that this was also an effective mechanism to address additional, recognized safety monitoring requirements for SMAs and CRAs.

3.3 However, APANPIRG/17 recognised the genuine concerns expressed in respect to the general complexity of the matters under discussion and specifically in relation to matters of legal liability. Although the MID RMA arrangements were functioning well, it was evident that a direct translation of these arrangements into the Asia/Pacific region was not viable and significant adjustments would need to be made. In any event, APANPIRG/17 considered that it was not reasonable to expect States to commit to the establishment of organisational entities until appropriate organizational documentation, terms of reference etc had been drafted. This would require careful and focused consideration and APANPIRG/17 agreed that the most appropriate mechanism in this respect was to constitute a task force to study the issues and develop appropriate documentation and implementation plans.

3.4 Additionally, APANPIRG/17 recognised that in matters such as these, each State had individual responsibility and therefore APANPIRG was unable to act for all States regionally in this respect. Progress on these matters would require the concurrence of all States involved, not just those in attendance at the meeting. APANPIRG/17 also had concerns in respect to the terminology "Boards" as the common usage of the term Boards suggested a high level and substantial entity and undertaking. Although unable to agree on a suitable alternative terminology, APANPIRG/17 agreed to the interim usage of "Committee" until the matter could be clarified. In order to allow States time to consult within their own administrations and consider the matter thoroughly, the meeting agreed to establish a task force to draft implementation proposals for the regional monitoring "committees", formulating the following Decision and associated Terms of Reference:

Decision 17/47 – Task Force to establish Regional Airspace Safety Monitoring Committees

That a Task Force be established to develop and distribute to States by 30 June 2007 implementation proposals for the establishment of Regional Airspace Safety Monitoring Committees. The Task Force would work in accordance with the terms of reference in Appendix A to the Report on Agenda Item 2.4 and use, inter alia, recent ICAO guidance materials in relation to the global approach for the funding of airspace safety monitoring.

Note: A summary of the guidance material is available in WP/22 for APANPIRG/17.

3.5 In discussing the slow progress in this matter, whilst fully endorsing Decision 17/47 and agreeing that the Terms of Reference were appropriate (**Appendix C** refers), RASMAG/6 recalled the many complexities that had been experienced thus far. In particular, although attempts had been made to ensure the attendance of appropriate State legal, financial and organizational experts at the Study Group called for under Conclusion 16/2, actual attendance of these experts had not eventuated. This had left RASMAG with the *de facto* responsibility to progress the matter, although funding issues were clearly outside the Terms of Reference of RASMAG and the experts routinely attending RASMAG were technical experts rather than financial or legal experts.

3.6 The meeting considered that the ability of RASMAG to continue to progress this matter was exhausted as the requisite legal and financial skill sets were not available amongst RASMAG delegates. However, the proposals contained in Working Paper 22 to APANPIRG/17 that had been prepared by RASMAG/5 comprehensively covered the circumstances and, in the hands of appropriate experts, would form a substantial foundation for further work in this area. Additional material was available from the work of the predecessor to RASMAG, the Asia/Pacific Airspace Safety Monitoring Task Force (APASM/TF) and was on file at the Regional office.

3.7 As such, the meeting reinforced that it was critical that participants at the Regional Airspace Safety Monitoring Committees Task Force (RASMC/TF) comprise State legal, financial and organizational experts with the organizational authority to make decisions on behalf of the affected States, particularly in respect to aspects of State sovereignty. In the absence of such experts, the RASMC/TF would be unlikely to progress any further than RASMAG in addressing the funding issues. Noting that the RASMC/TF/1 meeting had been scheduled for 14-16 February 2007, the meeting requested that the Secretariat make these issues very clear in the letter of invitation.

3.8 The Secretariat informed the meeting that a suitable discussion paper detailing the funding matters was under preparation for tabling during the 43rd Conference of Directors General of Civil Aviation for the Asia and Pacific regions during the first week of December 2006. Care would be taken in drafting this discussion paper to ensure that the effects of the withdrawal of RMA/CRA services in the Pacific as a result of the funding difficulties were highlighted, and assistance would be sought from regional DGCAs in ensuring that appropriate legal and financial experts were made available to attend the RASMC/TF meetings. The meeting supported a proposal from New Zealand, that members of RASMAG should take the opportunity to personally brief their DGCAs on these matters if possible.

3.9 The DGCA discussion paper would also highlight that, in the absence of appropriate safety monitoring arrangements, further implementation of reduced separation applications regionally would not be able to proceed, in accordance with the following APANPIRG Conclusion in this regard:

Conclusion 16/5 – No implementation of reduced separation unless compliant with Annex 11

That, recognizing that some States had not adequately complied with safety management provisions, the Regional Office advise States of the Asia/Pacific Region that further regional implementation of reduced separation minima should only proceed in circumstances where implementing States can demonstrate an ability to comply with Annex 11, Chapter 2, safety management provisions for the continuous monitoring and regular assessment of the safety level achieved.

Funding Arrangements for Pacific RMA and CRA

3.10 The United States had provided APANPIRG/17 with information in relation to the current arrangements for the provision of Regional Monitoring Agency (RMA) and Central Reporting Agency (CRA) services in the Pacific. Since 1995, the United States had provided and fully funded the Pacific Region RMA functions to monitor, through PARMO, the safety of RVSM for many of the Pacific FIRs. Commencing in 2000, the United States had also funded the CRA services for many South Pacific FIRs, with some financial assistance from Boeing since 2006. These services were provided as a gesture of goodwill to the region, in the expectation that in due course partner affected States would make provisions for equitable reimbursement. However, arrangements for equitable funding amongst the parties receiving these RMA and CRA services had yet to be resolved.

3.11 APANPIRG/17 was informed that, in principle, the United States agreed with the RASMAG proposal to establish a Regional Safety Monitoring Board and the step-by-step approach endorsed by the ALLPIRG/5, ANSEP/6 and RASMAG. Due to the rapid growth in the Asia/Pacific region, the United States requested via APANPIRG/17 that regional partners in the Pacific establish the *Regional Safety Monitoring Board – Pacific* as soon as possible and conduct the first meeting of the Board no later than 30 January 2007, with a commitment to completing administrative agreements no later than 90 days after the first meeting.

3.12 In this context, the United States offered to continue to serve as the multinational RMA/CRA organization for the Pacific Region until such time as the *Regional Safety Monitoring Board – Pacific* was operational and could permanently nominate the United States or other fully capable and equally cost effective provider through an agreed upon and transparent process.

3.13 However, APANPIRG/17 was informed that the United States requested that the regional partners involved commit to reimbursing the United States with 50% of the cost for the CRA and RMA services rendered on behalf of the Pacific region for calendar year 2007 onward, by formalizing administrative agreements or modifying existing bi-lateral agreements in order to equitably distribute the cost of these services.

3.14 Japan advised APANPIRG/17 that they were providing the CRA service for oceanic airspace within the Fukuoka FIR based on the IPACG agreement, and planned to expand the CRA services to South China Sea airspace. Japan was also conducting RVSM monitoring for domestic airspace in Fukuoka FIR and planned to expand RVSM assessment and monitoring functions to oceanic airspace within the Fukuoka FIR and neighboring airspace.

3.15 In addressing the concerns of both the United States and Japan, APANPIRG/17 formulated the following Conclusion:

Conclusion 17/48 − Funding of Pacific RMA & CRA

In recognizing that the United States/FAA was the current service provider of CRA and RMA services for the Pacific Region (with the exception of CRA services for Japan), it was acknowledged that:

a) FAA would remain the interim service provider for the Pacific Region until more formal arrangements have been made, and

b) Pacific States using these FAA services commit to reimburse the FAA for those CRA and RMA services rendered effective 30 June 2007.

Note: The FAA will be formally notifying each of these individual states that if reimbursement agreements are not in place by 30 June 2007, these services are at risk of being suspended.

3.16 In relation to this issue, the United States informed the meeting that the FAA was more concerned with funding arrangements for the CRA activity as this was significantly more expensive than activity associated with PARMO, given the cost of the number of specialists required for the CRA work. IATA confirmed to the meeting their continued support of the need for funding from States in relation to these activities, and reiterated previous offers for IATA to undertake collection of fees from States. The meeting was advised by the Secretariat that it should be remembered that the intention was not to create 'top heavy' Boards or complex processes to resolve the funding issue, but to establish a funds collection and distribution point empowered through a governance structure sitting over the top.

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

Guidance Material for ADS/CPDLC/AIDC Procurement and Implementation

4.1 In recognizing the lack of suitable guidance material in relation to the procurement, deployment and implementation of integrated data link systems (including AFN, ADS, CPDLC and AIDC), RASMAG had commenced work towards drafting suitable regional guidance material in this respect. The meeting was presented with an updated draft of the *"Asia/Pacific Guidance Material for ADS/CPDLC/AIDC Ground Systems Procurement and Implementation"* for review.

4.2 The Guidance Material had advanced considerably since last reviewed at RASMAG/5 in June 2006 and had also been presented to the Tenth Meeting of the CNS/MET Sub-Group (July 2006) for review. The meeting suggested a number of editorial corrections and additions, including the insertion of additional information explaining that datalink implementation was ultimately aimed at enabling reduced lateral and longitudinal separations for RNP10 and RNP4 flights with the ultimate objective of achieving 30/30 NM spacing. Some short comments in relation to the need for CRA services and monitoring both before and after commissioning were also considered advantageous.

4.3 Additional clarification was sought in terms of the usage of different screen presentation symbols for the various data sources e.g. ADS-C, ADS-B, radar, flight plan track etc. Updated information was provided from both Australia and the United States indicating current usage of 6 or 7 aircraft display symbols and associated hierarchy of display in which, if available, an ADS-B track was displayed in preference to an ADS-C track for the same aircraft, a radar track was displayed in preference to an ADS-B track and so forth.

4.4 The current version of the draft Guidance Material has been included as **Appendix D** for further review and feedback. Final comments and feedback should be provided directly to the primary authors in Japan and New Zealand by the end of November 2006 to enable incorporation into a circulation draft. This draft would be widely circulated by the Regional Office, including the FIT-SEA, FIT-BOB, IPACG, ISPACG and ASIOACG forums with a request for feedback. Final adjustments would be made to the draft during the next RASMAG meeting scheduled in June 2006, with a view to presenting the Guidance Material to APANPIRG/18 in September 2007 for adoption as regional guidance material.

4.5 The meeting recognized the considerable work that had already been undertaken by the authors in Japan and New Zealand in preparing the Guidance Material and thanked them for their continued commitment to the task.

SMA Handbook

4.6 The meeting recalled that RASMAG/2 (October 2004) had discussed the need to develop some form of guidance material for Safety Monitoring Agencies (SMAs) and proposed that a document could be developed along the lines of the RMA Handbook which, at that time, had recently been developed and agreed to by RMAs. Following further discussion on the contents of such a SMA handbook, RASMAG/2 agreed that, as a minimum, what would be required was a guide to the safety assessment actions needed for the implementation of reduced horizontal separation, such as the assessment undertaken by ISPACG for the implementation of 30NM lateral /30NM longitudinal separation minima utilizing ADS. Australia and the USA agreed to draft a document for distribution to and consideration by RASMAG members.

4.7 The draft Handbook had been presented at RASMAG/4 (October 2005) with a request for review and feedback to the primary authors but, unfortunately, no feedback had been received. The current draft of the SMA Handbook (**Appendix E** refers) was presented to the meeting for review. Feedback should be provided to the Chairman, Mr. Robert Butcher, as soon as possible and not later than 31 January 2007, in order to allow the Handbook to be finalized.

Agenda Item 5: Review the airspace safety monitoring arrangements in the Asia/Pacific Region and the activities of regional airspace safety monitoring agencies

Report of MAAR's RMA activities

Bay of Bengal

5.1 The Monitoring Agency for the Asia Region (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 2005 and the most recent rolling 12 months of Large Height Deviation (LHD) reports between January 2005 and September 2006 submitted by relevant States in the BOB region. The risk estimation was conducted based on the single alternate flight orientation scheme (FLOS) applied on the EMARSSH route structure over the BOB airspace

5.2 LHD occurrences in the BOB RVSM airspace were summarized as follows:

- Total of 9 LHD occurred in the BOB RVSM airspace between January 2005 and September 2006, accounting for 17.0 minutes of operational errors,

- Most of the LHD occurrences were a result of ATC loop error (Category I) – 8 of 9 LHD occurrences

5.3 **Table 5-1** below summarizes the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation in the BOB airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.77×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	1.11×10^{-9}	-	-
Total Risk	1.88×10^{-9}	5.0×10^{-9}	Satisfies Technical TLS

Table 5-1: Risk Estimates for the RVSM Implementation in BOB Airspace

5.4 In addition, **Figure 5-2** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month interval of LHD reports since January 2005.

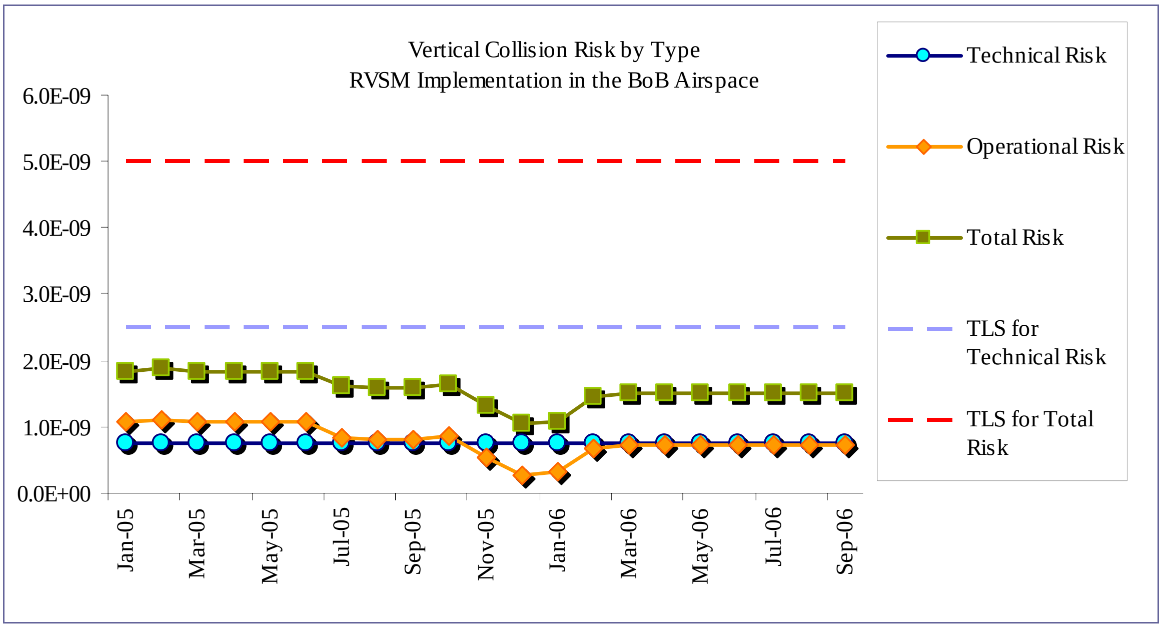

Figure 5-2: Trends of Risk Estimates for RVSM Implementation in BOB Airspace

5.5 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.

Western Pacific/South China Sea

5.6 MAAR also provided a summary of airspace safety oversight for RVSM implementation 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 2005 and the most recent rolling 12 months of Large Height Deviation (LHD) reports between January 2005 and September 2006 submitted by relevant States in the WPAC/SCS region. The risk estimation was conducted based on the modified single alternate flight orientation scheme (FLOS) applied on the on the WPAC/SCS route structures.

5.7 LHD occurrences in the WPAC/SCS RVSM airspace were summarized as follows:

- Total of 131 LHD occurred in the WPAC/SCS RVSM airspace between January 2005 and September 2006, accounting for 445.9 minutes of operational errors

- 71% of LHD occurrences were subject to errors in ATC-unit to ATC-unit transferred/transition message (Category M) – 92 of 131 LHD occurrences

- 66 operational errors for 384 minutes occurred during December 2005 – July 2006

- During this period, 256 and 110 minutes of which were reported by Manila FIR and Ujung Pandang FIR, respectively

- Significant LHD occurrences:
  - LHD reported by Manila FIR since December 2005
    - 8 operational errors for 95 minutes occurred on Route L625
    - 5 operational errors for 65 minutes occurred on Route A582
    - Combined 8 operational errors for 18, 16 and 16 minutes occurred on Route N884, L628 and A583, respectively

  - LHD reported by Ujung Pandang FIR since December 2005
    - One operational error for 45 minutes occurred in December 2005 on A584 (MAMOK)
    - Another operational error for 54 minutes occurred in March 2006 on Route A576 (SUMBU)

5.8 The meeting agreed with MAARs strong concerns that, based on the LHD summary, the number and duration of LHD occurrences for aircraft operations in the WPAC/SCS RVSM airspace are extremely high. **RASMAG supported MAAR in strongly recommending the WPAC/SCS RSG to investigate these occurrences and put in place the appropriate remedial actions on an urgent basis.**

5.9 **Table 5-3** summarizes the results of the airspace safety oversight 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	0.37×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	10.9×10^{-9}	-	-
Total Risk	$\mathbf{11.3 \times 10^{-9}}$	$\mathbf{5.0 \times 10^{-9}}$	**Exceeds Overall TLS**

Table 5-3: Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

5.10 In addition, **Figure 5-4** presents the trends of collision risk estimates for each month using the appropriate cumulative 12-month interval of LHD reports since January 2005.

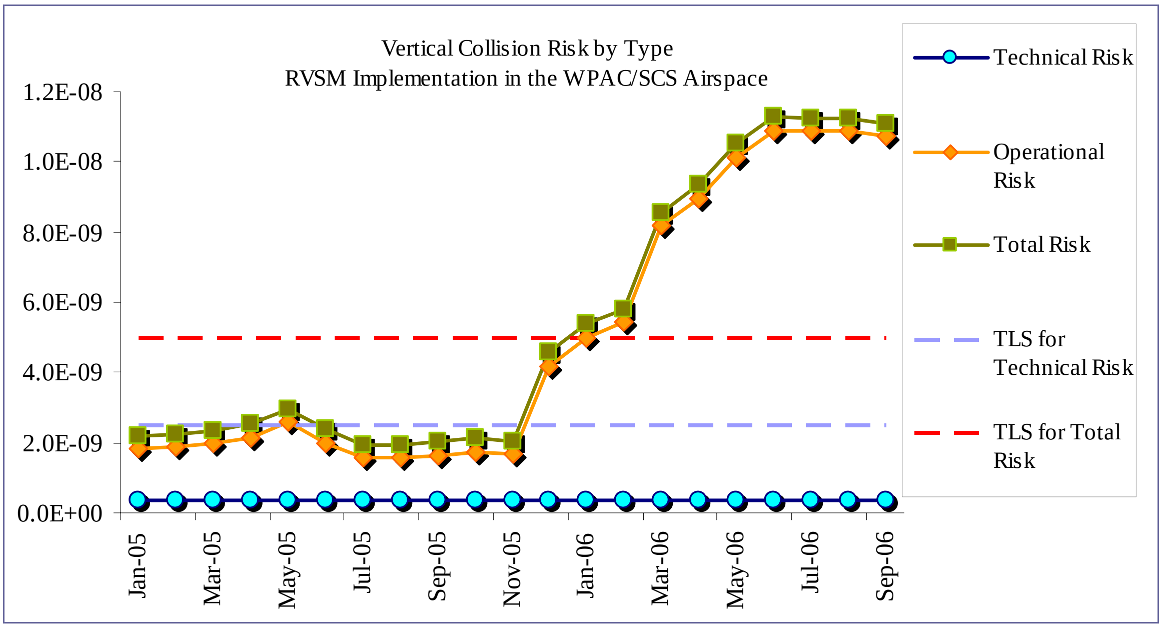

Figure 5-4: Trends of Risk Estimates for the RVSM Implementation in WPAC/SCS Airspace

5.11 Based on these collision risk estimates, the estimate of technical risks satisfies the agreed TLS values of no more than 2.5 x 10^{-9} fatal accidents per flight hour due to the loss of a correctly established vertical separation standard of 1,000 ft. However, the estimate of overall risk **significantly exceeds the agreed TLS** values of 5.0 x 10^{-9} fatal accidents per flight hour due to all causes.

5.12 The meeting recognized the adverse trend that was evident in terms of the WPAC/SCS safety assessment, recalling that previous RASMAG reports had recorded total risk estimates as follows:

RASMAG/3 (Jun 2005) = **4.90 x 10^{-9}** (provisional, due lack of data)
RASMAG/4 (Oct 2005) = **3.46 x 10^{-9}** (provisional, due lack of data)
RASMAG/5 (Jun 2006) = **7.08 x 10^{-9}**
RASMAG/6 (Nov 2006) = **11.3 x 10^{-9}**

5.13 In this context, the meeting strongly endorsed the early establishment of the RVSM Scrutiny Group (WPAC/SCS/RSG) as called for under APANPIRG Decision 17/5 as this was anticipated to bring the necessary sharp focus to what was evidently a deteriorating situation. The meeting also urged affected States to commence work immediately and continue work outside the WPAC/SCS RSG to correct the adverse trend as soon as possible.

5.14 The meeting thanked MAAR for the comprehensive reporting in respect to RVSM operations in both the BOB and WPAC/SCS areas, noting that the reporting in respect of the WPAC/SCS had brought the issues to the attention of the States involved and APANPIRG, prompting the establishment of a Scrutiny Group to address the issues.

Report of Australia's RMA activities

5.15 On behalf of the Australian RMA, the Chairman presented the results of a safety assessment of the Australian Domestic and Indian Oceanic Airspaces where RVSM has been introduced. The meeting was informed that the assessment conducted for the Australian FIRs was limited to that airspace west of the east coast of Australia given that the Tasman and Coral Sea traffic flows are monitored by PARMO as part of the South Pacific assessment. The meeting was reminded that the assessment also included a significant area of international airspace extending west in the Indian Ocean.

5.16 Estimates of the relevant occupancies for the collision risk model for this safety assessment were obtained from a sample of 31 days in December 2005. Specifically, the Chairman pointed out that the Australian RMA determines and applies in the CRM, the same and opposite direction vertical occupancies for the two way routes in the Australian domestic RVSM airspace, and for the two way routes in the Indian Oceanic RVSM airspace. The same direction occupancy for the one way domestic routes was also utilized in the model. The meeting was informed that as there are no published fixed one way routes in the Indian Ocean airspace, the limited number of flex tracks used in the area are defined on a flight by flight basis. The occupancy for these routes was calculated as zero on the basis of a 30 minute time window assessment of traffic.

5.17 With regards to the technical risk estimate determined in the assessment, Mr. Butcher informed the meeting that this had resulted in a figure of 0.0142×10^{-9} fatal accidents per flight hour in the Australian Domestic RVSM airspace, and 0.0135×10^{-9} in the Indian Oceanic RVSM airspace. This is more than two orders of magnitude less than the technical TLS in each case.

5.18 The meeting was informed that operational errors involving large height deviations were obtained from Airservices' Electronically Submitted Incident Report (ESIR) System, which is currently used to report and analyse such errors. A total of 255.5 minutes of operational errors in the 12-month period was determined, made up of 96.5 minutes for the Australian Domestic RVSM airspace, and 159 for the Indian Oceanic RVSM airspace.

5.19 The Chairman reported that the overall vertical risk in Australian RVSM airspace, weighted by flight hours in each airspace, is 4.6×10^{-9} fatal accidents per flight hour which **satisfies the regional TLS**. The meeting noted this was a significant result for the Australian FIRs considering the excursions of estimated risk in excess of the TLS over the last 2 years. The meeting considered that it was likely that the investigative and consequent remediation work undertaken by Australia under their ATS Safety Management System processes had assisted in achieving this result.

5.20 One aspect of the Australian RMA's work that was emphasized to the meeting was the detailed examination of operational errors that is undertaken to identify or review controls that have been recommended through investigations or some other process. This activity is an attempt to reduce the likelihood of re-occurrence. Australia provided details on this work in relation to the current assessment report and demonstrated how specific recommendations made from an investigation of an operational error were implemented and tracked to conclusion. The Chairman stressed that this type of detailed work was an important part of the routine role of an RMA or State, and even more so where the TLS has not been met.

5.21 The Chairman suggested to the meeting that it seemed that currently the RMAs of the Region report to RASMAG using significantly different formats and that it might be more useful for these RMA specific reports to at least follow an agreed template. This should make cross-referencing of data across the Region easier to undertake. Following a suggestion from the member from the United States the meeting agreed that the RMAs should standardize on the format used by MAAR. The Chairman agreed to format a template along those lines and discuss further with the RMAs. Additionally, the Chairman suggested that for the purposes of reporting annually to APANPIRG, the RMAs should collate a standardized single report that is presented to APANPIRG as the 'RASMAG Regional RVSM Safety Assessment Report' or similar. This was agreed by the meeting and action items were added to the Task List in these respects.

5.22 The meeting noted the good work undertaken by Australia in monitoring RVSM and particularly that the assessment now indicated that the TLS has been met within the Australian FIRs.

Report of PARMO's RMA activities

5.23 The Pacific Approvals Registry and Monitoring Organization (PARMO) provided an update to the meeting based on their 3rd quarter 2006 report, including a summary of large height deviation reports, results of traffic data analysis, and an estimate of vertical risk for the airspace. The report covers the current reporting period, October 2005 through September 2006, in the PARMO's ongoing process of providing quarterly updates of information relevant to the continued safe use of the RVSM in Pacific and North-East Asia airspace.

5.24 Fourteen risk-bearing large height deviations not involving whole numbers of flight levels were reported to the PARMO during the reporting period. The causes of 10 deviations were reported as pilot response to Traffic Alert and Collision Avoidance System (TCAS) or Airborne Collision Avoidance System (ACAS) resolution advisories. The causes of the remaining 4 deviations were reported to be turbulence or other weather-related cause.

5.25 Additionally, 40 risk bearing large height deviations involving whole numbers of flight levels were reported to the PARMO during the reporting period. Of these, 21 were related to ATC transition messages, with 17 of these events reported to be flight level errors in ATC-unit-to-ATC-unit transition messages – 13 in the Pacific airspace and 4 in the North East Asia airspace. Four additional errors were caused by a negative transfer received from another ATC-unit. Over 32 percent of the large height deviations involving whole numbers of flight levels were attributed to errors in the ATC-unit to ATC-unit transition messages.

Pacific Airspace

5.26 The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) continued to be met in Pacific airspace, thus supporting the ongoing safe application of RVSM in Pacific airspace. The technical risk was estimated to be 0.0978×10^{-9} fatal accidents per flight hour. The operational risk estimate was 1.68×10^{-9} fatal accidents per flight hour. The estimate of the overall vertical collision risk is therefore 1.78×10^{-9} fatal accidents per flight hour, this being approximately **64 percent below the regionally agreed TLS** value of 5.0×10^{-9} fatal accidents per flight hour. This new estimate was based on the most recent rolling 12 months of large height deviation reporting.

5.27 **Figure 5-5** provides the PARMO's updated risk estimates for Pacific RVSM airspace based on recent reports of large height deviations.

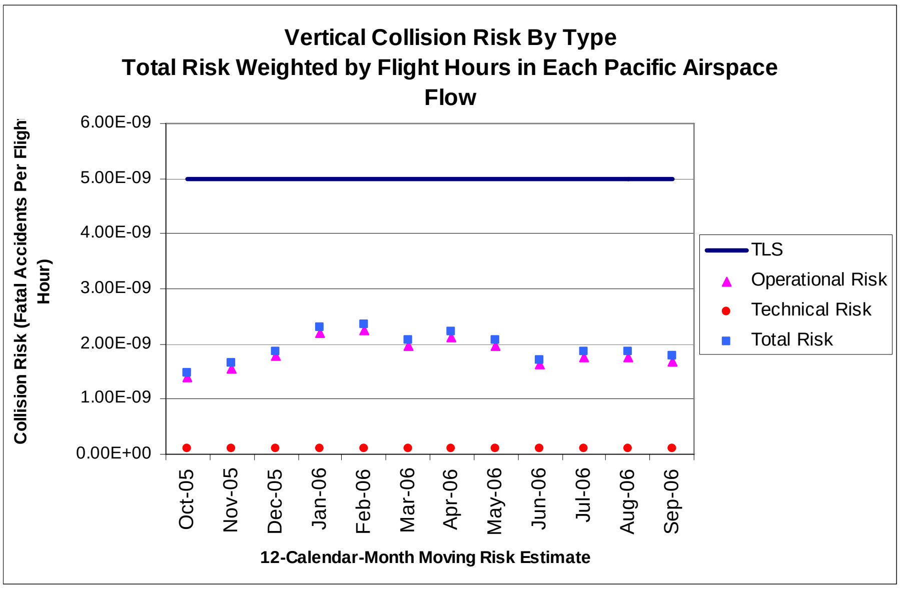

Figure 5-5. Vertical Collision Risk for Pacific RVSM Airspace

North East Asia Airspace

5.28 The vertical collision risk was estimated in order to determine whether the target level of safety (TLS) continued to be met in North East Asia airspace, thus supporting the ongoing safe application of RVSM in the airspace. The technical risk was estimated to be 8.08.x 10^{-10} fatal accidents per flight hour. This estimate is below the TLS value of 2.5 x 10^{-9} fatal accidents per flight hour for technical risk.
However, the initial operational risk estimate was 7.49 x 10^{-9} fatal accidents per flight hour, which did not satisfy the TLS value. The PARMO determined that a variation to parameter values in the Collision Risk Model (CRM) would result in a more consistent approach to risk assessment. This resulted in the risk estimate falling below the agreed TLS for the North-East Asia airspace, as described in paragraphs 5.32 – 5.36 below.

5.29 Further analysis demonstrated that the risk value was influenced substantially by the number of intersecting routes. The PARMO is undertaking additional analysis with a view to ensuring that parameter values used correctly reflect the route and traffic disposition in the North East Asia airspace. For example, if the parameter values in the South China Sea CRM were applied, the overall risk estimate would be 0.174x10^{-9}; being approximately 96 percent below the regionally agreed TLS value. PARMO would promulgate a final estimate of overall vertical risk for the North-East Asia airspace in due course, in consultation with other regional RMAs.

5.30 The results of the North East Asia airspace assessment were discussed at length by the meeting. Some concerns were raised regarding why the results seemed to suggest that the high number of LHDs related to ATC-ATC coordination messages were to be discounted from the calculations. PARMO advised that these errors accounted for more than half of the errors in the NE Asia airspace and that the intent was to provide some idea or a ‘snap-shot’ of what the risk would look like if it was assumed that these types of errors had been controlled and were not evident in the LHD data. The result, which included or did not include these errors, was simply to see the effect on risk. India questioned whether the use of lateral offsets was taken into account in determining risk estimates. PARMO advised they have not been to date, however pointed out that randomization of horizontal path reduces vertical risk in any case.

5.31 In recognizing the complexity of establishing appropriate CRM parameter values for ongoing application in the North East Asia airspace, the meeting thanked PARMO for their professional and thorough approach to these endeavors. The meeting commended the stable results in the Pacific airspace that consistently met the TLS.

Combined RMA meeting

5.32 The United States had introduced to the RASMAG some issues regarding the use of CRM parameter values for the North East Asia airspace. Currently a value of 1.73×10^{-4} for the probability of horizontal overlap for aircraft-pairs at adjacent flight levels on crossing routes that intersect at angle theta is used in the collision risk model. However, the figure used in the South China Sea RVSM assessment was 6.88×10^{-7}. Use of the latter value significantly reduces the estimation of risk within the North-East Asia airspace. As a result, the meeting supported a combined meeting of the four RMAs represented at RASMAG to resolve this issue during the course of the current RASMAG meeting.

5.33 The combined meeting of RMAs took place on 8 November and included representatives from the PARMO, MAAR, JCAB and Airservices Australia. The Chairman outlined to the meeting the need for the RMAs to coordinate to resolve issues regarding the validity of using the values of horizontal overlap used in the South China Sea assessment in the North-East Asia assessment.

5.34 The United States had demonstrated to the RASMAG meeting that calculation for the North-East Asia airspace using the existing CRM parameters exceeded the TLS but that if that calculation was made using the overlap probability routinely used for the South China Sea of 6.88×10^{-7}, then the risk value for North-East Asia airspace dropped significantly to 0.133×10^{-9} as opposed to 7.10×10^{-9}. Operational risk estimates for North-East Asia RVSM airspace presented to the meeting were:

a) 0.008×10^{-9} for same direction pairs;
b) 0.1×10^{-9} for opposite direction pairs; and
c) 7×10^{-9} for crossing pairs.

5.35 Of the overall risk of 7.1×10^{-9} almost all was made up of pairs of aircraft crossing at common points. The PARMO informed the combined RMA meeting that this relative contribution of crossing-route risk was contrary to results for other portions of global airspace, where this component was typically an order of magnitude less than the sum of same-direction and opposite-direction risk arising from same-route operations. The PARMO noted that the value of one CRM parameter, the probability of horizontal overlap for crossing routes, used in Northeast Asia risk estimates was roughly 250 times as large as that applied in South China Sea risk estimates. Since the estimated value of this parameter depends on the proportion of aircraft in an airspace equipped with GNSS navigation capability, the combined meeting agreed to review relevant procedures and calculations.

5.36 Detailed discussions took place during the meeting in an attempt to determine how the MAAR and PARMO horizontal overlap probabilities were determined. As part of the joint review, the MAAR examined risk estimates carried out in advance of RVSM implementation in Northeast Asian airspace. Through this cooperative effort, a revised value of overall risk equal to 0.65×10^{-9} fatal accidents per flight hour was determined to apply to the airspace of Northeast Asia. This value is roughly 10 percent of the TLS, indicating that the airspace in question is meeting the RVSM safety goal.

One Year Review – Japanese Domestic Airspace

5.37 Japan presented the meeting with the one-year post-implementation RVSM safety assessment for the Japanese domestic airspace, which was completed in coordination with PARMO and MAAR and with the assistance of the Electronic Navigation Research Institute (ENRI) of Japan. The safety assessment had been conducted based on relevant traffic sample data including the December 2005 TSD and monthly Large Height Deviation (LHD) reports between October 2005 and September 2006.

5.38 A total of 24 LHD occurrences were recorded between October 2005 and September 2006 in the Japanese domestic RVSM airspace. Of these, 10 were as a result of TCAS response, 7 related to ATC transfer errors, and 7 to weather related or other causes. The JCAB had scrutinized each case of LHD, identifying LHDs caused by human errors (ATC-transfer errors, pilot misunderstands clearance message, ATC issues incorrect clearance, etc) as attributable to operational risk. LHDs caused by technical errors (aircraft equipment failure, TCAS RA, turbulence, contingency events, etc) were generally attributed to the technical risk. This review concluded that out of 24 reported LHDs, 11 LHD occurrences would be attributable to operational error and 13 LHD occurrences would be attributable to technical error.

5.39 In regard to the 7 LHDs caused by ATC operational errors relating to transfer between ATC units, JCAB coordinated the matter with the adjacent ATC units concerned with the aim of preventing further recurrence of similar errors. JCAB was advised that as a result of this coordination, remedial actions were undertaken by the affected ATC units, such as conduct of refresher training courses for controllers and establishment of procedures to strengthen monitoring capability by supervisor as to transfer of control. JCAB will continue monitoring the situation and cooperate with other ATC units for any improvements.

5.40 **Table 5-6** below summarizes the results of the airspace safety oversight in terms of the technical, operational, and total risks for the RVSM implementation in the Japanese Domestic airspace.

Source of Risk	Lower Bound Risk Estimation	TLS	Remarks
Technical Risk	0.44×10^{-9}	2.5×10^{-9}	Satisfies Technical TLS
Operational Risk	4.53×10^{-9}	-	-
Total Risk	4.97×10^{-9}	5.0×10^{-9}	Satisfies Technical TLS

Table 5-6: Risk Estimates for the RVSM Implementation in Japanese Domestic airspace

5.41 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.

5.42 The meeting noted that JCAB considered that the overall risk estimate shown in this assessment was marginal, and would continue monitoring and take actions where necessary.

Safety Concerns in the WPAC/SCS area

5.43 Attention was drawn to the review by APANPIRG 17 of the work of RASMAG and the ATM/AIS/SAR Sub-Group in relation to operations in the Western Pacific/ South China Sea area (WPAC/SCS). APANPIRG/17 had recognized that there were three very significant safety matters outstanding in relation to WPAC/SCS operations that needed to be urgently addressed, as follows:

a) The target level of safety for WPAC/SCS RVSM operations was not being satisfied and was showing an adverse trend;

b) Concerns originally raised by RVSM/TF/22 (September 2004) in relation to the use of a modified alternate FLOS in the WPAC/SCS and the consequential RVSM interface arrangements with the single alternate FLOS used in areas surrounding the WPAC/SCS area had still not been addressed; and

c) Although the South China Sea parallel route structure had been implemented in November 2001, no updated horizontal safety assessment had been undertaken in the five years since implementation. Additionally, data used in the implementation safety assessment had necessarily been based on the "old" route structure; as such no horizontal safety assessment had been made based on data from the "new" route structure.

RVSM Scrutiny Group for WPAC/SCS

5.44 APANPIRG/17 agreed that the RVSM related safety issues in paragraph 5.43 a) and b) above should be urgently scrutinized by a dedicated working group that would specifically address matters relating to WPAC/SCS RVSM operations and adopted the following Decision and associated terms of reference for such a working group:

Decision 17/5 − Establishment of WPAC/SCS RVSM Scrutiny Working Group

Recognizing that:

a) incompatibilities exist between the modified single alternate flight level orientation scheme (FLOS) in use in the Western Pacific/South China Sea (WPAC/SCS) area and the single alternate FLOS in use in areas adjacent to the WPAC/SCS area, and

b) the RVSM Target Level of Safety in the WPAC/SCS area was not being satisfied and exhibited an adverse trend,

a Scrutiny Working Group be established to identify, study and address problems in the safety, efficiency and harmonization of WPAC/SCS RVSM operations in accordance with the Terms of Reference in Appendix A to the Report on Agenda Item 2.1.

5.45 The meeting fully supported the establishment of the dedicated WPAC/SCS RVSM Scrutiny Group (WPAC/SCS RSG), noting that the work of the Scrutiny Group was expected to address the problems that had previously been identified by RASMAG. The meeting was informed that the Regional Office had scheduled the first meeting of the WPAC/SCS RSG for 29 January – 2 February 2007, graciously hosted by the Civil Aviation Authority of Singapore (CAAS).

5.46 The meeting agreed that in order to progress this work in the most efficient manner, it was important to retain the specific focus of the Scrutiny Group and that, as such, participation should be limited to those parties immediately affected or who were in a position to directly assist. Accordingly, the Regional Office would limit membership of the Scrutiny Group to the States surrounding the WPAC/SCS area, Australia, Japan and the United States, the related RMAs (i.e. MAAR and PARMO) and IATA, IFATCA and IFALPA. Letters of invitation would be issued shortly.

5.47 It was recognized that in order to identify specific issues and recommend associated remediation, the WPAC/SCS RSG would have to undertake very detailed analysis of specific situations. For example, a consistent theme in the analysis of Large Height Deviations (LHD) was that of difficulties in ATC-to-ATC coordination, which accounted for a large proportion of LHD. The WPAC/SCS RSG would have to undertake a detailed investigation, to a depth at which the specific ACCs were identified, of each LHD with "ATC Unit to ATC Unit coordination" as a causal factor.

5.48 It was evident that the RMAs would play an important role in undertaking the preliminary analysis based on the routine traffic sample data and LHD reporting provided by States and that without identifying and detailing the specific circumstances of each occurrence, it was unlikely that meaningful improvements could be instituted. Recognising that it would therefore not be possible to completely de-identify all data, the meeting recommended that the WPAC/SCS RSG avoid making such detailed data widely available. In this context, the Regional Office agreed that due care would be taken in determining which of the WPAC/SCS RSG working/information papers and meeting reports would be made available via the Regional Office website.

5.49 The meeting agreed that the Terms of Reference (TOR) adopted by APANPIRG/17 for the WPAC/SCS RSG generally provided appropriate guidance and direction to the WPAC/SCS RSG. However, the meeting considered that respect for the privacy of parties identified in the safety data provided to the regional safety monitoring agencies was extremely important and that affected States should be made aware that, in addition to submissions directly from States, data from the RMAs would be used by the WPAC/SCS RSG to analyze operations in the WPAC/SCS area.

5.50 In this context, the meeting considered that the TOR should be strengthened by inclusion of new text at b) and d) of the TOR that noted that the WPAC/SCS RSG would "…. analyze data, *including data from regional monitoring agencies*, and evaluate ….". A copy of the TORs which includes the proposed wording has been included as **Appendix F** and the meeting requested that the Secretariat bring these proposals to the attention of the first meeting of the WPAC/SCS RSG for consideration. If appropriate, the WPAC/SCS RSG could then progress an amendment to the TOR via APANPIRG.

Safety assessment for RNP10 Operations in the SCS area

5.51 The meeting was informed that APANPIRG/17 had recognized that the lack of current horizontal safety assessment for the South China Sea route structure as referred to in paragraph 5.43 c) above should also be urgently addressed, adopting the following Conclusion:

Conclusion 17/6 − Completion of the horizontal safety assessment for the South China Sea route structure

That, recognizing that no horizontal safety assessment for the South China Sea parallel route structure had been conducted since implementation in 2001, the ICAO Regional Office urges concerned States to complete, by 30 June 2007, a horizontal safety assessment in accordance with ICAO ATS safety management provisions.

5.52 Recognizing the urgency of the situation, Thailand reported that they had taken a decision to offer their full commitment in providing appropriate staffing and resources to MAAR in order to satisfy this additional task in accordance with the requirements of Conclusion 17/6. In response to a query from Japan, MAAR confirmed that the safety assessment would be completed by 30 June 2007.

5.53 The meeting recalled that RASMAG/4 (October 2005) meeting had commended MAAR on its performance as an RMA and considered that it was likely that any additional services provided by MAAR could reasonably be expected to be of a similar quality. In respect to the provision of SMA services, RASMAG/4 had also noted expressions of support from a number of States represented at the RASMAG/4 meeting, including Australia, Hong Kong China, India, Japan, Singapore and the United States, as well as the Regional Office.

5.54 Noting that it was now more than 5 years since the implementation safety assessment for the South China Sea route structure had taken place the States present at the meeting, IATA and the

Regional Office supported this generous and timely offer from Thailand to complete the horizontal safety assessment in accordance with Conclusion 17/6 and thanked Thailand for their continued support. RASMAG/6 supported the initiatives of Thailand and encouraged MAAR to proceed in accordance with the proposal as presented to the meeting.

5.55 In terms of ensuring that appropriate data was available, the Regional Office had recently transmitted a State Letter (ref: AP105/06 (ATM), 7 Nov 2006, **Appendix G** refers) reminding States of their responsibilities to provide a December 2006 traffic sample data to MAAR and PARMO. Additionally, the meeting recalled that when the revised South China Sea route structure was implemented on 1 November 2001, an essential aspect of the project was the establishment of RNP 10 monitoring arrangements along six of the routes, *i.e.* L625, L642, M771, M767, N884 and N892. Hong Kong China, Philippines and Singapore were made responsible for the collection of relevant data concerning flight operations along these routes, including examples of lateral Gross Navigational Errors (GNE, >15NM lateral displacement) and longitudinal errors of 3 minutes or more, and an operational Letter of Agreement (LOA, **Appendix H** refers) was established in this respect. These States were also required to forward the data collected, each month, to the Civil Aviation Authority of Singapore (CAAS) for collation.

5.56 The meeting requested Singapore to bring the records of GNEs provided under the terms of the LOA fully up to date in order that the most accurate record would be available to MAAR by the end of February 2007. This data would be used in conjunction with traffic sample data from the December 2006 regional traffic sampling to form the basis of the data set for the horizontal safety assessment.

5.57 The Regional Office would work with MAAR to ensure that all available guidance material and other documentation were made available to MAAR to assist with the safety assessment. Additionally, the United States expressed their continued support to Thailand and MAAR and would assist MAAR wherever possible in the conduct of the horizontal safety assessment. The Chairman also proposed that, as Airservices Australia had previously undertaken the safety assessment for the South China Sea route structure, it would be of value to MAAR to discuss the assessment methodology used previously by Airservices. The Chairman agreed to coordinate this activity for MAAR representatives at the forthcoming SASP meeting in Australia during November 2006.

Expanded Airspace Monitoring and Assessment Capability – Japan

5.58 Japan reiterated its intention to fulfil the responsibility for providing airspace safety assessment and monitoring services for RVSM and RNAV/RNP within Fukuoka FIR by strengthening the current capabilities in terms of staffing, system equipment, expertise, etc, and also wished to be recognized as an RMA for RVSM and an SMA for RNP in the region when JCAB becomes fully capable of providing the services.

5.59 The meeting noted the following updated information from Japan in relation to the safety assessment and monitoring of RVSM and RNAV/RNP, and continued its support for Japan to provide airspace safety assessment and monitoring services within the entire Fukuoka FIR.

<u>RVSM</u>

5.60 At RASMAG/5, Japan had expressed its intention that JCAB would have full functions and capabilities to provide RMA services for the entire airspace of Fukuoka FIR by the end of 2006. However, although JCAB was now able to conduct in-house safety assessment for domestic and oceanic airspace by risk calculation methodologies, a proper mechanism to utilize results of assessment for the purpose of improving safety was yet to be established. As such, the second quarter of 2007 was considered more realistic for the availability of these services.

5.61 With regard to the provision of RMA services to other FIRs beyond Fukuoka FIR, JCAB will consider the matter taking into account future discussions concerning the establishment of Regional Airspace Safety Monitoring Committees and funding for RMAs.

RNAV/RNP

5.62 At RASMAG/5, Japan expressed its intention that JCAB would have full functions and capabilities to provide SMA services for the entire airspace of Fukuoka FIR by the end of 2007. JCAB is presently able to conduct in-house safety assessment for RNP10-based lateral separation reduction and longitudinal separation reduction using ADS/CPDLC in the oceanic airspace. However, JCAB recognises that although a standard collision risk model for RNAV/RNP horizontal separation has been developed by the ICAO Separation and Airspace Safety Panel, the availability date is not yet determined. Due consideration should also be given to the future discussions concerning the Regional Airspace Safety Monitoring Committees.

5.63 In light of the above, JCAB considered the second quarter of 2009 was more appropriate as a target to commence SMA services for Fukuoka FIR and would continue close working relationship with the established safety monitoring agencies in the region in order to contribute to enhancing regional airspace safety monitoring activities.

List of Competent Airspace Safety Monitoring Organisations

5.64 The meeting recalled that RASMAG was 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.

5.65 In order to assist in addressing these requirements, RASMAG updates and distributes a list of competent airspace safety monitoring organizations for use by States requiring airspace safety monitoring services. In this context, the meeting reviewed and updated the 'RASMAG List of Competent Airspace Safety Monitoring Organizations' as presented in **Appendix I** to this report.

Agenda Item 6: Review of regional safety assessment activities/requirements

Preparedness of States to implement ATS Safety Management Systems

6.1 The meeting recalled that in August 2005, APANPIRG/16 was informed regarding a Special Implementation Project (SIP) that had been conducted by the Regional Office during August 2005 in four States in South-East Asia, with a focus on ATS safety management. A similar SIP conducted in 2004 had covered a number of States in the Bay of Bengal area and included consideration of ATS operational safety matters.

6.2 The August 2005 mission noted that ICAO recommended safety management systems had not been fully implemented by any of the four States visited and they were at various stages of developing their strategy and implementing changes to their existing safety management practices. In most cases, the State civil aviation authorities lacked funding, human resources and expertise to develop and operate ICAO compliant safety management systems.

6.3 Subsequently, APANPIRG/16 raised Conclusions 16/18 and 16/19 with the intention of assisting States to implement ATS safety management systems. Conclusion 16/18 requesting States with expertise in ATS SMS to assist others had resulted in an offer from the Civil Aviation Department (CAD) of Hong Kong, China to host a combined CAD/ICAO ATS SMS Workshop; coordination was taking place with a view to the workshop being held in the second quarter 2007. However, in relation to Conclusion 16/19, as shown below, no action had yet been taken.

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.

6.4 Although recognizing that resource restrictions were such that it was unlikely that a workable plan of action could be put in place, the meeting considered that an up to date regional record of the status of State implementation of Annex 11 compliant ATS safety management systems would be valuable and encouraged the Regional Office to go ahead with a suitable survey.

ICAO Safety Management Systems Training

6.5 The meeting noted that during September/October 2006, two SMS courses and an ATS SMS workshop were conducted at the Regional Office for States and international organizations. Each course/workshop was of 5 days duration, comprising 30 classroom hours including exercises and case studies. In all, approximately 100 representatives from 25 States and international organizations received SMS training during this period.

ICAO Headquarters SMS Courses

6.6 In September 2006, two SMS courses of 35 participants each were conducted at the Regional Office. These training course 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 areas of aircraft operations, air traffic services, maintenance of aircraft and aerodrome operations. Participants were subjected to a process of continual assessment during the course and a final written exam, in order to gain a passing grade in these courses.

Regional Office ATS Safety Management SIP

6.7 APANPIRG/16 (August 2005) expressed concerns in relation to a number of matters related to ATS safety management including the non provision of safety related data by some States, the lack of robust organisational and funding arrangements to establish regional safety monitoring agencies, target levels of safety in enroute airspaces were being exceeded, significant numbers of large height deviations were being reported, horizontal plane safety assessments for RNP10 route structures were not updated and difficulties were being experienced at the interfaces between differing flight level orientation schemes (FLOS) in use regionally.

6.8 In order to address these matters, the Regional Office had received approval from the Council for the conduct of the following SIP on ATS Safety Management System Training, for completion during 2006:

Project: To formulate a two/three day ATS safety management workshop and deliver the workshop in-country to a minimum of three States.

Objective: To assist States to meet obligations for ATS safety management by facilitating a suitable ATS safety management workshop enabling practical hands on experience in the application of safety management techniques.

6.9 A requirement of the SIP was that, in addition to the ICAO SIP official, a fully funded State ATS SMS expert would be made available to support the SIP. Unfortunately, a fully funded State official could not be made available to support the SIP and, as a consequence, the Regional Office was obliged to redirect the SIP. To enable the objectives of the SIP to be met a SIP official was engaged however, as the SIP would not be supported by a State expert, the budget would not permit conducting the workshop in three States as originally planned. A decision was therefore taken to hold a single full-week workshop at the Regional Office.

6.10 The SIP was intended to address the concerns expressed by APANPIRG. Its objectives were to address both the general needs of States in implementing the provisions of Annex 11 and the PANS-ATM (Doc 4444) in relation to ATS safety management, and the specific issues related to the data collection and analysis activities needed to support reduced separation minima. In structuring the SIP workshop, it was considered that these objectives could be best met by a combination of presentations on basic safety management principles, with a particular emphasis on the techniques relevant to ATS, and practical exercises in small groups to provide practical experience in the application of safety management techniques.

6.11 The major source of available existing material was the ICAO Safety Management Systems Course. This course presented a uniform approach to safety management for air traffic services, flight operations, aircraft maintenance and aerodrome operations, and was intended more for State regulatory authorities than for service providers. The material from this course formed the basis of the presentations on basic safety management principles for the workshop.

6.12 However, the SIP identified that there were two areas of particular importance to ATS safety management that were not covered in the ICAO Safety Management Systems Course. Firstly, the PANS-ATM (Doc 4444) requires safety assessments prior to the implementation of any significant changes to ATS systems, airspace or procedures. This requires the application of hazard identification and risk analysis techniques in the planning phase, prior to implementation. Secondly, the other area specific to ATS was the application of collision risk modelling for safety assessment of separation minima, and the associated data collection requirements. Consequently, additional presentations addressing these two issues were developed, along with relevant exercises for use in the group practical sessions.

6.13 The workshop was well supported by States, with a total of 29 participants from 13 States including Bangladesh, Cambodia, Hong Kong China, India, Indonesia, Japan, Maldives, Nepal, Papua New Guinea, Philippines, Singapore, Sri Lanka and Thailand.

6.14 In reporting on the project, the ICAO SIP official considered that although the project produced was effective in addressing a definite need for training and assistance to States in the implementation of ATS safety management systems, considerable work remained to be done before the majority of the States would be able to implement safety management systems which are fully ICAO compliant.

Modification to the CRM for the South China Sea

6.15 The United States informed the meeting that the ICAO endorsed Collision Risk Model (CRM) was the Reich Collision Risk Model. The vertical form of the Reich CRM is used to conduct a comprehensive safety assessment prior to the introduction of RVSM. During the safety assessment work associated with the South China Sea airspace, a modification was made to the operational risk portion of the ICAO endorsed CRM for the vertical dimension prior to the implementation of the RVSM in South China Sea airspace.

6.16 The original form of the Reich CRM was developed for the North Atlantic (NAT) airspace. The NAT traffic follows a systematic schedule, keeping the peak period traffic in a unidirectional flow. The unmodified CRM provides a conservative estimate of the operational risk for opposite-direction traffic. The conservative estimate results from the model form, which considers the possibility that an operational error could result in a head-on collision if an aircraft were to operate at the wrong flight level for its direction of travel.

6.17 However, portions of the South China Sea airspace have routes with single-alternate Flight Level Orientation Scheme (FLOS). The opposite-direction vertical occupancy estimates for traffic using these single-alternate FLOS routes were large compared to similar estimates for other oceanic airspace with mostly unidirectional traffic like the NAT airspace. As such, a modification was necessary to enable appropriate parameter values to be utilized in the CRM in acknowledgement of the traffic disposition and route structure in the South China Sea airspace. Full details of the modification and associated justifications are contained in the working paper from the United States PARMO shown as **Appendix J**.

Bay of Bengal ATFM Operational Trial

6.18 The meeting was informed that during the Special ATS Coordination Meeting – Go/No Go Decision in respect of the Bay of Bengal ATFM Operational Trial (SCM GO BOB ATFM, 14 − 16 June 2006) the ATFM Task Force took a ‘Go’ decision to commence a ghosting phase of the ATFM Operational Trial on 29 June 2006, using the automated Bay of Bengal Cooperative ATFM Advisory System (BOBCAT) developed by Aeronautical Radio of Thailand Limited (AEROTHAI).

6.19 As a result of satisfactory ghosting performance, the trial advanced to the operational phase on 24 July 2006 and, pursuant to a comprehensive review, the ATFM/TF/7 meeting (31 July – 3 August 2006) extended the operational phase of the trial until further notice.

6.20 Attention was drawn to the difficulties in respect of the sheer numbers of people involved in the daily interaction with the operational trial. As well as administrative staff generally in many affected States and organizations, there were many air traffic controllers in more than 15 separate ACCs and Control Towers in 6 or 7 primary States, as well as pilots and dispatchers from up to 25 airlines involved. The flow task was also extremely complex, with sequencing parameters for a restrictive 10-minute longitudinal CVSM airspace being applied to aircraft prior to becoming airborne in order that they meet a Kabul entry fix time typically 5 or 6 hours after departure

6.21 The meeting was pleased to note that the ATFM operational trial had a direct and measurable safety benefit to Kabul FIR by increasing the numbers of overflights that were separated in accordance with PANS-ATM provisions from about 72% to about 95% of total overflying traffic. Additionally, the ATFM operational trial had made the management of existing traffic levels more efficient and would enhance the capability of Afghanistan to manage the increased traffic growth forecast in the near future.

6.22 The ATFM operational trials highlighted a number of shortcomings which had surfaced during the first six days of the trials. It was recognized that the shortcomings were not related to the performance of BOBCAT, however the application of BOBCAT metering had highlighted inefficiencies in the current ATS coordination arrangements between States that could lead to traffic bunching on the eastern side of the Bay of Bengal and the need for tactical intervention at the expense of efficiency. Additional complexity resulted from the intersection of a number of FIR boundaries in this vicinity.

6.23 APANPIRG/17 (August 2006) was updated in regard to the progress of the ATFM operational trial and agreed that the States and airspace users should ensure full compliance with the ATFM operational trial procedures, adopting Conclusion 17/12 in this respect:

Long Term Monitoring of RVSM Height Keeping Performance

6.24 APANPIRG/17 was informed that the current requirements for on-going height keeping performance monitoring differed from region to region. This meant that operators were required to meet different requirements simply because of their geographical area of operation. APANPIRG/17 recognized that that any long term monitoring requirements which may be developed by the ICAO Separation and Airspace Safety Panel (SASP) should be globally harmonized as opposed to the current regional approach. The meeting noted that a concurrent meeting of global RMAs would take place during the November 2006 meeting of the SASP and that the issue of long term monitoring of RVSM height keeping performance was a significant agenda item for this meeting.

6.25 In recognition of the need for global harmonization APANPIRG/17 developed the following Conclusion:

Conclusion 17/4 − Long Term Monitoring of RVSM Height Keeping Performance

That, in recognition of the desirability of global harmonization and interoperability, ICAO be invited to consider appropriate measures to ensure that any requirements for long term monitoring of RVSM height keeping performance be standardized and applied on a global basis.

Airspace characteristics related to Oakland 30/30 Trial

6.26 On 22 December 2005, the Federal Aviation Administration (FAA) implemented 30 NM lateral / 30 NM longitudinal separation standards (30/30) on an operational trial basis in a portion of the Oakland Oceanic Flight Information Region (FIR). The operational trial permits FAA to evaluate the relevant performance of aircraft with suitable State approval for participation in the trial, as well as operation of the new Ocean21 oceanic automation system introduced into full-time operation at the Oakland Air Route Traffic Control Center (ZOA) on 17 October 2005. The implementation followed all guidelines in outlined in Annex 11 of the Convention on International Civil Aviation and the International Civil Aviation Organization (ICAO) Doc 4444.

6.27 To support the operational trial, FAA has formed a group of experts to evaluate performance of the various components of the system supporting the reduced separation minima. This group has been termed the "30/30 Scrutiny Group," more simply known as the scrutiny group. The scrutiny group is chaired by FAA Flight Standards Services and has representatives from various groups within the FAA, such as Oakland and Anchorage ARTCC, Flight Standards Services, Aircraft Certification Service, Oceanic Standards, FAA Technical Center (TC) and support contractors. The scrutiny group has met four times since the start of the operational trial in order to review pertinent data from a number of sources. The data reviewed thus far covers the period from 22 December 2005 through 30 September 2006. The United States presented the meeting with a summary of airspace characteristics related to the operational trial of 30/30 separation standards in the Oakland FIR. Included were analyses detailing the number of flights per day conducted by operators participating in the operational trial, the proportion of overall flights that were FANS-1/A equipped and descriptive information on Oakland Oceanic airspace. A copy of the presentation has been included as **Appendix K.**

Anomalies and issues of concern identified during Oakland 30/30 Trial

6.28 The FAA introduced 30/30 on a trial basis in Oceanic Control Sector 3 (OC3) of the Oakland Oceanic FIR, between pairs of aircraft with State Approval for Required Navigation Performance (RNP) 4 and appropriate data link operations. As a practical matter, the operational trial use of 30/30 minima is limited to aircraft equipped with the Future Air Navigation System (FANS) package and approved for RNP-4 operation. A key contributor to the application of the reduced separation minima is the heightened level of tactical air traffic control possible with FAA's new oceanic automation system, Ocean21. This system also provides the means of collecting data for evaluation of overall system performance during the operational trial.

6.29 The meeting was presented with a summary of anomalies and issues of concern identified during the operational trial – a copy of the presentation has been included as **Appendix L**. The anomalies are divided into two categories 1) those which are or will be resolved as the result of FAA work, and 2) those whose resolution requires further coordination and action outside the FAA. The anomalies and issues of concern are characterized under the following categories:

a) Poor Availability of Ground Earth Stations (GES)

b) Extended Observed Downlink Transit Times for ADS-C Messages & Related Anomalies

c) Negligible Uplink One-Way ADS Transit Times

d) Missing Basic Periodic Reports

e) Lateral Deviation Contract (LDC) Events & Related Anomalies

f) Duplicate Downlink ADS Messages

g) ADS Uplink Messages With No Response

6.30 The information regarding anomalies provided by the United States drew lengthy discussion by the meeting. IATA noted that not all the anomalies were the sole responsibility of the datalink service providers, but that some issues were the responsibility of airlines themselves. The Chairman also advised that Australia had seen similar anomalies to those identified by the United States, and was concerned with the number and length of unannounced system outages. Further discussion by the meeting identified increasing concern with regards to datalink service availability and reliability, specifically as to the impact this could have on the implementation of 30/30 separation minima. As a result the meeting agreed that States or relevant ANSPs should be collecting and scrutinizing datalink information and messaging, and assessing this in relation to requirements detailed in the FANS Operations Manual (FOM) or relevant ICAO separation standards. Additionally this information should be made available on a routine basis to RASMAG for Regional review.

6.31 The meeting encouraged States represented at RASMAG to establish scrutiny groups where practical along similar lines to that implemented by the United States.

Expansion of 30/30 Trial – Oakland

6.32 The meeting recalled that the FAA had presented RASMAG/5 with information regarding the success of the operational trial for the application of 30 NM lateral / 30 NM longitudinal separation (30/30) in Oakland Center Oceanic Control Sector 3 (OC3) for Required Navigational Performance (RNP) 4 approved aircraft. Based on the outcome of the operational trial, FAA committed to the Phase I expanded use and application of 30/30 into at least two (2) additional airspace volumes within the Oakland Oceanic FIR by March 2007.

6.33 The meeting noted that the FAA established a 30/30 Scrutiny Group (SG) to evaluate the OC3 30/30 operational trial. The SG examined data from the operational trial and data link communications within the entire Oakland Oceanic FIR and concluded that the March 2007 target date for expansion of 30/30 within the Oakland FIR was realistic and attainable provided a number of issues are mitigated or resolved. Three issues are considered serious and, if not corrected, will force postponement of the planned March 2007 operational trial expansion.

- Availability of Ground-Earth Stations (GES) is a serious issue. The major concern is the frequency and duration of unplanned outages. The Perth GES is scheduled to be upgraded in October; SG will review the November data to determine whether performance and availability has improved. The communication service provider has announced upgrades for the Santa Paula GES and the availability of Santa Paula will be monitored. Mean Time Between Failure (MTBF), when combined with Mean Time To Repair (MTTR), will be monitored as an indication of availability. A short MTBF will prevent expansion of the 30/30 operational trial until the reliability issues are resolved.

- Overall message delivery times are also a serious issue. FOM performance targets are not being met, and the trend is that the proportion of messages exceeding FOM targets is increasing. It is anticipated that the upgrades to the Perth and Santa Paula GESs mentioned above will contribute to improvements in this area of concern.

- Lateral deviations (e.g., weather deviations), with or without an ATC clearance, increase risk in the application of any reduced separation standard. It is imperative that the controller be able to retain situational awareness during these maneuvers. Data scrutinized to date may lead to an increased automatic update rate in the Ocean21 software.

6.34 The structure and timing of additional expansion phases will be determined by the results of the Phase I expansion of the operational trial, including analysis of collected data, a collision risk assessment and a Safety Risk Management assessment. Phase II foresees Oakland FIR-wide implementation of 30/30 to the maximum extent possible; FAA anticipates redesigning route structures to take advantage of the lateral component of the 30/30 standard as part of this effort. Phases III and IV will expand application of 30/30 to the Anchorage Center (ZAN) and New York Center (ZNY) oceanic airspaces, respectively.

RASMAG comment on Oakland 30/30 trial

6.35 The meeting thanked the United States for the comprehensive update in relation to all aspects of the 30/30 operational trial. As one of the early implementations of 30/30 NM reduced separations, the meeting considered that there was a significant onus upon the FAA to ensure that comprehensive safety monitoring and remediation arrangements were in place to ensure the continued safety performance of the trial. In this context, the establishment of the Scrutiny Group was proving to be an extremely effective mechanism by which to retain a clear focus on the operational and safety aspects of the trial, and the data and analysis from the trial being made freely available by the FAA was of significant benefit and interest to many parties.

6.36 In supporting the further expansion of the trial in accordance with the planning proposals presented to the meeting, RASMAG was mindful of the serious concerns described above that had been identified by the Scrutiny Group processes that could act to impede the safe progress of the trial. The meeting expressed confidence in the Scrutiny Group to ensure safety as the primary consideration in further expansion, or deferral, of the trial.

CMA-900 FANS ADS Non-Compliance Notification

6.37 The meeting was informed that the Ocean21 automation system at Oakland ARTCC uplinks two Contract Request (CR) messages to all aircraft that indicate in their AFN Contact message that they support ADS version 1. The CR messages are for a Periodic contract and an Event contract. These CR messages contain a default set of reporting groups and parameter values that have been determined to meet the ATM needs at Oakland ARTCC. However, Oakland ARTCC has been receiving "Non-compliance Notification" (NCN) responses to the CR from aircraft that are equipped with the CMA-900 FANS avionics.

6.38 The manufacturer of the CMA-900 FANS equipment has investigated the difficulties being experienced. The aircraft using this FANS equipment are fitted with the older non-certified Litton Performance Management System (PMS). The CMA-900 Flight Management System installed in these aircraft cannot use the non-certified PMS predicted altitude and therefore sends a "partial" non-compliance specifying that it can send the data without the "altitude at next waypoint" (parameter 2) and "altitude at next waypoint+1" (parameter 6) data. This response to the CR is permitted by RTCA DO-258, paragraph 4.5.1.4.3.

6.39 It was noted that the NCN will be generated any time the aircraft receives a CR that includes information that can not be supported by the avionics. Therefore, they can be encountered throughout the flight for actions such as the uplinking of a Demand contract or a new Event contract to establish a new Lateral Deviation Change threshold for the purposes of a weather deviation. The Ocean 21 system does process the NCN and updates the flight's profile from the available data. However, a copy of the message is presented to the controller as an advisory. This does represent a small, unnecessary, workload issue since there is no practical action that the controller can take to correct the problem.

Agenda Item 7: Review and update RASMAG Task List

7.1 In reviewing the RASMAG task list, the meeting was apprised of the status of items considered complete and suitable for closure as well as those remaining open, noting the progress that had been made. Additional items were added in relation to the adoption of a standardized regional template for RMA reporting based on the MAAR proforma and the compilation of a consolidated regional RMA report for presentation to APANPIRG each year. The meeting agreed that the updated task list shown at **Appendix M** accurately reflected the work programme of RASMAG.

Agenda Item 8: Any other business

Airbus A380 Wake Vortex – Revised Guidance Material

8.1 The meeting recalled that in November 2005 two State Letters had been promulgated advising States to exercise considerable caution with regard to horizontal and vertical separation between A380 aircraft and other aircraft until more definitive guidance was provided by the ad hoc working group of experts studying the matter.

8.2 It was noted that after the subsequent release during 2006 of the report from the working group of experts, which included the United States Federal Aviation Administration, the European Organization for the Safety of Air Navigation (Eurocontrol), the Joint Aviation Authorities and the manufacturer, the Regional Office had issued a State Letter (Ref.: T3/4.4 – AP099/06 ATM, **Appendix N** refers) providing updated wake vortex information. The State Letter included revised guidance material on wake vortex separation criteria for the A380 based on the completed flight test programme and current outcome of the work group and strongly encouraged the implementation of this revised guidance as soon as possible.

ICAO Language Proficiency Provisions

8.3 The meeting recalled that on 5 March 2003, the Council (168/9) adopted Amendment 164 to Annex 1 – *Personnel Licensing* containing language proficiency requirements applicable on 27 November 2003. The provisions require that, as of 5 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 the level specified in the language proficiency requirements of ICAO documentation. The minimum level that is required be achieved is Operational Level 4.

8.4 A global survey of the status of implementation was conducted in early 2006 (APANPIRG Conclusion 16/21 refers) through all ICAO Regional Offices, in order to provide the ANC with up-to-date information for their review. The meeting was presented with a brief summary of the main points of the Commission's June 2006 review, based on ANC working paper AN-WP/8138**,** noting that the ANC had:

- agreed that the applicability date of 5 March 2008 for the demonstration of language proficiency in accordance with the requirements contained in Appendix 1 to Annex 1, be retained;
- agreed that States be informed of the Commission's decision and reminded of the need to take the necessary measures to implement the language proficiency requirements in a timely manner;
- agreed to establish an ad hoc group to develop, in coordination with the Secretariat and based on the discussion, a strategy to support the timely and effective implementation of the language proficiency requirements by States; and
- requested the Secretariat to provide an updated status of the implementation of the language proficiency provisions in States during the 174th Session;

8.5 Subsequent to the ANC review State Letter AN 12/44-06/90, dated 27 October 2006, was transmitted advising States of the outcomes and requesting that a questionnaire concerning implementation of language proficiency requirements be completed by 15 January 2007. The data collected through the questionnaire would be reviewed by the ANC during early 2007. Also, the meeting was informed that ICAO will host the second International Aviation Language Symposium from 7 to 9 May 2007. The theme of the symposium will be "*Language Proficiency: Implementing the Requirements*". The objective is to present proactive implementation models that ensure quality aviation language training and testing. Letters of invitation will be transmitted shortly.

Report of Second ICAO Interregional Coordination Meeting

8.6 The meeting was informed of the Second Inter-Regional Co-Ordination Meeting (IRCM/2) on Interface Issues between the Asia/Pacific (APAC), European and North Atlantic (EUR/NAT) and Middle East (MID) Regional Offices of ICAO was held at the EUR/NAT Office in Paris on 11 to 13 September 2006.

8.7 The meeting reviewed Section 6 (Safety Management related issues) and Section 11 (Regional Monitoring Agencies) of the report of IRCM/2, which were of particular relevance to RASMAG. A copy of the IRCM/2 report is available from the ICAO Asia/Pacific web site at http://www.icao.int/apac/

Flight Safety Information Exchange Website

8.8 The Secretariat drew the attention of the meeting to the ICAO The Flight Safety Information Exchange website (FSIX), which had been developed by ICAO to provide the aviation community with access to safety-related information. The website was now being updated on a regular basis and contains a very significant volume of information provided by both ICAO and Contracting States related to all aspects of aviation safety and related. Audit reports from the Universal Safety Oversight Audit Programme (USOAP) were also regularly posted to the site.

8.9 ICAO considers that cooperation between States and information exchange are essential elements for the success of any aviation safety-related activity, in pursuit of the common goal to improve aviation safety. This site at http://www.icao.int/fsix/ is intended as a portal to existing safety related websites as well as a place to exchange information through various newsgroups.

Agenda Item 9: Date and venue of RASMAG/7 meeting

9.1 Although it was still intended that RASMAG would eventually move towards a single annual meeting, it was apparent to the meeting that there was still much work to be completed by RASMAG in ensuring adequate oversight of current safety monitoring issues in the region. Accordingly, the meeting considered that a further meeting was necessary in approximately 6 months time and requested that the Secretariat make arrangements for the week of 11-15 June 2007.

Closing of the meeting

9.2 The Chairman, Mr. Butcher, thanked delegates for their participation in the meeting and for the excellent work achieved. Improvements by several States in submitting data required for airspace safety monitoring were evident. Mr. Butcher noted that this type of increased interest and attention to safety monitoring was a major step forward to developing and improving safety management programs.

9.3 Participants were urged to review the guidance material documents that were presented during the meeting and to forward recommendations for changes to the authors. There were still a number of items on the task list that needed attention before the next meeting and Mr. Butcher encouraged delegates to pursue actions in this regard.

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LIST OF INFORMATION AND WORKING PAPERS

WORKING PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
WP/1	1	Provisional Agenda	Secretariat
WP/2	5	Summary of the Airspace Safety Review for the RVSM Implementation in the Asia Region	Thailand (MAAR)
WP/3	6	Provision of a Safety Monitoring Agency (SMA) Service for Asia Region	Thailand
WP/4	2	ALLPIRG/5 Follow-up	Secretariat
WP/5	6	Review of RASMAG List of Competent Airspace Safety Monitoring Organizations	Secretariat
WP/6	5	Safety concerns in the WPAC/SCS area	Secretariat
WP/7	3	Task Force to establish Regional Airspace Safety Monitoring Committees	Secretariat
WP/8	7	Review of RASMAG Task List	Secretariat
WP/9	2	Conclusions and Decisions of APANPIRG/17	Secretariat
WP/10	6	Study of preparedness of States to implement safety management systems	Secretariat
WP/11	5	Updates on JCAB planning to strengthen airspace safety assessment and monitoring capability for RVSM and RNAP/RNP within Fukuoka FIR, including oceanic airspace	Japan
WP/12	6	A Modification to the Operational Risk Form of the Collision Risk Model in South China Sea Airspace	USA (PARMO)
WP/13	4	3rd Quarter 2006 Safety Monitoring Report from the Pacific Approvals Registry and Monitoring Organization	USA (PARMO)
WP/14	4	Guidance Material – Data Link Ground Equipment	Japan & New Zealand
WP/15	6	Unexpected Automatic Dependent Surveillance (ADS) Lateral Deviation Change (LDC) Events	United States
WP/16	5	Safety Assessment for the introduction of RVSM within the remaining portions of Australian Domestic and Indian Oceanic Airspaces	Australia
WP/17	3	Draft of a Handbook to Guide Monitoring in the International Airspace of the Asia/Pacific Region in Connection with Introduction and Continued Safe Use of an Horizontal-Plane Separation Minimum where Required Navigation Performance (RNP) is Applied	Australia

INFORMATION PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
IP/1	-	List of Working Papers (WPs) and Information Papers (IPs)	Secretariat
IP/2	6	Airbus A380 Wake Vortex – Revised Guidance Material	Secretariat
IP/3	6	Bay of Bengal ATFM Operational Trial	Secretariat
IP/4	8	Report of Second Inter-regional Coordination Meeting (IRCM/2)	Secretariat
IP/5	8	ICAO Language Proficiency Provisions	Secretariat
IP/6	6	ICAO Safety Management Systems Training	Secretariat
IP/7	5	Summary of one-year post-implementation RVSM safety assessment for the Japanese domestic airspace	Japan
IP/8	8	Summary of Issues of Concern and Anomalies discovered during the Operational Trial of 30NM Lateral/30NM Longitudinal Separation Standards (30/30) in the Oakland Flight Information Region	United States
IP/9	8	A Summary of Airspace Characteristics related to the Operational Trial of 30NM Lateral/30NM Longitudinal Separation Standards (30/30) in the Oakland Oceanic Flight Information Region (FIR)	United States
IP/10	8	CMA-900 FANS ADS Non-Compliance Notification	United States
IP/11	8	Action Plan for Expansion of 30NM Lateral/30NM Longitudinal Separation (30/30)	United States
IP/12	8	ICAO Website of the Flight Safety Information Exchange	Secretariat

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TERMS OF REFERENCE

Task Force for establishment of Regional Airspace Safety Monitoring Committees (RASMC/TF)

Objective

To develop proposals and take action to implement Regional Airspace Safety Monitoring Committees for the Asia/Pacific Region.

Terms of Reference

a) Develop proposals for the establishment of Regional Airspace Safety Monitoring Committees including terms of reference;

b) Identify the appropriate regional monitoring entities and determine the number and area of responsibility;

c) Formulate the duties, responsibilities and scope of regional monitoring entities;

d) Establish a formula for the basis of cost recovery as well as cost recovery mechanism;

e) Determine a methodology for assigning the responsibility for a regional monitoring entity to a State.

f) The RASMC/TF will report via RASMAG to the APANPIRG.

Composition

ICAO will facilitate the Task Force, which will consist of designated experts from the following States:

1. Australia,
2. China,
3. Fiji,
4. India,
5. Japan,
6. New Zealand,
7. Republic of Korea,
8. Singapore,
9. Thailand,
10. United States of America

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

DRAFT GUIDANCE MATERIAL

FOR THE ASIA/PACIFIC REGION

FOR ADS/CPDLC/AIDC GROUND SYSTEMS

PROCUREMENT AND IMPLEMENTATION

Draft V-0.8

Issued by the ICAO Asia/Pacific Regional Office, Bangkok

TABLE OF CONTENTS

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 traffic service (ATS) providers with the implementation of datalink-based air traffic management (ATM) systems.

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

Integrated datalink systems are playing an increasingly important role in air traffic management. Datalink 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 datalink systems. As the use of these systems spreads, so more ATS providers 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 datalink 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 datalink 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 datalink-based ATM system, and the third gives guidance on specifying a system.

For the purposes of this material, it is assumed that the Air Traffic Service Provider (ATSP) 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 datalink systems and specific requirements for:

- Datalink 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 datalink systems is to support reduced separation minima: any new datalink system should be capable of supporting 30NM lateral and 30NM longitudinal separation based on 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 every few seconds; 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 DataLink Communications 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 Datalink 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 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 ATSP 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 ATSP.

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 ATSP and the vendor is essential to achieve a high total system quality.

2.1.2 Roles and Responsibilities of the ATSP

The ATSP is ultimately responsible for successful implementation of the system. It is therefore vital that the ATSP 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 ATSP'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.

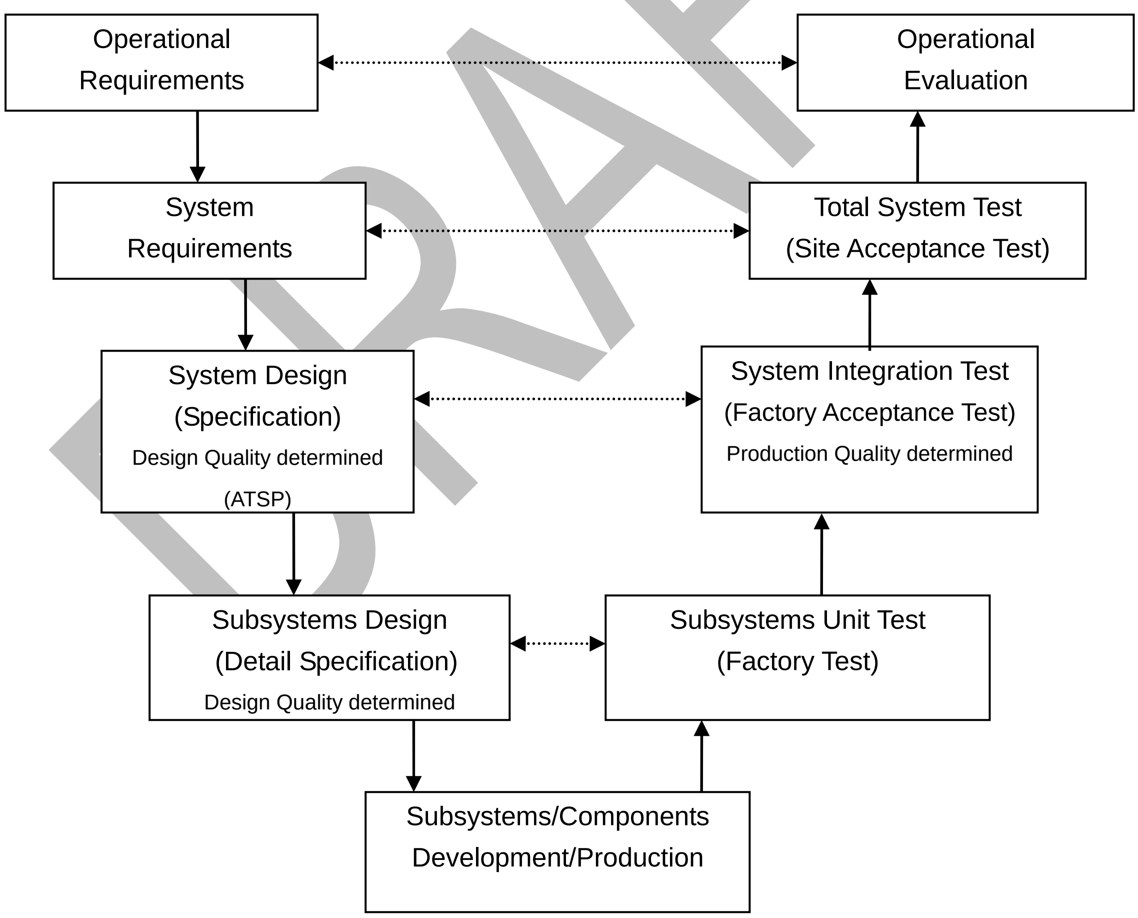

Figure1. Relationship between Requirement, Specification and Test/Evaluation

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 ATSP 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, supported by engineers and by other specialists as necessary.

2.3.1.1 Studies of Existing Systems

The operational requirements team must have an appreciation of how datalink 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.
- Datalink Service Provider and its 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 ATSP.

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 ATSP is involved in all these activities to some degree, except manufacture; but the ATSP 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 ATSP 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 ATSP 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 ATSP 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 ATSP 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 ATSP 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 datalink applications.

The ATSP 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 ATSP 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 ATSP 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 ATSP 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 ATSP 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 datalink applications.

Training on the manipulation of the displays and controls should be provided initially by the vendor, and the ATSP'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 datalink applications have been developed within the Region and are laid out in regional documents. The vendor cannot be expected to provide training on datalink 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 ATSPs that have experience of datalink 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 ATSP 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

ATSP, 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 datalink 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 datalink 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 datalink communication 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

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), version 2

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

FANS 1/A Operations Manual

4.1.3.2 Industry Standards

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

- ARINC 622: ATS Datalink 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: Datalink 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).

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 datalink 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 FOM 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 DATALINK 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 Datalink 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 datalink 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 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 datalink 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 Datalink 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. Specifications produced by technical personnel often concentrate on technical features at the expense of operational suitability, when the whole purpose of the system is to support operational activities!

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 Communication 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 communication service providers (CSP) to pass information between the airline operating centre (AOC) and the aircraft. ADS and CPDLC required an air-ground datalink and, in the absence of the Aeronautical Telecommunication Network (ATN), the ACARS system was used.

Access to the ACARS datalink 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 datalink 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 datalink 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 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 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 datalink 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 new 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 for recording data for use by the agencies monitoring RNP, RVSM and datalink 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.

To meet CRA requirements, the specification should include a requirement for datalink 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 datalink monitoring requirements for ATS providers.

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 datalink)
CRC	Cyclic Redundancy Check
DL	Downlink message
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
RASMAG	Regional Airspace Safety Monitoring Advisory Group
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), version 2		ICAO Asia Pacific Office
Guidance Material for End-to-End Safety and Performance Monitoring of ATS Datalink 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
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

Criteria	Definition	Values
Performance	End-to-end round trip time for uplinks. (from sending of the uplink until reception of the 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 both 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)*	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)

Note: RTCA SC189/EUROCAE WG 53 defines the performance requirements for specific operational environments.

INTERNATIONAL CIVIL AVIATION ORGANIZATION
ASIA AND PACIFIC OFFICE

Draft of A Handbook to Guide Monitoring in the International Airspace of the Asia/Pacific Region in Connection With Introduction and Continued Safe Use of an Horizontal-Plane Separation Minimum Where Required Navigation Performance (RNP) Is Applied

Draft – November 2006

Issued by the ICAO Asia/Pacific Regional Office, Bangkok

Table of Contents

Part 1

1 Introduction

1.1 Background

1.1.1 The Regional Airspace Safety Monitoring Advisory Group (RASMAG) was established 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. 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 for other air traffic management (ATM) services, such as reduced horizontal separation based on required navigation performance (RNP), and 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) was at an advanced stage of development by the ICAO Separation and Airspace Safety Panel (SASP). There was no comparable document under development by ICAO for the continued safe use of a horizontal-plane separation minimum where RNP is applied.

1.1.2 The experience gained by the Informal Pacific Air Traffic Control Coordination Group (IPACG) and the Informal South Pacific ATS Coordinating Group (ISPACG) FANS Interoperability Teams (FITs) and the supporting Central Reporting Agencies (CRAs) to monitor end-to-end performance of automatic dependent surveillance (ADS) and controller-pilot data link communication (CPDLC) for both aircraft and ground systems was used as a resource on which to develop regional guidance material.

1.1.3 ICAO provisions require that the implementation of specified reduced separation minima, e.g. 50 NM lateral and longitudinal separation based on RNP 10, and 30 NM lateral and longitudinal separation based on ADS and RNP 4, must first meet safety management system requirements and undergo a safety assessment based on collision risk modeling to confirm that the target level of safety (TLS) has been met for the airspace. Additionally, periodic safety reviews must be performed in order to permit continued operations.

1.1.4 To date, the performance of safety assessments and continued monitoring for RVSM, reduced horizontal separation minima, and ATS data link services had been carried out by a few specialized teams made up of technical experts and contractors supporting States within the region.

1.1.5 The RASMAG agreed that there was a need to develop a reduced horizontal separation handbook aimed at standardizing the principles and practices of safety monitoring agencies (SMAs), which are responsible for the safe application of reduced horizontal separation standards in international airspace.

1.1.6 It is important to note that RNP is a navigational requirement, which can be used as part of the basis for establishing a separation minimum. Deliberations within the SASP and other forums appear to be converging on a common view that a statement of requirements associated with RNP values of 4 or greater, consists of a specification of navigational accuracy only. In contrast, a statement of requirements associated with RNP values of less than 4 must address other factors such as the availability, continuity of service and integrity of the source of navigation. In view of the anticipated use of RNP within the international airspace of the Asia/Pacific Region, this handbook is being developed to serve the monitoring needs associated with an RNP value of 4 or greater.

1.2 Purpose of Handbook

1.2.1 It is intended that this handbook will introduce a common set of principles and practices for monitoring in connection with horizontal-plane minima based in part on application of RNP. The handbook will also help to promote an interchange of information among different regions in support of achieving common operational monitoring procedures.

1.3 SMA Duties and Responsibilities

1.3.1 The duties and responsibilities of an organization providing airspace monitoring in connection with RNP-based horizontal-plane separation minimum are to:

a) establish and maintain a database of aircraft approved by the respective State authorities for RNP operations and other required aircraft capabilities;

b) coordinate monitoring of horizontal-plane navigational performance and the identification of large horizontal-plane errors;

c) receive reports of those large horizontal-plane errors of non-compliant aircraft;to take the necessary action with the relevant State and operator to determine the likely cause of the horizontal-plane error and verify the approval status of the relevant operator;

d) analyze data to detect horizontal-plane error trends and, hence, to take action as in the previous item;

e) undertake data collections as required by the regional planning group to:

    i. investigate horizontal separation performance of the aircraft in the core of the distribution;

    ii. establish or add to a database on the horizontal separation performance of:
        - the aircraft population
        - aircraft types or categories
        - individual airframes

f) archive results of navigational performance monitoring and contribute to conduct of annual risk assessment in light of agreed regional safety goals;

g) monitor compliance of operators with State RNP approval requirement after implementation of RNP-based horizontal-plane separation minimum;

h) contribute to regional database of monitoring results;

i) initiate necessary remedial actions and coordinate with specialist groups as necessary in light of monitoring results;

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

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

ii. calculate the frequency of occurrence;

iii. assess the overall risk in the system against the overall safety objectives; and

iv. initiate remedial action as required.

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

l) submit annual reports to the regional planning group.

1.4 In order to effectively carry out the duties and responsibilities of horizontal separation SMA, certain prescribed standards shall be met. These standards include competence as demonstrated by:

a) previous monitoring experience;

b) participation in ICAO technical panel or other bodies which developed horizontal separation requirements or criteria for establishing separation minima based on RNP; and

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

1.5 Once competence has been demonstrated, the SMA should receive a formal recommendation by a State or group of States within Region; and/or receive approval from APANPIRG.

1.6 List of Definitions

The following definitions are intended to clarify specialized terms used in this document.

<u>Collision risk</u>

The expected number of mid-air aircraft accidents 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.)*

<u>Horizontal separation</u>

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

<u>Occupancy</u>

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 RNP has been implemented.

Overall risk

The risk of collision due to all causes, which includes the technical risk (see definition) and all risk due to operational errors and in-flight emergencies

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.

PART 2

2 Working Principles Common to all Safety Monitoring Agencies

2.1 Review of operational concept

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

2.1.2 An SMA should review carefully the operational concept agreed by the body overseeing implementation of reduced horizontal separation based on RNP, 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.

2.2 Establishment and Maintenance of an RNP Approvals Database

2.2.1 The experience gained through the introduction of RVSM has shown that the concept of a monitoring agency is essential to ensure safety in the region. It has a significant role to play in all aspects of the safety monitoring process. One of its functions is to establish a database of aircraft approved by their respective State authorities for RNP operations 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 and many aircraft may be approved for RNP operations and their approvals have been registered with an SMA operating in a region where reduced horizontal separation has previously been implemented. Thus, there is considerable opportunity for information sharing between SMAs. While a region or sub-region introducing RNP-based separation may need its own SMA to act as a focal point for the collection and collation of RNP approvals for aircraft operating solely in that region, it may not need to maintain a complete database of all aircraft in the world that are RNP approved. It will, however, be required to establish links with other SMAs in order to determine the RNP status of aircraft, so that an assessment of the technical height-keeping risk can be made.

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

2.2.4 It is important to note that, in general, the aircraft operating in airspace where RNP-based separation introduction is planned can be categorized into two classes. Some aircraft operate solely within the airspace targeted for introduction of RNP-based separation standards, and others operate both within that airspace and other portions of airspace. It is the responsibility of the SMA supporting introduction of RNP-based separation to gather State approvals for the former category of aircraft from authorities 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 RNP approval status.

2.2.5 Where possible, the SMA should collect State approvals information for the latter category of aircraft – those operating outside the targeted RNP airspace – from other SMAs. This collection will be facilitated if each SMA maintains, in a similar electronic form, a database of State RNP approvals containing a minimum informational content for each approval

2.2.6 Appendix D contains the minimum database content and format, which 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 navigation errors within the ATC system.

2.3.2 An SMA must enlist the cooperation of States and ATS providers in monitoring horizontal-plane navigational performance through the use of secondary surveillance radar. States and ATS providers 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 Navigation Errors

2.3.3 Experience has shown that large navigation errors – errors of 25 NM or more in magnitude – have had significant influence on the outcome of safety assessments before and after implementation of RNP-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 **XX** provides direction to an SMA for action in the event that this program uncovers the occurrence of a large navigation error.

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

a) Reporting unit
b) Location of error, either as latitude/longitude or ATC fix
c) Date and time of large navigation error
d) Sub-portion of airspace, such as established route system, if applicable
e) Flight identification and aircraft type
f) Assigned flight level
g) Final reported flight level or altitude and basis for establishment (pilot report or Mode C)
h) Size of navigation error
i) Cause of error
j) Any other traffic in potential conflict during error
k) Crew comments when notified of error
l) Remarks from ATC unit making report

2.3.6 Other sources for reports of large navigation errors 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, such as the Aviation Safety Reporting System administered by the U.S. National Aeronautics and Space Administration, as possible sources of large navigation error 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 navigation errors. Rather, an SMA should enlist the support of the ICAO regional planning group, the relevant 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

2.4.1 A safety assessment consists of estimating the risk of collision associated with the horizontal-plane separation standard and comparing this risk to the TLS. 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. Currently, there is no standard collision risk model (CRM) that is applicable to all airspace. In order to take account of regional variations, it is necessary to obtain regional agreement on existing CRMs to be used by all SMAs.

Safety Assessment

2.4.2 A principal duty of an SMA is to conduct a safety assessment associated with the implementation of a horizontal-plane separation standard.

2.4.3 The regional planning group will determine the safety reporting requirements for the SMA.

Establishing the Competence Necessary to Conduct a Safety Assessment

2.4.4 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.

2.4.5 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 organization possessing the necessary competence.

2.4.6 If it is necessary to use an external organization to conduct a safety assessment, an SMA must have the internal 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.

2.4.7 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 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 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

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

2.4.9 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.

2.4.10 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 fix or latitude/longitude into the airspace

h) time at entry fix

i) flight level at entry fix

j) exit fix or latitude/longitude leaving the airspace

k) time at exit fix

l) flight level at exit fix

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

2.4.11 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 x** 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.

2.4.12 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 Met as the Result of a Safety Assessment

2.4.13 The overall safety goal value which must be satisfied is a TLS value of 5 x 10-9 fatal accidents per flight hour due to loss of planned (lateral and longitudinal) separation.

2.5 On-going Safety Reporting and Monitoring Operator Compliance with State Approval Requirements Implementation of Horizontal-Plane Separation

2.5.1 The overall intent of post-implementation SMA activities is to support continued safe use of the horizontal-plane separation. One important post-implementation activity is carrying out periodic checks of the approval status of operators and aircraft using airspace where RNP-based separation is applied. This activity is especially vital if RNP-based separation is applied on an exclusionary basis, that is, if State RNP approval is a prerequisite for use of the airspace. This activity is termed as monitoring operator compliance with State approval requirements. The regional planning group 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, aircraft and registration marks conducting operations in the airspace; and the database of State RNP 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 RNP approval status shown on the flight plan of each aircraft movement should be compared to the database of State RNP approvals. When a flight plan shows an RNP 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 x** 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 RNP approval.

2.6 Remedial Actions

2.6.1 Remedial actions are those measures taken to remove causes of systematic problems associated with factors affecting safe use of the RNP-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 RNP requirements

b) aircraft operating practices resulting in large navigational errors

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 navigational errors with a view toward uncovering systematic problems. Should such a problem be discovered, an SMA should report its findings to the organization overseeing RNP-based separation implementation, or to the organization that authorized the establishment of the SMA. An SMA should include in its report the details of large navigation errors suggesting the existence of a systematic problem.

TERMS OF REFERENCE

Western Pacific/South China Sea RVSM Scrutiny Working Group (WPAC/SCS RSG)

Objective

To identify, study and address problems in the safety, efficiency and harmonization of RVSM operations in the Western Pacific/ South China Sea area.

Terms of Reference

a) To assemble subject matter experts from affected States and international organizations, including those experienced in air traffic control, data analysis and risk modeling;

b) To analyze ***data, including data from regional monitoring agencies,*** and evaluate problems in air traffic operations in the RVSM airspace of the WPAC/SCS area regarding RVSM transition activities;

c) To promote the minimization of transition activities and enhance the harmonization of flight level assignment with the adjacent regions where RVSM was implemented;

d) To analyze ***data, including data from regional monitoring agencies,*** and evaluate problems in air traffic operations in the RVSM airspace of the WPAC/SCS area regarding large height deviation (LHD) occurrences;

e) To identify any other problems associated with RVSM operations in WPAC/SCS airspace;

f) To recommend remedial actions to improve safety and reduce risk in RVSM operations; to identify beneficial trends in system performance and promote practices that ensure continued safe operations;

g) To report to the ATM/AIS/SAR Subgroup in order to assist in determining the safety, efficiency, and harmonization of RVSM implementation in the WPAC/SCS area; and

h) To keep the Regional Airspace Safety Monitoring Advisory Group of APANPIRG (RASMAG) up to date with developments.

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International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Ref.: T3/10.0, T3/10.1.17 – AP105/06 (ATM)

7 November 2006

Subject: December collection of one month Traffic Sample Data (TSD)

Action required: TSD be submitted to RVSM Regional Monitoring Agencies (RMAs) by the end of January 2007

Sir/Madam,

I have the honour to direct your attention to the Conclusions of the Sixteenth and Seventeenth Meetings of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/16 & APANPIRG/17) held in Bangkok, Thailand from 22–26 August 2005 and 21–25 August 2006, respectively. APANPIRG/16 noted the amended provisions of Annex 11, effective 24 November 2005, that specifically require the institution of ongoing monitoring on a regional basis of aircraft height keeping performance for all airspace where RVSM is applied. APANPIRG also recognized that periodic monitoring by States of the safety performance of reduced horizontal separation was also necessary under the broader provisions of Annex 11 which require implementation of systematic and appropriate ATS safety programmes.

In regard to the continuous monitoring and regular assessment of target levels of safety in reduced separation applications (including RVSM and RNP), APANPIRG/16 endorsed the use of a standardized approach to the sampling of vertical and horizontal traffic data under the terms of the following Conclusion:

Conclusion 16/4 – Traffic Sample Data Collection

That, States be advised by Regional Office that December every year had been adopted for the routine collection of 30 days of traffic sample data to satisfy airspace safety monitoring requirements.

Additionally, APANPIRG/16 adopted Conclusion 16/6 requiring that States not providing safety related data to regional safety monitoring agencies in accordance with the parameters of the safety monitoring agencies would be included in the APANPIRG List of Deficiencies in the ATM/AIS/SAR fields.

./2

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In its review of these matters, APANPIRG/17 noted the very positive response from States in respect of the provision of Traffic Sample Data (TSD) for December 2005. APANPIRG/17 considered that the situation had improved significantly compared with previous years and it was expected that this improvement could be sustained. However, as some States had still not provided appropriate safety data APANPIRG/17 included them in the List of Deficiencies in the ATM/AIS/SAR Fields in accordance with Conclusion 16/6.

APANPIRG/17 also recognized that although the South China Sea parallel route structure had been implemented in November 2001, no updated horizontal safety assessment had been undertaken in the four and a half years since implementation. Additionally, data used in the implementation safety assessment had necessarily been based on the "old" route structure; as such no horizontal safety assessment had been made based on data from the "new" route structure. In order that this matter be urgently addressed, APANPIRG/17 adopted the following Conclusion:

Conclusion 17/6 – Completion of the horizontal safety assessment for the South China Sea route structure

That, recognizing that no horizontal safety assessment for the South China Sea parallel route structure had been conducted since implementation in 2001, the ICAO Regional Office urges concerned States to complete, by 30 June 2007, a horizontal safety assessment in accordance with ICAO ATS safety management provisions.

Accordingly, in addition to the routine provision of RVSM Large Height Deviation (LHD) reports and RNP Gross Navigational Error (GNE) reports – including "Nil" reports - States are required to complete a traffic sampling during December 2006. States not providing data will continue to be included on the APANPIRG List of Deficiencies in the ATM/AIS/SAR fields.

The RVSM Regional Monitoring Agency (RMA) for the FIRs listed below is the Monitoring Agency for the Asia Region (MAAR). States with responsibilities for these FIRs should complete traffic sampling for a period of one month for December 2006 in accordance with the format and requirements of MAAR. Resulting data should be submitted electronically to MAAR by the end of January 2007 for airspace safety analysis. The appropriate Traffic Sample Data format and instructions are available from the MAAR website at: http://www.aerothai.co.th/maar/dl.php.

Bangkok	Calcutta	Chennai	Colombo	Delhi	Dhaka	Hanoi	Ho Chi Minh
Hong Kong	Jakarta	Karachi	Katmandu	Kota Kinabalu	Kuala Lumpur	Lahore	Male
Manila	Mumbai	Phnom Penh	Sanya FIR	Singapore	Ujung Pandang	Vientiane	Yangon

Additionally, States with responsibilities for the RNP10 monitoring arrangements of gross navigational errors (GNE) in respect of the South China Sea route structure, including ATS routes L625, M771, N884 and N892, should ensure appropriate data as required under the terms of the existing Letter of Agreement is captured on an ongoing basis and forwarded to the Civil Aviation Authority of Singapore for collation. In accordance with APANPIRG Conclusion 17/6, TSD from the relevant FIRs in the South China Sea will be used to update the horizontal safety assessment for the South China Sea route structure during the first half of 2006.

Similarly, the RVSM RMA for the FIRs listed below is the Pacific Approvals Registry and Monitoring Organization (PARMO). States with responsibilities for these FIRs should complete traffic sampling for a period of one month for December 2006 in accordance with the format and requirements of PARMO. Resulting data should be submitted electronically to PARMO by the end of January 2007 for airspace safety analysis. The appropriate Traffic Sample Data format and instructions are available from the PARMO website at http://www.tc.faa.gov/acb300/PARMO/

Anchorage Oceanic	Auckland Oceanic	Brisbane (east of Australian mainland)	Honiara	Incheon	Melbourne (east of Australian mainland)
Nadi	Nauru	Oakland Oceanic	Port Moresby	Tahiti	

Accept, Sir/Madam, the assurances of my highest consideration.

L. B. Shah
Regional Director

OPERATIONAL LETTER OF AGREEMENT

BETWEEN

General Administration of Civil Aviation of China	China
Civil Aviation Department	Hong Kong, China
Directorate General of Air Communications	Indonesia
Department of Civil Aviation	Malaysia
Air Transportation Office	Philippines
Civil Aviation Authority	Singapore
Aeronautical Radio of Thailand Ltd	Thailand
Civil Aviation Administration	Viet Nam

FOR

MONITORING OF AIRCRAFT NAVIGATION ERRORS

IN THE

SOUTH CHINA SEA

Operational Letter of Agreement

Document Management

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Checklist of Effective Pages

Subject	Pages	Issue Date
Letter of Agreement	1 - 10	1 Nov 2001
Appendix A-Navigation Error Report	A1 - 6	1 Nov 2001

Operational Letter of Agreement

Overview

Introduction

The following document is a Letter of Agreement (LOA) between those Air Traffic Service (ATS) authorities shown on page one of this document. The letter of agreement details monitoring procedures between the following ATS units:

Bangkok ACC
Hanoi ACC
Ho Chi Minh ACC
Hong Kong ACC
Jakarta ACC
Kota Kinabalu ACC
Kuala Lumpur ACC
Manila ACC
Sanya ACC
Singapore ACC

Objective

The objective of this LOA is to define agreed procedures for the monitoring, notification, investigation, analysis and reporting of aircraft navigation errors in respect of aircraft to which the 60NM lateral separation standard and a 10 minute or 80NM RNAV longitudinal separation minima is applied when operating on the following designated RNAV routes:

L642	M771	N892
L625	M767	N884

Scope

The procedures contained in this LOA implement the performance monitoring requirements associated with the introduction of the 60NM lateral separation standard, and for the reporting and monitoring of gross lateral and longitudinal navigational errors.

For the purposes of this LOA, the term 'Service Providers' refers to organisations which are responsible for the provision of Air Traffic Control (ATC) services.

The term 'Regulatory Authority' refers to those organisations responsible for the investigation of navigational errors. In some cases, the Regulatory Authority may be the same as the Service Provider.

Effective Date

This letter of agreement becomes effective on 1 Nov 2001.

Overview, Continued

Background

The use of these lateral and longitudinal separation standards is restricted to aircraft which meet the requirements detailed in the respective States' AIP Supplements. This includes a requirement for Required Navigation Performance (RNP) 10 approval and it is the responsibility of the operator to ensure that such requirements are satisfied when so declared.

RNP 10 approval includes operators meeting certain requirements with regard to crew training and in-flight operating procedures. The responsibility for approval for such operations rests with the State of Registry of the Operator.

Monitoring navigation errors is a joint responsibility between the aircraft operators, the States of Registry, and the ATC providers. There are established requirements for the operators to monitor navigation performance under the terms of their RNP 10 approval. This document sets out the responsibilities and procedures to be followed by staff of the signatory organisations to this LOA.

Area of Applicability

The procedures outlined in this LOA shall be applied to all aircraft operating on the following designated RNAV routes:

L642	M771	N892
L625	M767	N884

Operational Letter of Agreement

Monitoring Procedures

Lateral Deviations

Monitoring shall be based on radar observations.

When the radar controller observes a lateral deviation of 15NM or more, the controller shall:

- immediately advise the pilot in command; and
- provide the 'duty supervisor' with the necessary information to enable **Part 1** of the *Navigation Error Investigation Form* (as shown in Appendix A) to be completed.

Where an aircraft is off-track as the result of an ATC approved diversion (e.g. due weather), no notification under the terms of this Letter of Agreement need be submitted.

Longitudinal Deviations

Monitoring of longitudinal errors shall be accomplished by reporting occurrences where the observed longitudinal separation, following a check, is either less or more than the expected longitudinal separation as detailed below.

Where a time standard is being used, this check will follow the receipt of a routine position report. Notification, in accordance with Appendix A, shall be submitted in all cases where:

- the separation standard is infringed; or
- the expected time between two aircraft varies by 3 minutes or more, even if the applicable separation standard is not infringed; or
- a pilot estimate varies by 3 minutes or more from that advised in a routine position report.

Where a distance standard is being used, the check may be based on ADS, radar observations, or it may be the result of a specific request for RNAV distance reports. Notification, in accordance with Appendix A, shall be submitted in all cases where:

- the separation standard is infringed; or
- the expected distance between two aircraft varies by 10NM or more, even if the applicable separation standard is not infringed.

Notification Procedures

Action by ATC Unit

The duty supervisor, when advised of the deviation, shall be responsible for completion and submission of a *Navigation Error Investigation Form.*

A copy of the aircraft's flight plan shall be attached to the *Navigation Error Investigation Form*, and forwarded to the Chief of ATC.

The Chief of ATC shall forward copies of the *Navigation Error Investigation Form* (Parts 1 to 4) to the aircraft operator and the State of Registry of the aircraft or the State of the Operator, as considered appropriate.

In addition, the copy for the aircraft operator shall be sent with a covering letter (as provided in Appendix A) requiring the operator to complete the *Navigation Error Investigation Form* and to provide reasons for the error.

Operational Letter of Agreement

Investigation Procedures

Investigation Procedures

The investigation of errors notifiable under this Letter of Agreement is a joint responsibility of the operator, the ATC Authority of the airspace in which the error occurred, and the State of Registry or State of the Operator of the aircraft involved.

The initial investigation shall be undertaken by the aircraft operator, who is responsible for supplying all data and comments needed to complete the form at Appendix A. The completed reports are to be returned by the operator to the originating ATC Authority. For aircraft registered in States not included in this LOA, these reports are also to be forwarded to the State of Registry of the aircraft or the State of the Operator.

Further action by States other than signatories to this LOA is outside the scope of this agreement, and shall be at the discretion of that State.

On receipt of the completed report from the aircraft operator, the relevant ATC Authority will first check that all information required has been supplied and, if necessary, the ATC Authority shall request any further information from either the operator, the State of the Operator, or the State of Registry of the aircraft.

If the completed form from the aircraft operator is not received within 14 days of the date of dispatch, the ATC Authority will contact the operator and request the completed form.

Once the completed information has been received, the ATC Authority will complete Part 5 of the *Navigation Error Investigation Form* as detailed in Appendix A. The cause of the error is to be classified in accordance with the criteria specified in Part 5.

The decision as to whether any further investigation is warranted will be taken by the ATC Authority based on their assessment of the seriousness of the error.

Analysis of Errors & Reporting

At the end of each month, Service Providers shall forward to the Operations Division, Civil Aviation Authority of Singapore (CAAS), a copy of all completed *Navigation Error Investigation Forms* (Parts 1 to 5) covering reported errors or nil reports for that month, together with data on the number of movements on the routes being monitored as recorded by the relevant Flight Data Processing System, or other auditable means.

CAAS shall be responsible for calculation of the frequency of the errors, in accordance with Doc 7030.

Each six months, the Monitoring Authority should prepare an assessment schedule setting out the results of the monitoring for the preceding six-month period and forward a copy of this schedule to:

a. all signatory States to the Monitoring Letter of Agreement; and
b. The Chairman of the APANPIRG ATS/AIS/SAR Sub-Group, through the ICAO Bangkok Office.

Permitted Error Rate Exceeded

Where the summary statistics show a long term trend which could result in the Permitted Error Rate being exceeded, ATC Authorities of the States concerned, in conjunction with the ICAO Regional Office, will jointly consider the causes, to determine if the problems can be eliminated, and to take appropriate remedial action.

Revision

This LOA shall remain in force until it is cancelled or superseded.

For any reason, which might make it advisable to change this agreement and its associated attachments, the interested State shall propose the pertinent revision.

Operational Letter of Agreement

Authority

China	Mr Su Langen Executive Deputy Director General of Air Traffic Management Bureau of General Administration of Civil Aviation of China
Hong Kong, China	Mr Shung-Man Norman Lo Assistant Director General of Civil Aviation (Air Traffic Management) Air Traffic Management Division Civil Aviation Department
Indonesia	Mr Mohamad Iksan Tatang Director of Aviation Safety Directorate General of Air Communications
Malaysia	Mr Noordin Bin Haji Saad Director of Air Traffic Services Division Department of Civil Aviation

Continued on next page

Operational Letter of Agreement

Authority, Continued

Philippines	Mr Anacleto V Venturina Director, Air Traffic Service Air Transportation Office Department of Transportation and Communications
Singapore	Mr Goh Sin Heng Head (ATC Operations) Civil Aviation Authority of Singapore
Thailand	Mr Kumtorn Sirikorn Vice President Air Traffic Service Operations Bureau AEROTHAI
Viet Nam	Mr Bui Van Vo Deputy Director Air Navigation and Air Transport Department Civil Aviation Administration of Viet Nam

Operational Letter of Agreement

Appendix A

NAVIGATION ERROR REPORT

Dear

Air Traffic Control service providers are monitoring traffic on routes in the South China Sea area, as part of the implementation of reduced separation minima on those routes.

These procedures require the reporting and investigation of:

i) lateral tracking errors of 15NM or more;

ii) variations of longitudinal separation of three minutes or more; or

iii) variations of longitudinal separation of 10NM or more.

A *Navigation Error Investigation Form* relating to one of your aircraft is enclosed.

An investigation of this occurrence is required. A detailed explanation should be provided **within 10 days**, using the attached *Navigation Error Investigation Form*. In your reply, you are also requested to indicate any corrective action taken to prevent future occurrences.

Yours faithfully,

NAVIGATION ERROR INVESTIGATION FORM

Instructions for Service Provider responsible officer:

Please ensure that **Part 1** of this form has been completed to the maximum extent possible, and distribute according to the requirements of the Letter of Agreement on monitoring of aircraft navigation errors in the South China Sea airspace.

Instructions for aircraft owner/operator:

Please supply any details required in **Part 1** of this form which have not already been completed, together with the information requested in **Parts 2, 3 and 4** (if applicable), and return to:

[*appropriate Regulatory Authority*]

Instructions for Investigating Agency (Regulatory Authority) :

Please complete **Part 5** of this form and return to:

[*appropriate Service Provider*]

NAVIGATION ERROR INVESTIGATION FORM

PART 1 **To be completed by responsible officer in the Service Provider (and aircraft owner/operator if needed)**		
ATC Unit Observing Error:		
Date/Time (UTC):		
Type of Error: (tick one) ❑ LATERAL ❑ LONGITUDINAL		
Details of Aircraft		
	First Aircraft	**Second Aircraft** (When longitudinal deviation observed)
Aircraft Identification:		
Name of Owner/Operator:		
Aircraft Type:		
Departure Point:		
Destination:		
Route Segment:		
Cleared Track:		
Position where error was observed: (BRG/DIST from fixed point or LAT/LONG)		
Extent of deviation - magnitude and direction: (NM for lateral, min/NM for longitudinal)		
Flight Level:		
For All Errors		
Action taken by ATC:		
Other comments:		

****(Please Attach ATS Flight Plan)**

NAVIGATION ERROR INVESTIGATION FORM

PART 2

Details of Aircraft, and Navigation and Communications Equipment Fit

(To be completed by aircraft owner/operator)

LRNS	**Number of Systems (0,1,2 etc.)**	**Make**	**Model**
INS			
IRS			
GNSS			
FMS			
Other (please specify)			
COMS			
HF			
VHF			
SATCOM			
CPDLC			

Which navigation system was coupled to the autopilot at the time of observation of the error?	
Which NAV MODE was selected at the time of observation of the error?	
Which coms system was in use at the time of observation of the error?	
Aircraft registration and model/series	
Was the aircraft operating according to RNP 10 requirements?	☐ Yes ☐ No

NAVIGATION ERROR INVESTIGATION FORM

PART 3 - Detailed description of incident (To be completed by owner/operator - use separate sheet if required)
Please give your assessment of the actual track flown by the aircraft, and the cause of the deviation:
Corrective action proposed:

PART 4 -To be completed by owner/operator, only in the event of partial or total navigation equipment failure.

Nav System Type	INS	IRS/FMS	Other (Please specify)
Indicate the number of units of each type which failed			
Indicate position at which failure(s) occurred			
Give an estimate of the duration of the equipment failure(s)			
At what time were ATC advised of the failure(s)?			

NAVIGATION ERROR INVESTIGATION FORM

PART 5 - To be completed by investigating agency

Have all required data been supplied?	❑ Yes	❑ No
Is further investigation warranted?	❑ Yes	❑ No
Will this incident be the subject of a separate report?	❑ Yes	❑ No

General comments:

Classification: (please circle) A B C D E F G H I

CLASSIFICATION OF GROSS NAVIGATION ERRORS

Class	Cause
A	Aircraft not approved to RNP 10
B	ATC system loop error
C	Waypoint insertion error, due to correct entry of incorrect position or incorrect entry of correct position
D	Other navigation errors, including equipment failure notified to ATC in time for action
E	Other navigation errors, including equipment failure notified to ATC too late for action
F	Other navigation errors, including equipment failure of which notification was not received by ATC -
G	Mode select error
H	Weather deviation (other than approved)
I	Other (please specify):

Procedures for the Assessment of Aircraft Navigation Errors in Support of the Implementation of a Revised ATS Route Structure (60NM Route Spacing) in the South China Sea Area

1. Introduction

1.1 This document provides guidance on the methodology to be adopted in the assessment of navigation errors associated with the implementation of a revised route structure, and a revised lateral separation minimum of 60NM, in the South China Sea.

1.2 This document should be read in conjunction with the Letter of Agreement between States of the South China Sea area, entitled *"Letter of Agreement for the Monitoring of Aircraft Navigation Errors in the South China Sea"*.

2. Data Gathering Responsibility

2.1 The States responsible for the gathering and onwards forwarding of data relating to the monitoring letter of agreement, and the monitoring areas identified in paragraph 4, shall be Hong Kong China, the Philippines, and Singapore.

2.2 Data gathering requirements are detailed in paragraph 5.

3. Monitoring Authority

3.1 Until such time as a permanent monitoring authority is established by APANPIRG, the organisation responsible for the collation and reporting of navigation error data will be the Civil Aviation Authority of Singapore (CAAS).

4. Designated Monitoring Areas

4.1 In order to validate the monitoring requirements supporting the reduction in lateral separation to 60NM, it is necessary to assess the track keeping ability of aircraft operating on the route structure, whilst they have been using on-board RNAV navigation systems only, for a maximum period of time, relative to the route being flown.

4.2 It is also essential that observation of the navigation of the aircraft, using radar, occurs before the on-board navigation systems have been able to "up-date" using ground-based navigation aids, such as DME/DME, or VOR/VOR.

4.3 In assessing navigation errors on the 6 core routes - ie L642, M771, N892, L625, N884 and M767 - there are only four appropriate areas at which the required monitoring may be undertaken, given the extensive ground-based navigation aid coverage in the South China Sea.

4.4 These areas are the route segments between:

a) DULOP and DUMOL on M771
b) AKOTA and AVMUP on L625

c) LULBU and LEGED on N884
d) MELAS and MABLI on N892

4.5 Monitoring of aircraft on these route segments should be undertaken as soon as possible after the aircraft enters radar coverage.

4.6 It should be noted that navigation error reports relating to areas other than those stated above, should also be processed and reported on, in order to support data gathering for future reductions in lateral and longitudinal separation. Details on the processing of these reports are given at paragraph 7.

5. Collection and Forwarding of Data

5.1 Those States identified in Paragraph 2, are required, at the end of each month, to collect the following data:

a) recorded navigation errors at the required monitoring areas, by way of the "Navigation Error Investigation Form", as detailed in the Letter of Agreement on the Monitoring of Navigation Errors; and

b) total monthly movement statistics relating to air traffic passing the designated monitoring areas within the designated monitoring height band.

Note: The recording of monthly traffic movement statistics in the monitoring areas should be auditable - in other words, some formal method of recording the movements - eg copies of flight progress strips or data from Flight Data Processing Systems - should be available for audit if required.

5.2 After collection, the required data should be forwarded to the Monitoring Authority (CAAS), for assessment, to arrive not later than 15 days from the end of the month within which the data was collected. This will allow time for the Navigation Error Investigation Forms relating to occurrences near the end of a month, to be processed and returned as detailed in that form.

5.3 In respect of paragraph 5.1.a), if there have been no error reports submitted, a "Nil Return" should be submitted to the monitoring authority.

6. Assessing of Navigation Errors

6.1 The monitoring requirements associated with the introduction of the reduced lateral separation minima of 60NM will be in accordance with the requirements for RNP 10 navigation performance, i.e. aircraft navigation performance shall be such that the standard deviation of lateral track errors shall be less than 8.7 km (4.7 NM).

6.2 The requirements will be met, if the number of navigation errors by approved flights, measured in the monitoring areas, divided by the total number of approved flights over those monitoring points, is less than the required parameters, over a period of time for RNP 10 navigation performance. (see Appendix B).

6.3 The assessments for each month should be recorded separately, and also cumulatively, on a month-to-month basis. If the assessment in any particular month exceeds the required parameter, a check should be made to ensure that the cumulative assessment does not also exceed the required parameter.

6.4 If a trend is identified, which indicates that the required parameter is being exceeded regularly, or the cumulative assessment indicates an upwards trend, the Monitoring Authority should notify, through the ICAO Bangkok Office, the APANPIRG ATS/AIS/SAR Sub-Group, which should then investigate the need for a review of the applicable procedures.

6.5 An example of an assessment schedule is shown at Appendix B.

7. Processing of Navigation Error Reports Relating to Areas Other Than Required Monitoring Areas

7.1 The Letter of Agreement on the Monitoring of Navigation Errors requires all participating States to notify all appropriate navigation errors to the monitoring authority. This data should be collated and assessed in the following manner.

7.2 If the navigation error report relates to aircraft tracking on RNAV routes M771, L625, N884, or N892, the error should be assessed and processed in accordance with paragraph 6 above.

7.3 If the report relates to aircraft tracking on other routes, the errors should be assessed, and recorded separately. This information should be assessed by the APANPIRG ATS/AIS/SAR Sub-group meeting, for appropriate action.

8. Reporting Procedures

8.1 The Monitoring Authority should prepare an assessment schedule (refer to Appendix B), and forward a copy of this schedule, at least every 6 months, to:

a) all signatory States to the Monitoring Letter of Agreement; and

b) The Chairman of the APANPIRG ATS/AIS/SAR Sub-Group, through the ICAO Bangkok Office.

8.2 In addition, a report should be prepared on those errors reported in accordance with paragraph 7.3 above.

9. Attachments

Appendix A - Assessment Schedule Process
Appendix B - Sample Assessment Schedule

Appendix A

Assessment Schedule Process For Designated Monitoring Areas

STEP 1.

Hong Kong, Philippines and Singapore carry out a total monthly traffic count for approved traffic at FL290 and above, over the points:

a) DULOP and DUMOL on M771
b) AKOTA and AVMUP on L625
c) LUBLU and LEGED on N884
d) MELAS and MABLI on N892

STEP 2.

Hong Kong, Philippines, and Singapore collate all Navigation Error Investigation Forms.

STEP 3.

Not later than the 15th day of each month, send the statistics gathered in Steps 1 and 2, to the Monitoring Authority (CAAS).

STEP 4.

The Monitoring Authority collates the information into an assessment schedule.

STEP 5.

Each 6 months, the assessment schedule is sent to:

a) all signatory States to the Monitoring Letter of Agreement; and

b) The Chairman of the APANPIRG ATS/AIS/SAR Sub-Group, through the ICAO Bangkok Office.

STEP 6 (if required).

If the trend in errors is increasing, notify, through the ICAO Bangkok Office, the APANPIRG ATS/AIS/SAR Sub-Group, for appropriate action.

Appendix B

Example of Navigation Error Assessment Schedule For Designated Monitoring Areas

a. Example of Monthly Total - Single Area

Month/ 1997	Total traffic at DULOP/DUMOL	Errors Category 1	Errors Category 2	Error Ratio Category 1	Error Ratio Category 2
April	3105	1	0	3.22×10^{-4}	0
May	3042	2	0	6.57×10^{-4}	0
June	2810	0	0	0	0
July	2995	1	1	3.34×10^{-4}	3.34×10^{-4}

Category 1 = >30NM Category 2 = 50 - 70 NM

b. Example of Cumulative Monthly Total - Single Area

Month/ 1997	Total traffic at DULOP/DUMOL	Errors Category 1	Errors Category 2	Error Ratio Category 1	Error Ratio Category 2
April	3105	1	0	3.22×10^{-4}	0
May	6147	3	0	4.88×10^{-4}	0
June	8957	3	0	3.35×10^{-4}	0
July	11952	4	1	3.45×10^{-4}	8.36×10^{-5}

Category 1 = >30NM Category 2 = 50 - 70 NM

c. Example of Monthly Total - All Four Areas

Month/ 1997	Total traffic All Areas	Errors Category 1	Errors Category 2	Error Ratio Category 1	Error Ratio Category 2
April	7852	2	0	2.55×10^{-4}	0
May	8311	2	0	2.41×10^{-4}	0
June	8263	1	0	1.21×10^{-4}	0
July	7678	1	1	1.30×10^{-4}	1.30×10^{-4}

Category 1 = >30NM Category 2 = 50 - 70 NM

d. Example of Cumulative Monthly Total - All Four Areas

Month/ 1997	Total traffic All Areas	Errors Category 1	Errors Category 2	Error Ratio Category 1	Error Ratio Category 2
April	7852	2	0	2.55×10^{-4}	0
May	16163	4	0	2.47×10^{-4}	0
June	24426	5	0	2.05×10^{-4}	0
July	32104	6	1	1.87×10^{-4}	3.11×10^{-5}

Category 1 = >30NM Category 2 = 50 - 70 NM

NAVIGATION ERROR INVESTIGATION FORM

Instructions for Service Provider responsible officer:

Please ensure that **Part 1** of this form has been completed to the maximum extent possible, and distribute according to the requirements of the Letter of Agreement on monitoring of aircraft navigation errors in the South China Sea airspace.

Instructions for aircraft owner/operator:

Please supply any details required in **Part 1** of this form which have not already been completed, together with the information requested in **Parts 2, 3 and 4** (if applicable), and return to:

Assistant Director-General of Civil Aviation (Air Traffic Management)
4/F Air Traffic Control Complex
Hong Kong International Airport
Hong Kong

Instructions for Investigating Agency (Regulatory Authority) :

Please complete **Part 5** of this form and return to:

OO(G)

Attachment 2

NAVIGATION ERROR INVESTIGATION FORM

PART 1 **To be completed by responsible officer in the Service Provider (and aircraft owner/operator if needed)**		
ATC Unit Observing Error:	Hong Kong	
Date/Time (UTC):		
Type of Error: (tick one)	❑ LATERAL	❑ LONGITUDINAL
Details of Aircraft		
	First Aircraft	**Second Aircraft** (When longitudinal deviation observed)
Aircraft Identification:		
Name of Owner/Operator:		
Aircraft Type:		
Departure Point:		
Destination:		
Route Segment:		
Cleared Track:		
Position where error was observed: (BRG/DIST from fixed point or LAT/LONG)		
Extent of deviation - magnitude and direction: (NM for lateral, min/NM for longitudinal)		
Flight Level:		
For All Errors		
Action taken by ATC:		
Other comments:		

****(Please Attach ATS Flight Plan)**

NAVIGATION ERROR INVESTIGATION FORM

PART 2 Details of Aircraft, and Navigation and Communications Equipment Fit. (To be completed by aircraft owner/operator)			
LRNS	**Number of Systems (0,1,2 etc.)**	**Make**	**Model**
INS			
IRS			
GNSS			
FMS			
Other (please specify)			
COMS			
HF			
VHF			
SATCOM			
CPDLC			
Which navigation system was coupled to the autopilot at the time of observation of the error?			
Which NAV MODE was selected at the time of observation of the error?			
Which coms system was in use at the time of observation of the error?			
Aircraft registration and model/series			
Was the aircraft operating according to RNP 10 requirements?	❑ Yes ❑ No		

NAVIGATION ERROR INVESTIGATION FORM

PART 3 - Detailed description of incident **(To be completed by owner/operator - use separate sheet if required)**
Please give your assessment of the actual track flown by the aircraft, and the cause of the deviation:
Corrective action proposed:

PART 4 -To be completed by owner/operator, only in the event of partial or total navigation equipment failure.

Nav System Type	INS	IRS/FMS	Other (Please specify)
Indicate the number of units of each type which failed			
Indicate position at which failure(s) occurred			
Give an estimate of the duration of the equipment failure(s)			
At what time were ATC advised of the failure(s)?			

NAVIGATION ERROR INVESTIGATION FORM

PART 5 - To be completed by investigating agency

Have all required data been supplied?	❑ Yes	❑ No
Is further investigation warranted?	❑ Yes	❑ No
Will this incident be the subject of a separate report?	❑ Yes	❑ No

General comments:

Classification: (please circle) A B C D E F G H I

CLASSIFICATION OF GROSS NAVIGATION ERRORS

Class	Cause
A	Aircraft not approved to RNP 10
B	ATC system loop error
C	Waypoint insertion error, due to correct entry of incorrect position or incorrect entry of correct position
D	Other navigation errors, including equipment failure notified to ATC in time for action
E	Other navigation errors, including equipment failure notified to ATC too late for action
F	Other navigation errors, including equipment failure of which notification was not received by ATC
G	Mode select error
H	Weather deviation (other than approved)
I	Other (please specify):

Attachment 3a

[NAME AND ADDRESS OF OPERATOR]

Dear Sir,

Navigation Error Report

I am writing in connection with an occurrence concerning navigation error of one of your aircraft.

Air Traffic Control service providers are monitoring the navigation performance of traffic on routes in the South China Sea area, as part of the implementation of reduced separation minima on those routes co-ordinated by the ICAO Asia/Pacific Regional Office.

These procedures require the reporting and investigation of:

i) lateral tracking errors of 15NM or more;

ii) variations of longitudinal separation of three minutes or more; or

iii) variations of longitudinal separation of 10NM or more.

A *Navigation Error Investigation Form* relating to one of your aircraft is enclosed.

An investigation of this occurrence is required. I should be grateful if you would provide a detailed explanation within 10 days, using the attached *Navigation Error Investigation Form*. Please complete Parts 2 to 4 therein. In your reply, you are also requested to indicate any corrective action taken to prevent future occurrences.

Please also forward a copy of the completed form to [INSERT NAME OF THE APPROPRIATE AUTHORITY] who has been informed of the occurrence.

Yours faithfully,

( )
for Director-General of Civil Aviation

Encl.

[NAME AND ADDRESS OF AUTHORITY]

Dear Sir,

Navigation Error Report

I am writing in connection with an occurrence concerning navigation error of an aircraft operated by [INSERT COMPANY NAME].

Air Traffic Control service providers are monitoring the navigation performance of traffic on routes in the South China Sea area, as part of the implementation of reduced separation minima on those routes co-ordinated by the ICAO Asia/Pacific Regional Office.

These procedures require the reporting and investigation of:

i) lateral tracking errors of 15NM or more;

ii) variations of longitudinal separation of three minutes or more; or

iii) variations of longitudinal separation of 10NM or more.

A *Navigation Error Investigation Form* concerning the captioned flight has been filed. An investigation of this occurrence is being instituted and the aircraft operator concerned has been requested to provide the necessary details. A copy of our letter to the operator together with the investigation form is provided herewith for your reference.

You may wish to note that the operator concerned has been requested to furnish you with a copy of the completed form.

Yours faithfully,

( )
for Director-General of Civil Aviation

Encl.

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 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 in the vertical plane (i.e. RVSM);
- SMA – Safety Monitoring Agency – safety assessment in the horizontal plane (i.e. RHSM, RNP10, RNP4); and
- CRA – Central Reporting Agency – technical performance of data link systems (i.e. ADS/CPDLC)
- FIT – FANS 1/A Interoperability/Implementation Team – parent body to a CRA.

(last updated 10 November 2006)

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed
Airservices Australia (Mr Robert Butcher, Manager Human Factors and Analysis, Safety Management Group, email robert.butcher@airservicesaustralia.com)	Australia	RMA	Current	Brisbane & Melbourne FIRs not including oceanic airspace east of Australian mainland.
		SMA	Current	Brisbane & Melbourne FIRs

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed
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
CRA Japan (Mr. Yoshiro Nakatsuji, Director, Air Traffic Control Association Japan, email: naka@atcaj.or.jp)	Japan	CRA	Current	Fukuoka FIR for IPACG/FIT Ho Chi Minh, Manila, Singapore FIRs for FIT-SEA
IPACG/FIT (Mr. Hiroshi Inoguchi, JCAB Co-Chair, email: Inoguchi-h2hh@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)
ISPACG/FIT (Mr. Bradley Cornell, Boeing Engineering, email Bradley.D.Cornell@Boeing.Com)	Boeing USA	FIT & CRA	Current	South Pacific

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed
FIT/SEA (ICAO Regional Office email icao_apac@bangkok.icao.int & CRA Japan (Mr. Yoshiro Nakatsuji, Director, Air Traffic Control Association Japan, email: naka@atcaj.or.jp)	ICAO Regional Office & Japan	FIT & CRA	Current	South China Sea
Japan Civil Aviation Bureau (JCAB) (Mr. Takashi Imuta, Chief of Airspace Safety Monitoring Section, email: imuta-t2in@mlit.go.jp	Japan	RMA	Available second quarter – 2007	Fukuoka FIR
		SMA	Available second quarter – 2009	Fukuoka FIR

Organisation *(including contact officer)*	State	Competency	Status	Airspace assessed
Monitoring Agency for the Asia Region (MAAR) (Dr. Paisit Herabat Executive Officer, Systems Engineering,Aeronautical Radio of Thailand Ltd. Email: paisit@aerothai.co.th	Thailand	RMA	Current	Bangkok, Calcutta, Chennai, Colombo, Delhi, Dhaka, Hanoi, Ho Chi Minh, Hong Kong, Jakarta, Karachi, Kathmandu, Kota Kinabalu, Kuala Lumpur, Lahore, Male, Manila, Mumbai, Phnom Penh, Sanya FIR, Singapore, Taibei, Ujung Pandang, Vientiane, Yangon FIRs
		SMA	Available third quarter-2006	Bangkok, Calcutta, Chennai, Colombo, Delhi, Dhaka, Hanoi, Ho Chi Minh, Hong Kong, Jakarta, Karachi, Kathmandu, Kota Kinabalu, Kuala Lumpur, Lahore, Male, Manila, Mumbai, Phnom Penh, Sanya FIR, Singapore, Taibei, Ujung Pandang, Vientiane, Yangon FIRs
Pacific Approvals Registry and Monitoring Organization (PARMO) (Mr Brian Colamosca Manager, Separation Standards Analysis Group, FAA, email: brian.colamosca@faa.gov.)	USA	RMA	Current	Anchorage Oceanic, Auckland Oceanic, Brisbane (east of Australian mainland), Honiara, Incheon, Melbourne (east of Australian mainland), Nadi, Nauru, Oakland Oceanic, Port Moresby, Tahiti FIRs
Civil Aviation Authority of Singapore (CAAS) (Mr. Kuah Kong Beng, Chief Air Traffic Control Officer, email: KUAH_Kong_Beng@caas.gov.sg)	Civil Aviation Authority of Singapore (CAAS)	Monitoring Authority for Gross Navigation Error (GNE)	Current	Hong Kong, Ho Chi Minh, Manila, Sanya, Singapore FIRs,

International Civil Aviation Organization

The Sixth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/6)

Bangkok, Thailand, 6-10 November 2006

Agenda Item 6: Review of regional safety assessment activities/requirements

A MODIFICATION TO THE OPERATIONAL RISK FORM OF THE COLLISION RISK MODEL IN SOUTH CHINA SEA AIRSPACE

(Presented by Pacific Approvals Registry and Monitoring Organization (PARMO))

SUMMARY

This Information Paper describes describe a modification made to the operational risk portion of the ICAO-endorsed vertical Collision Risk Model (CRM). This modification was first applied to the South China Sea airspace prior to the implementation of the Reduced Vertical Separation Minimum (RVSM).

1. Introduction

1.1. The International Civil Aviation Organization (ICAO)-endorsed Collision Risk Model (CRM) is the Reich Collision Risk Model (reference 1). The vertical form of the Reich collision risk model is used to conduct a comprehensive safety assessment prior to the introduction of the reduced vertical separation minimum (RVSM).

1.2. The purpose of this information paper is to describe a modification made to the operational risk portion of the ICAO-endorsed CRM for the vertical dimension prior to the implementation of the RVSM in South China Sea airspace.

2. Background

2.1. The introduction of the RVSM into an airspace follows the guidance provided by the ICAO *Manual on the implementation of a 300 m (1,000 ft) Vertical Separation Minimum Between FL290 FL410 Inclusive, ICAO Doc 9574* (reference 2). This document provides direction to a State, a group of States or an ICAO regional planning group concerning the requirements and related factors necessary to implement the RVSM in a safe manner.

2.2. In the context of reference 2, "safe" has an explicit meaning: the risk of collision due to the loss of the RVSM, as estimated using collision risk modeling, does not exceed an agreed quantitative safety goal. This goal is called the Target Level of Safety (TLS).

2.3. Reference 2 lays out the implementation process for introduction of the RVSM. Among other actions recommended during this process, the document calls for a comprehensive safety assessment prior to RVSM implementation in order to ensure that the

TLS will be met, that is, that the risk associated with the RVSM as estimated by ICAO risk modeling will be less than the TLS value.

2.4. In planning for RVSM implementation and conducting this comprehensive safety assessment, reference 2 requires that not only aircraft height keeping performance be taken into account, but also all other factors affecting safety. The guidance suggests that chief among these are instances of large height deviations arising from errors in granting or executing air traffic control (ATC) clearances. To account for the anticipated effect of large height deviations, Doc 9574 recommends apportioning the overall TLS. The recommended manner is to allocate one-half of the value as the safety goal for risk attributable to aircraft height keeping performance, while the overall value serves as the bound on risk from all causes – aircraft height keeping performance, referred to as "technical risk" and large height deviations, referred to as "operational risk".

2.5. This document will focus on the operational risk component of the overall risk for the South China Sea airspace.

3. Discussion

3.1. The original form of the Reich CRM was developed for the North Atlantic (NAT) airspace. The NAT traffic follows a systematic schedule, keeping the peak periods traffic in a unidirectional flow. The unmodified CRM provides a conservative estimate of the operational risk for opposite-direction traffic. The conservative estimate results from the model form, which considers the possibility that an operational error could result in a head-on collision if an aircraft were to operate at the wrong flight level for its direction of travel.

3.2. Portions of the South China Sea airspace have routes with single-alternate Flight Level Orientation Scheme (FLOS). The opposite-direction vertical occupancy estimates for traffic using these single-alternate FLOS routes were large compared to similar estimates for other oceanic airspace with mostly unidirectional traffic.

3.3. Prior to the RVSM implementation, each Flight Information Region (FIR) in the airspace submitted monthly reports of large height deviations. There were 24 operational errors reported for the airspace. Many of the reported operational errors were caused by an error in the ATC-unit-to-ATC-unit transfer messages. Due to the geography of the region, even short duration flights traverse through several separate FIRs, which provide more opportunity for errors to be made in the required transition messages.

3.4. Based on the reported operational errors for the South China Sea airspace - none of which involved aircraft operating at incorrect flight level for direction of travel – a modification was made to the model in an effort to reflect the use of the standard single-alternate FLOS routings in the airspace. It was assumed that air traffic controllers within the South China Sea airspace NEVER permit aircraft at flight levels that are inconsistent with the direction of travel. That is, if a flight level is designated to be easterly, air traffic control would not permit an aircraft traveling in a westerly direction to be at that flight level even if there are no aircraft traveling in an easterly direction. If an aircraft would need to cross to another route, it is expected that air traffic would keep that aircraft at flight levels consistent with the airspace on all of the routes.

3.5. Therefore, for the South China Sea airspace, if an aircraft is at the wrong flight level due to an operational error, it is expected that it may anticipate traffic at that flight level that is consistent with the occupancy values for either same-direction traffic or opposite direction traffic, but not both. That is, if the direction of travel for the flight level that the aircraft is on after the operational error is committed is in the same direction as the aircraft then only same-direction occupancy applies. If the direction of travel for the flight level that the aircraft is on after the operational error is committed is in the opposite direction as the aircraft then only opposite-direction occupancy applies. For the South China Sea airspace, the current collision risk equation required a modification.

3.6. However, if there is any chance that there may be an aircraft permitted at a flight level in a direction opposite the normal traffic flow, regardless of the reasons, then the above assumptions are invalid. Therefore, the modification to the model would need to be revised or removed if there are changes made to the South China Sea airspace routings and flight level rules. It is also important that all future operational error reports be examined to determine whether aircraft were operating at an incorrect flight level for direction of travel, as this would require an adjustment to the original modification of the operational error CRM.

3.7. Development of the Modification

3.7.1. Prior to the implementation of the RVSM in South China Sea airspace, there were 24 operational errors occurring within the previous calendar year. None of these 24 events resulted in an aircraft operating at an incorrect flight level for its direction of flight.

3.7.2. The Poisson distribution is typically used to model the number of occurrences of a rare event when the number of opportunities for the event is very large, but the probability that the event occurs in any specific instance is very small (reference 5). The Poisson distribution was chosen to model the number of operational errors occurring in the wrong direction for flight level rules in the South China Sea airspace. This choice in distributional form is valid based on the assumption that that air traffic controllers within the South China Sea airspace do not permit aircraft at flight levels that are inconsistent with the direction of travel (paragraph 3.4.)

3.7.3. Let x denote the number of operational errors which occur in the wrong direction for flight level rules. Based on the assumptions stated in paragraph 3.7.2, x follows the Poisson distribution. Of interest, is the 95% confidence limit for x, the mean number of operational errors occurring in the wrong direction for the flight level rules, in a sample of 24 operational errors. Reference 6 provides the method for computing the confidence limit for the Poisson distribution, ξ :

$$\xi = \frac{1}{2}\chi^2_{1-P_1} \quad for \quad f = 2(x_o + 1) \qquad (1)$$

3.7.4. Of the 24 reported operational errors, zero operational errors resulted in a flight operating in the wrong direction for flight level rules, therefore, $x = 0$.

3.7.5. For the 95% confidence limit, substitute into (1): x_o=0, and P_1=0.05:

$$\xi = \frac{1}{2}\chi^2_{0.95} \quad for \quad f = 2(0+1) \quad d.o.f.$$

$$from \quad \chi^2 \quad table \quad \chi^2_{0.95} = 5.99 \quad (f = 2)$$

$$\xi = \frac{1}{2}\chi^2_{0.95} = 3$$

3.7.6. Using the χ^2 distribution, the 95% confidence limit is found to be equal to 3 for the mean number of operational errors occurring in wrong direction for flight level rules in a sample of N=24 operational errors.

3.7.7. Therefore, for each random sample of 24 operational errors that contain zero operational errors in the wrong direction for flight level rules, it is concluded, that for a large number of operational errors at most 3 operational errors will occur in the wrong direction for flight level rules per 24 operational errors sample. In the long run, 5% of the conclusions will be false.

3.7.8. Conditional probability rules are necessary to make use of the conclusion presented above:

$$P(AC) \quad = P(C)P(A|C) \qquad (2)$$

3.7.9. In (2), let :

C = number of times operational errors occur

A = number of times operational errors occur in wrong direction for flight level rules

3.7.10. Therefore, *P(C)* is the proportion of times that operational errors occur and *P(A)* is the proportion of times that operational errors occur in wrong direction for flight level rules. *P(A|C)* represents the proportion of times *A* occurs given that event *C* has occurred. *P(AC)* represents the proportion of times in which both *C* and *A* occur.

3.7.11. To estimate *P(C)*, the estimated number of total flights and the number of operational errors in the South China Sea airspace are needed. Prior to the implementation of the RVSM in South China Sea airspace, the estimated number of total flights per year was 430,000 flights and the number of operational error reports received was 24. Therefore, the estimate of *P(C)*, $\widehat{P}(C)$, is equal to 24 ÷ 430,000.

3.7.12. Using the 95% confidence limit presented in paragraph 3.7.6 and the number of operational error reports received, the confidence limit, $P(A|C)_u$, is estimated as 3 ÷ 24. The subscript *u* is added to denote that this estimate represents the upper 95% confidence limit for *P(A|C)*.

3.7.13. Finally, $P(AC)_u$ can be estimated using (2) as 3÷430,000 or 6.977×10^{-6}. Again, the subscript *u* is added to denote that this estimate represents the upper 95% confidence limit for *P(AC)*.

3.8. Operational Risk Modification

3.8.1. The unmodified statement of the operational risk form of the CRM is:

$$N_{az} = P_i P_z(0) P_y(0) \frac{\lambda_x}{S_x} \left\{ E_z(same) \left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] + E_z(opp) \left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] \right\} \qquad (3)$$

3.8.2. The operational risk parameter definitions shown in (3) are presented in Table 1.

CRM Parameter	Description
N_{az}	Expected number of accidents per aircraft flight hour resulting from collisions due to the loss of vertical separation between aircraft pairs at adjacent flight levels
S_X	Length of longitudinal window used to calculate occupancy.
$P_z(0)$	Probability that two aircraft nominally flying at the same level are in vertical overlap
P_i	The proportion of total flying time spent at incorrect levels, may be interpreted as the probability that an aircraft is flying at an incorrect level
$P_y(0)$	Probability that two aircraft on the same route are in lateral overlap.
λ_x	Average aircraft length.
λ_y	Average aircraft wingspan.
λ_z	Average aircraft height with undercarriage retracted.
$E_Z(same)$	Same-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.
$E_Z(opp)$	Opposite-direction vertical occupancy for a pair of aircraft at adjacent flight levels on same route.
$\overline{\|\Delta V\|}$	Average absolute relative along-track speed between aircraft on same direction routes.
$\overline{\|V\|}$	Average absolute aircraft ground speed.
$\overline{\|\dot{y}\|}$	Average absolute relative cross track speed for an aircraft pair nominally on the same track.
$\overline{\|\dot{z}\|}$	Average absolute relative vertical speed of an aircraft pair that have lost all vertical separation

Table 1. CRM Parameters - Operational Risk

3.8.3. In (3), P_i is equivalent to the proportion of time in which operational errors occur. This is computed as the total flight time attributed to operational errors divided by the total flight time during the operational error monitoring.

3.8.4. Let t_{oe} equal the average flight time of an operational error. Then P_i is equal to

$$P_i = t_{oe} \times \frac{C}{Number\ \ of\ \ Flights} = t_{oe} \times P(C) \qquad (4)$$

3.8.5. Allocating a proportion of the number of times operational errors occur in wrong direction for flight level rules given that operational errors occur, *P(A|C),* to same and opposition direction operational risk gives:

$$N_{az} = P_i P_z(0) P_y(0) \frac{\lambda_x}{S_x} \left\{ \begin{array}{l} [1-P(A|C)] E_z(same) \left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] + \\ P(A|C) E_z(opp) \left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] \end{array} \right\} \quad (5)$$

3.8.6. Substituting (4) into (5) and multiplying terms gives:

$$N_{az} = P_z(0) P_y(0) \frac{\lambda_x}{S_x} \left\{ \begin{array}{l} t_{oe} P(C) [1-P(A|C)] E_z(same) \left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] + \\ t_{oe} P(C) P(A|C) E_z(opp) \left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] \end{array} \right\} \quad (6)$$

3.8.7. Further expand the terms in (6) gives:

$$N_{az} = P_z(0) P_y(0) \frac{\lambda_x}{S_x} \left\{ \begin{array}{l} t_{oe} P(C) E_z(same) \left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] - \\ t_{oe} P(C) P(A|C) E_z(same) \left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] + \\ t_{oe} P(C) P(A|C) E_z(opp) \left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z} \right] \end{array} \right\} \quad (7)$$

3.8.8. Substitute $P_i = t_{oe}P(C)$, $\widehat{P}(A|C)$ for *P(A|C)* in the same direction term of (7), where $\widehat{P}(A|C)$ is estimate of *P(A|C)* from the large height deviation reports. From the operational error data collected, the value of $\widehat{P}(A|C)$ is 0 ÷ 24. Instead of using this estimate for *P(A|C)* in the opposite direction term of (7), we substitute a larger, more conservative value for *P(A|C)*. The more conservative value is $P(A|C)_u$, where $P(A|C)_u$ is the upper 95% confidence limit for the mean number of operational errors occurring in the wrong direction for flight level rules.

$$N_{az} = P_i P_z(0) P_y(0) \frac{\lambda_x}{S_x} \left\{ \begin{array}{l} E_z(same)\left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] - \\ \hat{P}(A|C) E_z(same)\left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] + \\ P(A|C)_u E_z(opp)\left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] \end{array} \right\} \quad (8)$$

3.8.9. Combining common terms gives:

$$N_{az} = P_i P_z(0) P_y(0) \frac{\lambda_x}{S_x} \left\{ \begin{array}{l} [1 - \hat{P}(A|C)] E_z(same)\left[\frac{\overline{|\Delta V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] + \\ P(A|C)_u E_z(opp)\left[\frac{2\overline{|V|}}{2\lambda_x} + \frac{\overline{|\dot{y}|}}{2\lambda_y} + \frac{\overline{|\dot{z}|}}{2\lambda_z}\right] \end{array} \right\} \quad (9)$$

3.8.10. To apply (9) to the operational risk for South China Sea airspace, estimates of $\hat{P}(A|C)$ and $P(A|C)_u$ are needed. $\hat{P}(A|C)$ is the proportion of times that operational errors occur in the wrong direction for flight level rules given that operational errors occur. From the 24 large height deviation events reported prior to the RVSM implementation in the South China Sea, zero operational errors occurred in the wrong direction for flight level rules. Therefore, the estimate $\hat{P}(A|C)$ is equal to 0 ÷ 24 or 0.

3.8.11. The 95% confidence limit for the mean number of operational errors occurring on the wrong direction for flight level rules in a sample of 24 operational errors, $P(A|C)_u$, was found to be 3 ÷ 24 (paragraph 3.7.12).

3.9. Application of the Modified Risk Equation

3.9.1. Table 2 presents the vertical collision risk estimates for South China Sea airspace. The second column in Table 2 shows the vertical risk estimates for South China Sea airspace prior to the operational risk modification. The third column in Table 2 presents the vertical risk estimates for South China Sea airspace after the modification to the operational risk.

	Before Modification to Operational Risk	**After Modification to Operational Risk**
Technical Risk	6.172×10^{-11}	6.172×10^{-11}
Operational Risk	4.104×10^{-9}	1.073×10^{-9}
Total Risk	4.165×10^{-9}	1.135×10^{-9}

Table 2. Technical, Operational and Total Vertical Risk Estimates for South China Sea Airspace before and After the Modification to the CRM Was Applied

3.9.2. The modified CRM for operational risk presented in (9) is used to obtain the operational risk estimate in Column 3 of Table 2. From the operational error data collected prior to RVSM implementation, in which zero of the 24 operational errors resulted in an aircraft at the wrong flight level for flight level rules, the estimate of the proportion of times that operational errors occur in the wrong direction for flight level rules given that operational errors occur, $\widehat{P}(A|C)$, is 0. The 95% confidence limit for the mean number of operational errors occurring on the wrong direction for flight level rules in a sample of 24 operational errors, $P(A|C)_u$, is 3 ÷ 24. The remainder of the parameters in (9) are identical to those in the unmodified form.

3.9.3. In this case, the modification to the CRM simply reduces the contribution of the operational risk for opposite-direction traffic by a factor of 1/8. Table 3 breaks down the contribution of same-and-opposite direction operational risk.

	Before Modification to Operational Risk	**After Modification to Operational Risk**
Same-Direction operational Risk	4.669×10^{-10}	4.669×10^{-10}
Opposite-Direction operational Risk	3.463×10^{-9}	4.329×10^{-10}
Crossing traffic Operational Risk	1.738×10^{-10}	1.738×10^{-10}
Total Operational Risk	4.104×10^{-9}	1.073×10^{-9}

Table 3. Breakdown of Operational Risk Before And After Modification to CRM for South China Sea Airspace

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5. Tamhane, A.C., Dunlop, D.D., *Statistics and Data Analysis From Elementary to Intermediate*, Prentice Hall, Upper Saddle River, NJ 2000.

6. Hald, A., *Statistical Theory with Engineering Applications*, John Wiley & Sons, Inc., New York, 783 pp., 1952.

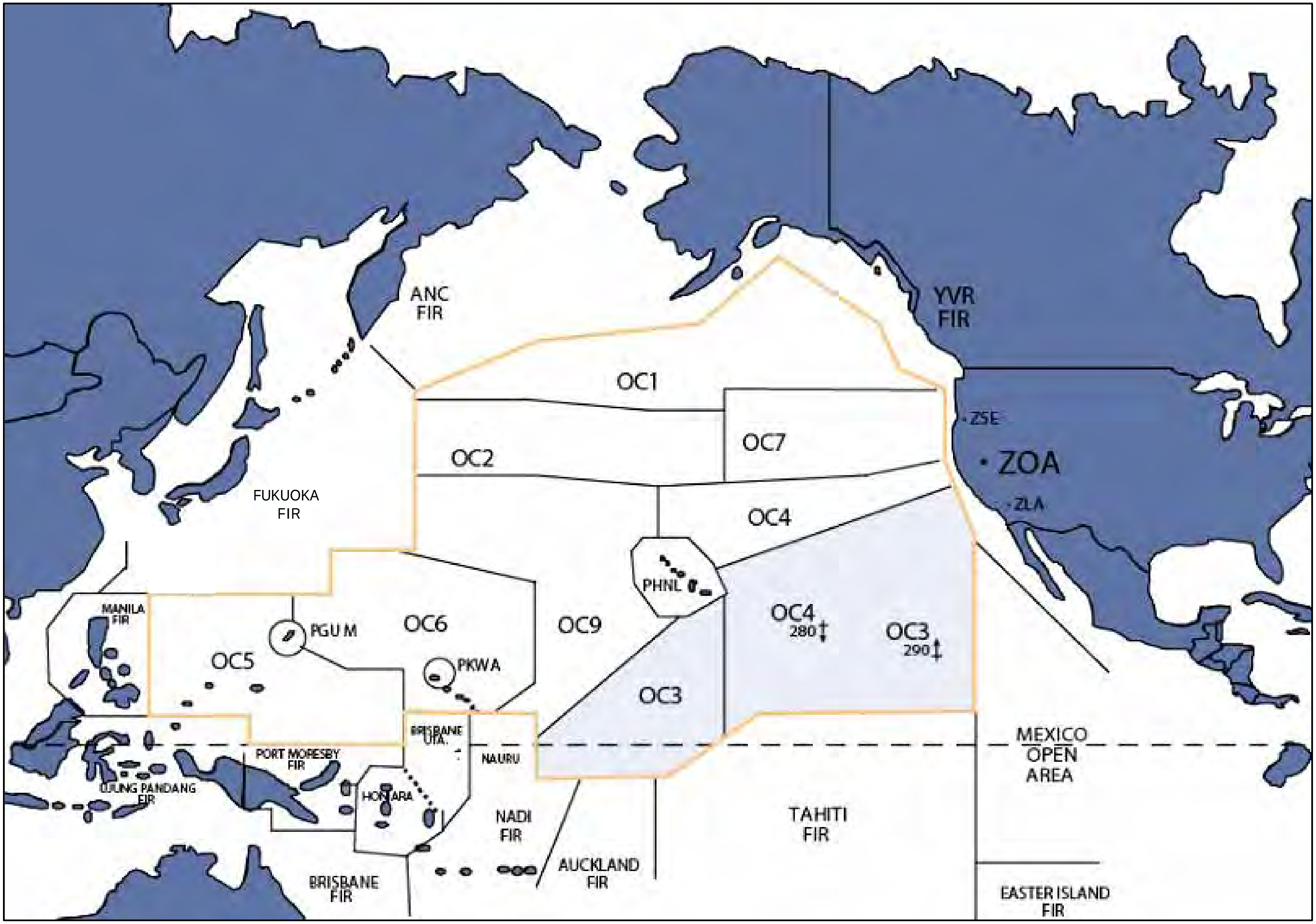
IP/9, A Summary of the Airspace Characteristics Related to the Operational-Trial Use of 30-NM Lateral and Longitudinal Separation Standards in the Oakland Flight Information Region

Federal Aviation Administration

RASMAG/6
Bangkok, Thailand
6 – 10 November 2006

Introduction

- On 22 December 2005, the FAA implemented 30-nm lateral and longitudinal separation standards on an operational trial basis in Oakland Oceanic Sector 3 (OC3)
- The implementation followed all guidelines outlined in Annex 11 and the PANS ATM (ICAO Doc 4444)
- The operational trial, permits the FAA to evaluate the relevant performance of aircraft with suitable State approval for participation in the trial, as well as operation of the new Ocean21 oceanic automation system introduced into full-time operation at the Oakland ARTCC in October 2005



ANC FIR
YVR FIR
OC1
OC7
OC2
ZSE
ZOA
ZLA
FUKUOKA FIR
OC4
PHNL
MANILA FIR
PGUM
OC6
OC9
OC4 280
OC3 290
OC5
PKWA
OC3
BRISBANE FIR
NAURU
MEXICO OPEN AREA
PORT MORESBY FIR
UJUNG PANDANG FIR
HONIARA
NADI FIR
TAHITI FIR
AUCKLAND FIR
BRISBANE FIR
EASTER ISLAND FIR

Introduction

- As part of the operational trial, the FAA has formed a group of experts to evaluate performance of the various components of the system supporting the reduced separation minima
- This group has been termed the “30-30 Scrutiny Group”, more simply known as the scrutiny group. The scrutiny group is composed of representatives from various FAA organizations, members of the scrutiny group include:
  - Specialists in oceanic air traffic control and engineering operations from the Oakland Center,
  - As well as representatives from the following:
    - Headquarters air traffic services,
    - Headquarters oceanic program office,
    - The Flight Standards Service
    - The Aircraft Certification Service, and
    - The FAA Technical Center

Data Sources Available

- Ocean21 data reduction and analysis archives
- Enhanced Traffic Management System
- Technical Center archives of ZOA radar data
- FAA accident and incident databases
- NASA Aviation Safety Reporting System

Ocean21 Data Reduction & Analysis

- Ocean 21 System's Data Reduction & Analysis (DR&A) process provides a history of operational data

- These data are made available to the FAA Technical Center on a regular basis (approximately every 11 days) and include;
  - Automatic Dependent Surveillance-Contract (ADS-C) messages,
  - Controller-Pilot Datalink Communication (CPDLC) messages,
  - High Frequency (HF) radio messages, and
  - ICAO Filed flight plans

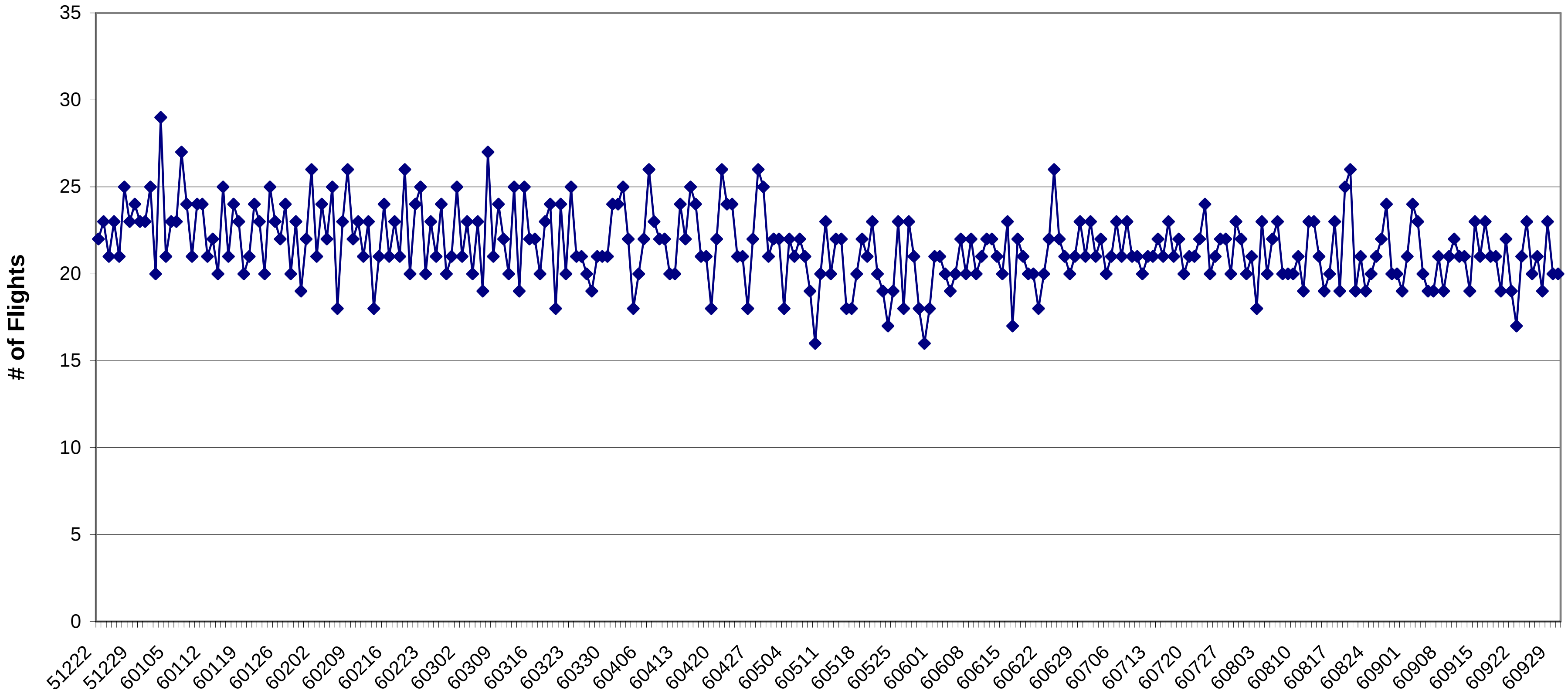
Background – OC3 Airspace

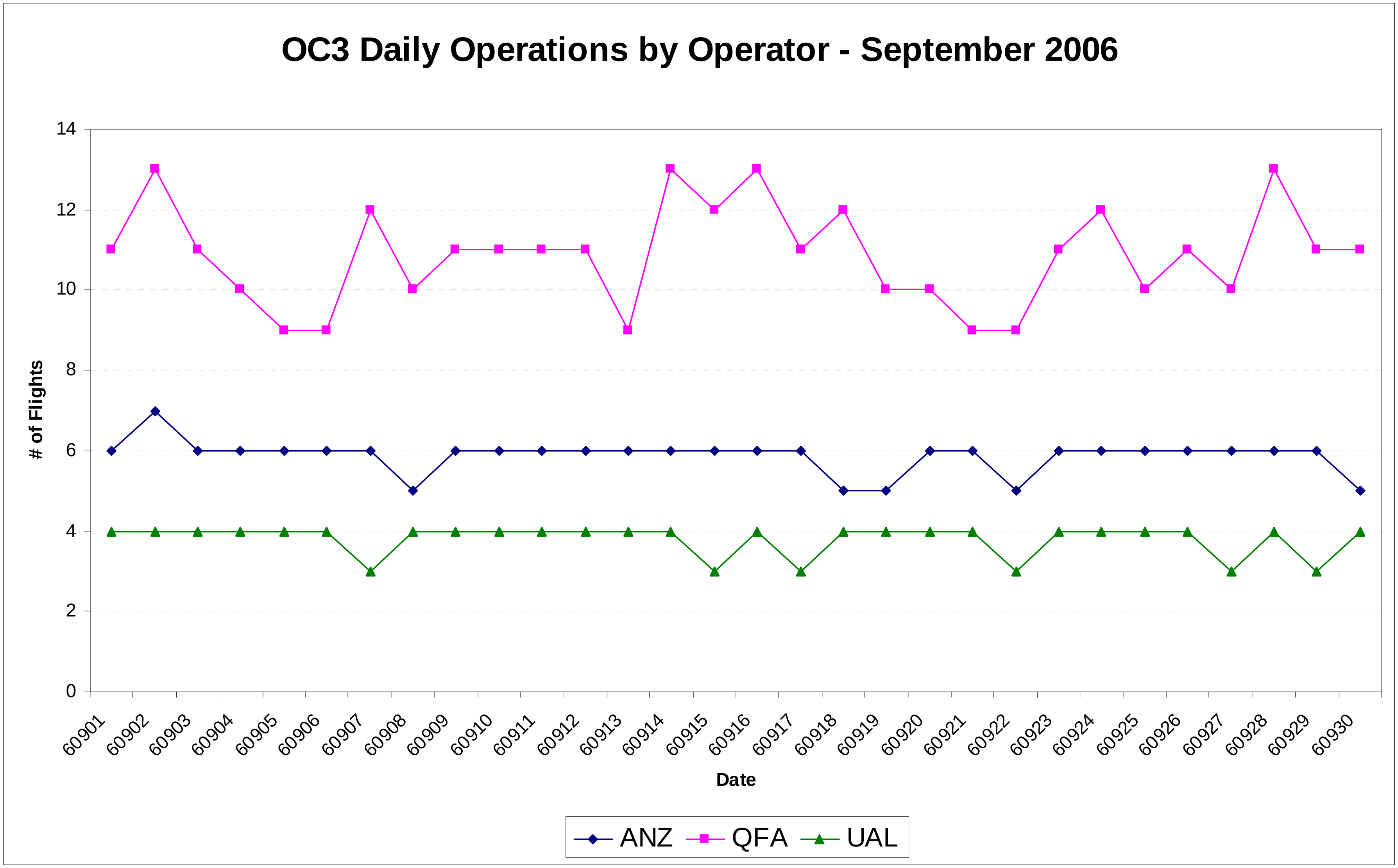
- Three operators participating in the operational-trial are ANZ, QFA, and UAL

- These operators account for approximately 23 flights per day in OC3 airspace

- The principle city pairs for these operators include:
  - Los Angeles/San Francisco (KLAX/KSFO) to/from Sydney (YSSY)/Brisbane (YBBN)/Melbourne (YMML), and
  - KLAX/KSFO to/from Auckland (NZAA)/Christchurch (NZCH)

Daily Operations by all Operators Participating in the 30-30 Trial (22 Dec 2005 - 30 Sep 2006)

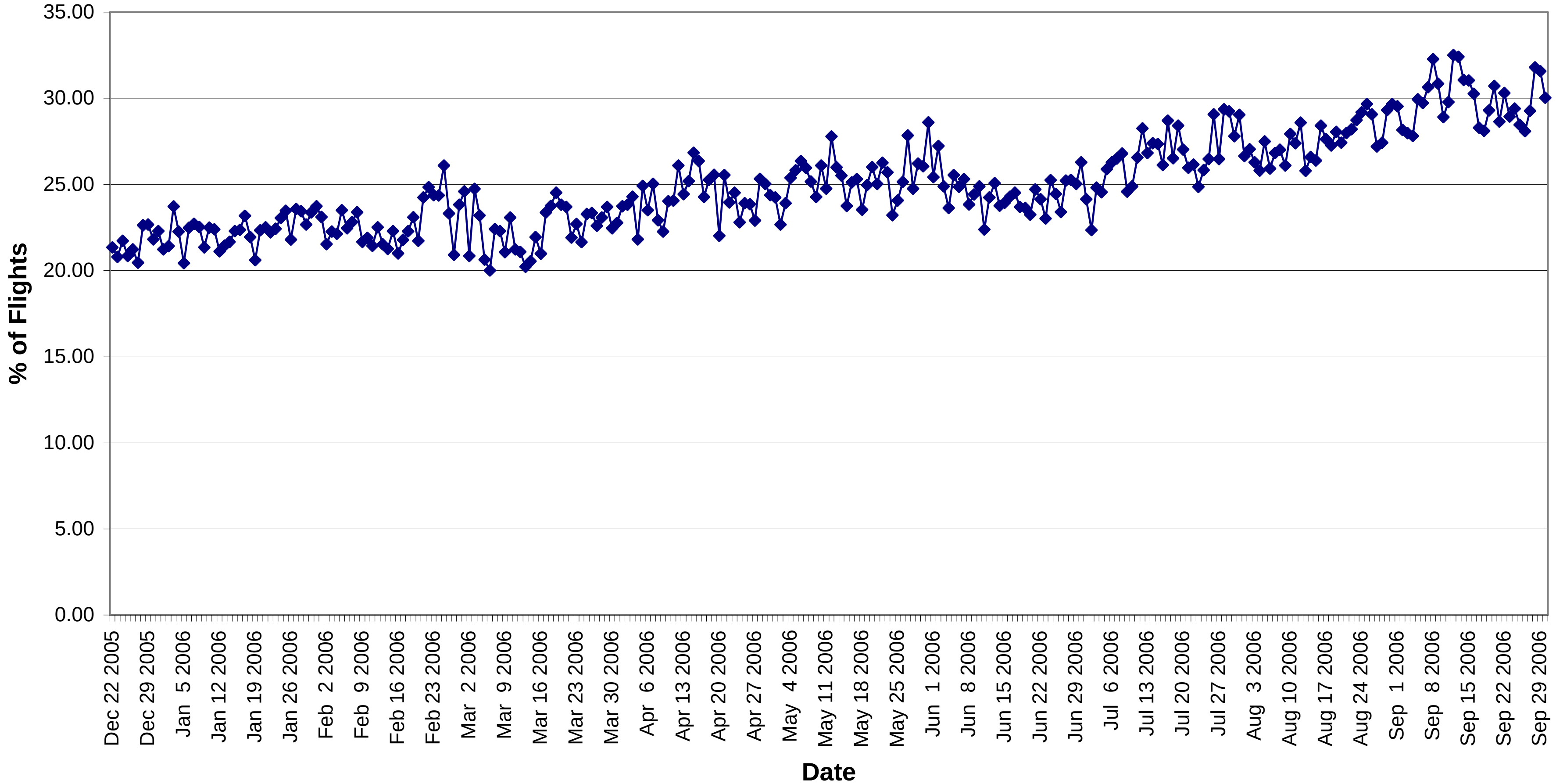



OC3 Daily Operations by Operator - September 2006
# of Flights
0
2
4
6
8
10
12
14
60901
60902
60903
60904
60905
60906
60907
60908
60909
60910
60911
60912
60913
60914
60915
60916
60917
60918
60919
60920
60921
60922
60923
60924
60925
60926
60927
60928
60929
60930
Date
ANZ
QFA
UAL

Background – Oakland Oceanic Airspace

- The average number of flights per day within all of Oakland Oceanic airspace is 669
- Of these flights approximately 24.95 percent file ADS-C capable in ICAO flight plan
  - SXWDHIJRYZ/CD (sample)
  - /D denotes ADS equipped
  - J denotes satellite data link

Percent of Flights Filing ADS in ZOA



Flights Utilizing Data Link

Month	% of Flights Filing ADS	% of Flights Filing ADS and Using ADS
February 2006	**22.701**	**86.368**
March 2006	**22.437**	**85.317**
April 2006	**24.290**	**82.538**
May 2006	**25.339**	**81.445**
June 2006	**24.520**	**80.412**
July 2006	**26.590**	**82.566**
August 2006	**27.568**	**82.088**
September 2006	**29.862**	**81.896**

Background – Oakland Oceanic Airspace

- In addition to the operators participating in the trial, three additional operators are filing flight plans indicating approval to participate in airspace where 30-NM lateral and longitudinal separation standards are applied (RNP4)

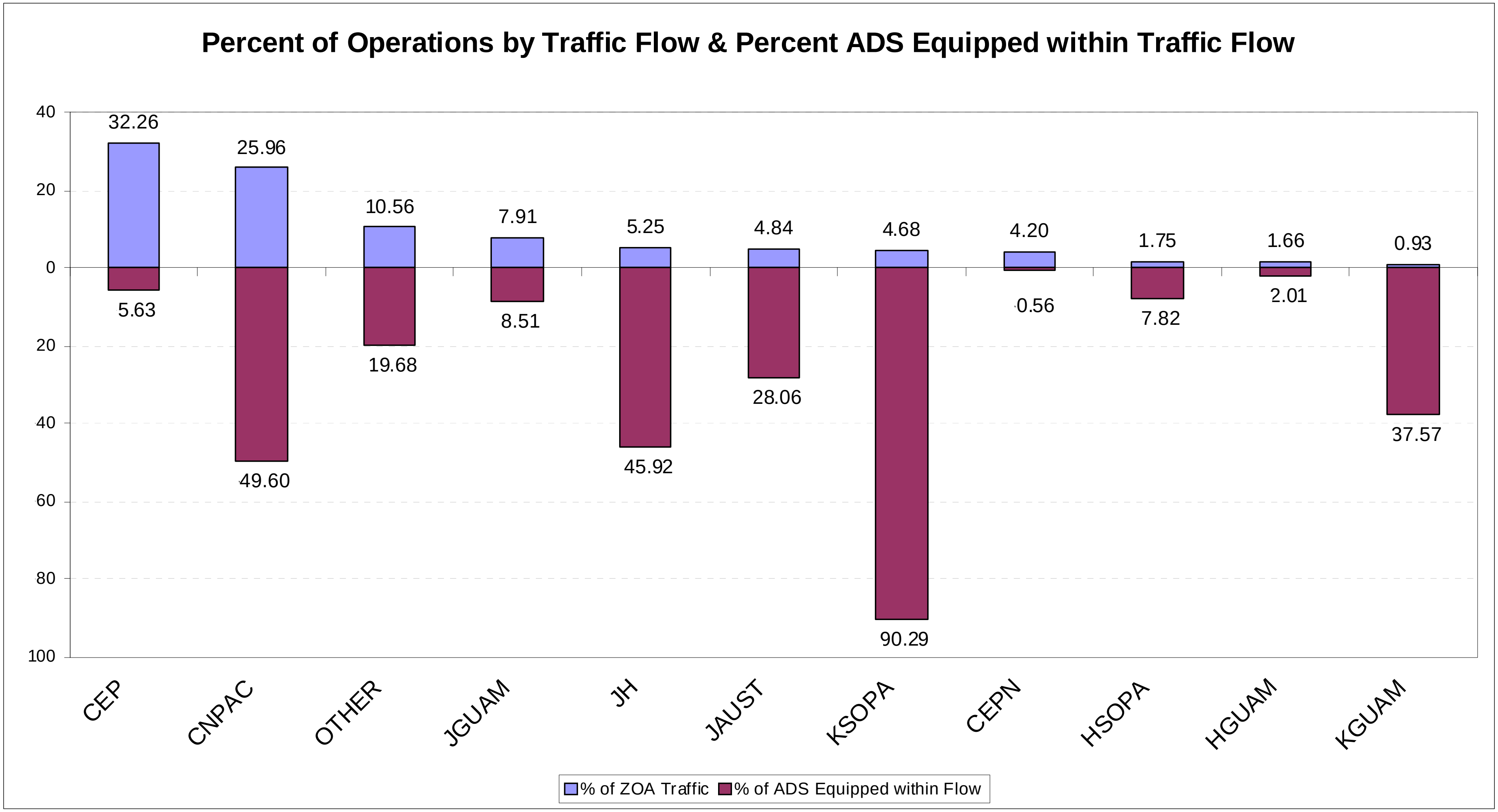
- These additional operators are: CPA, SIA, SQC - these operators do not currently conduct operations within OC3 airspace

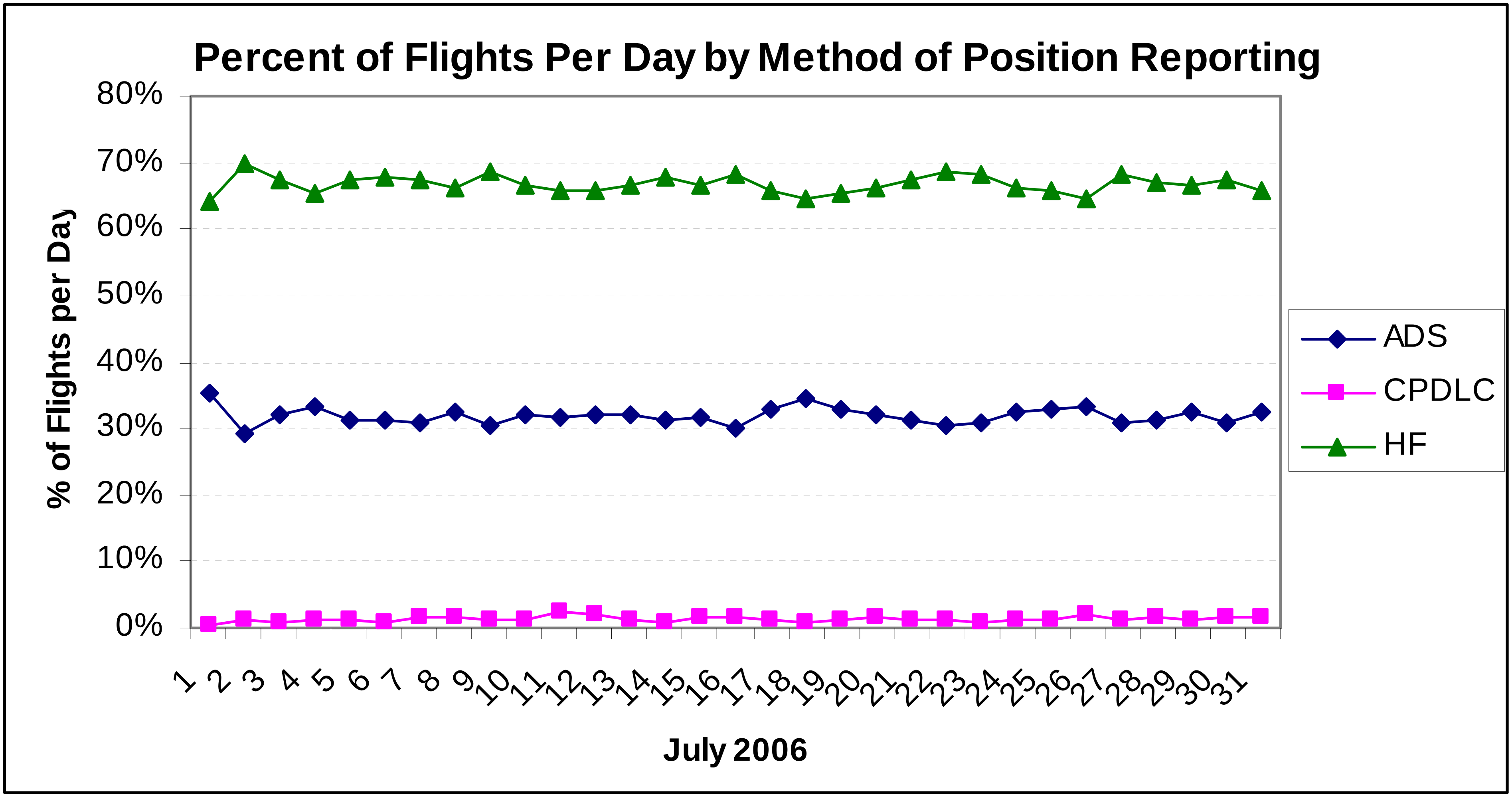
Oakland Oceanic Airspace Traffic Flows

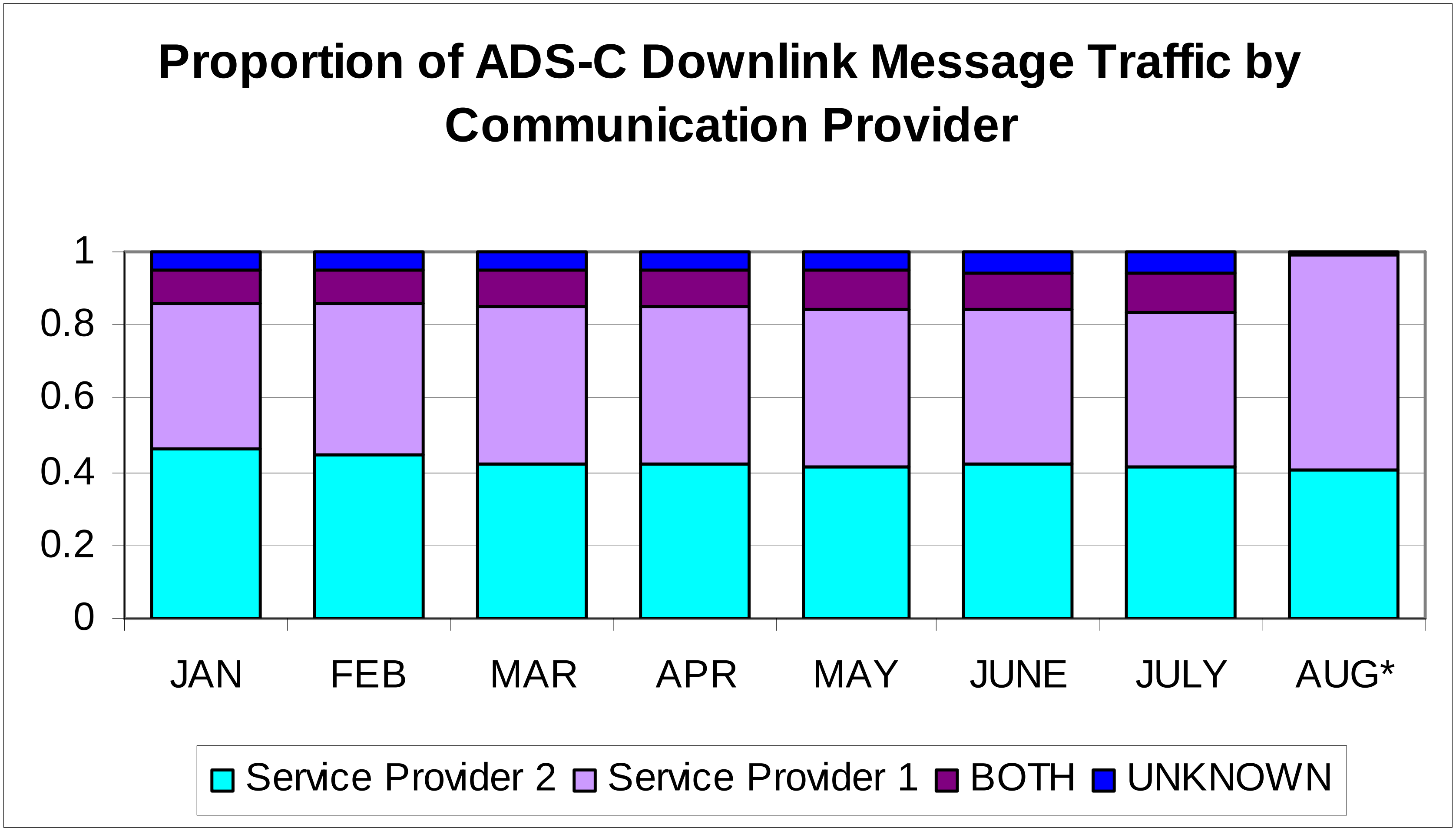
- The FAA Technical Center developed groupings of the traffic data in Oakland oceanic airspace by origin/destination pairings as a means of further categorizing the data

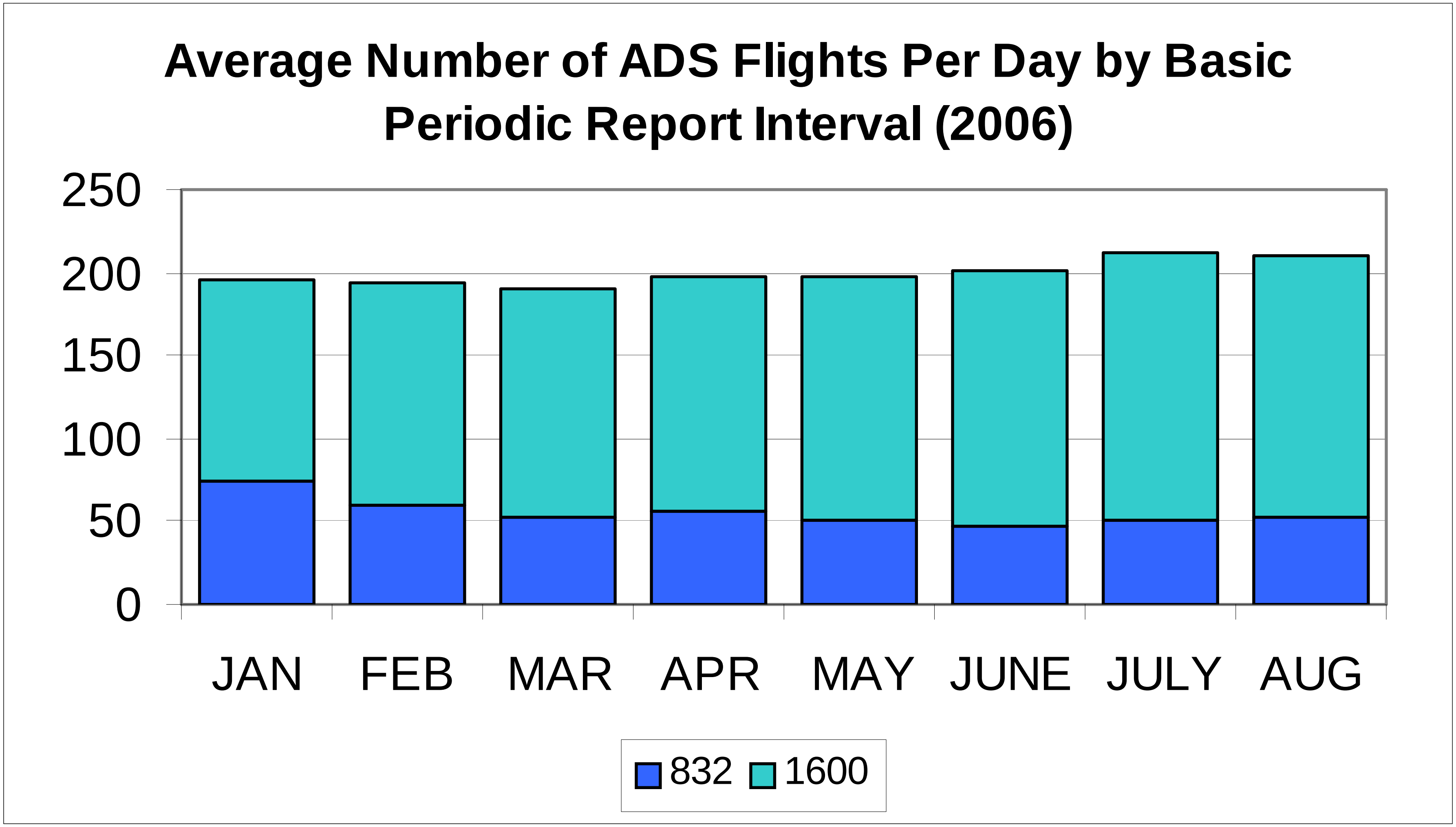
Oakland Oceanic Airspace Traffic Flows

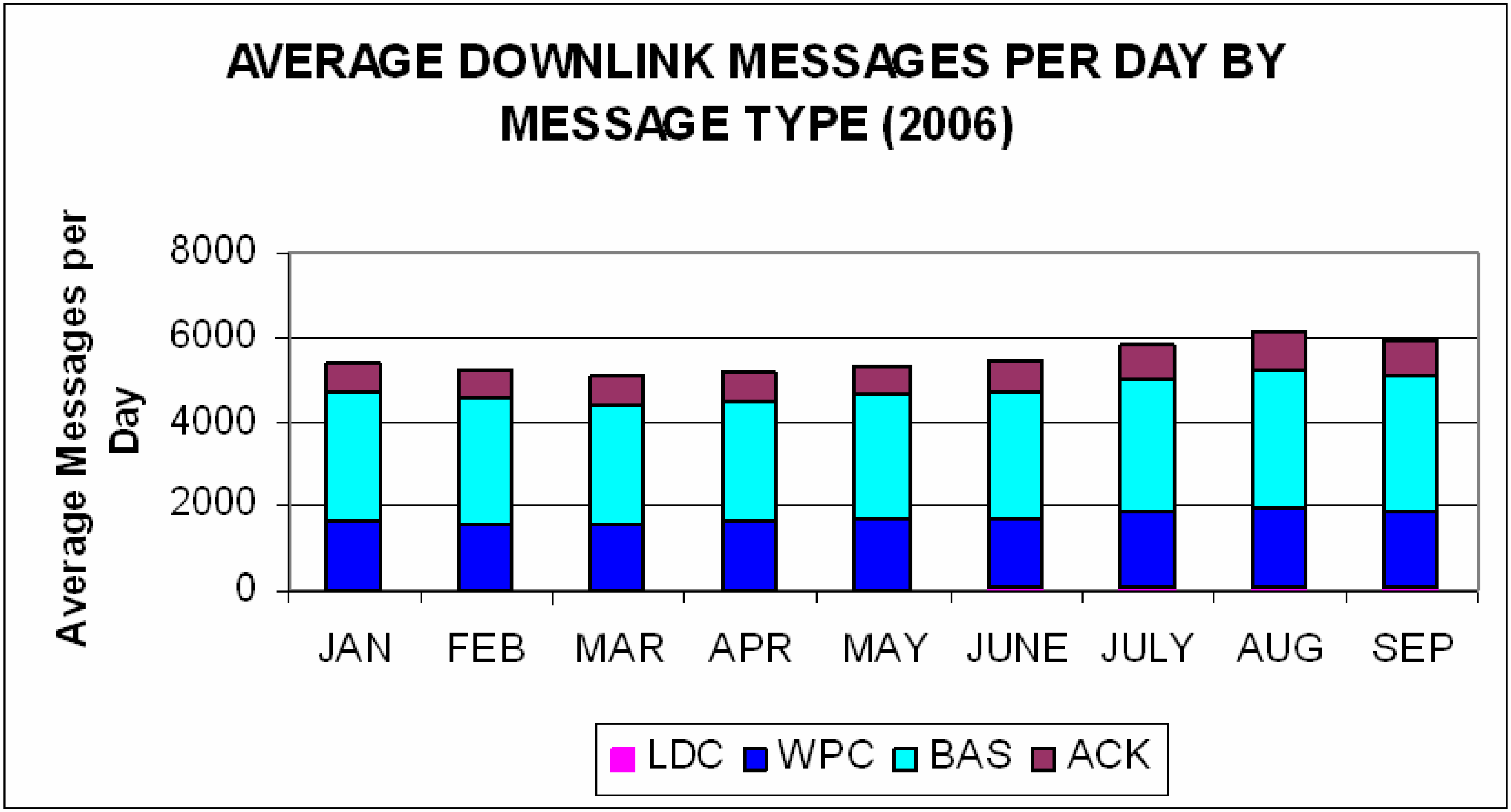
Flow Designator	Flow Name	Description of Flow
CEP	Central East Pacific	Hawaii to/from North American mainland to and from Hawaii
CEPN	Northern Central East Pacific	Hawaii to/from Northwest US/Canada/Alaska
CNPAC	Central Pacific	North American mainland to/from Japan/Korea/other Asian origins
HGUAM	Hawaii to Guam Area	Hawaii to/from Guam/Saipan/other proximate destinations
HSOPA	Hawaii to South Pacific	Hawaii to/from South Pacific
JAUST	Japan to South Pacific	Japan to/from South Pacific
JGUAM	Japan to Guam area	Japan to/from Guam/Saipan/other proximate destinations
JH	Japan to Hawaii	Japan to/from Hawaii
KGUAM	North America/Hawaii to Guam Area	North American mainland to/from Guam/Saipan/other proximate destinations
KSOPA	North America to South Pacific	North American mainland to/from South Pacific

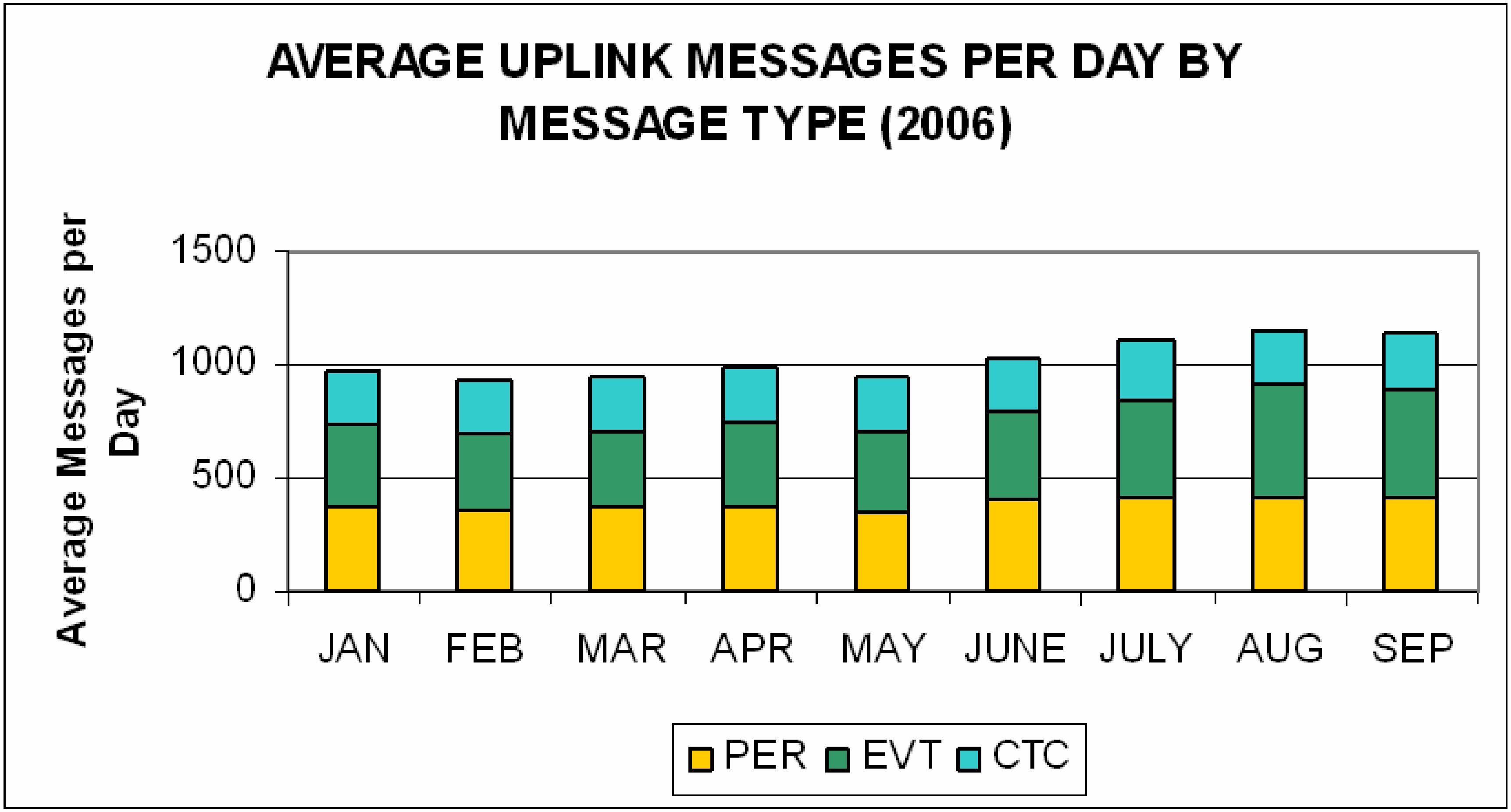

Percent of Operations by Traffic Flow & Percent ADS Equipped within Traffic Flow
40
20
0
20
40
60
80
100
32.26
25.96
10.56
7.91
5.25
4.84
4.68
4.20
1.75
1.66
0.93
5.63
49.60
19.68
8.51
45.92
28.06
90.29
0.56
7.82
2.01
37.57
CEP
CNPAC
OTHER
JGUAM
JH
JAUST
KSOPA
CEPN
HSOPA
HGUAM
KGUAM
% of ZOA Traffic
% of ADS Equipped within Flow


Percent of Flights Per Day by Method of Position Reporting
80%
70%
60%
50%
40%
30%
20%
10%
0%
% of Flights per Day
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
July 2006
ADS
CPDLC
HF

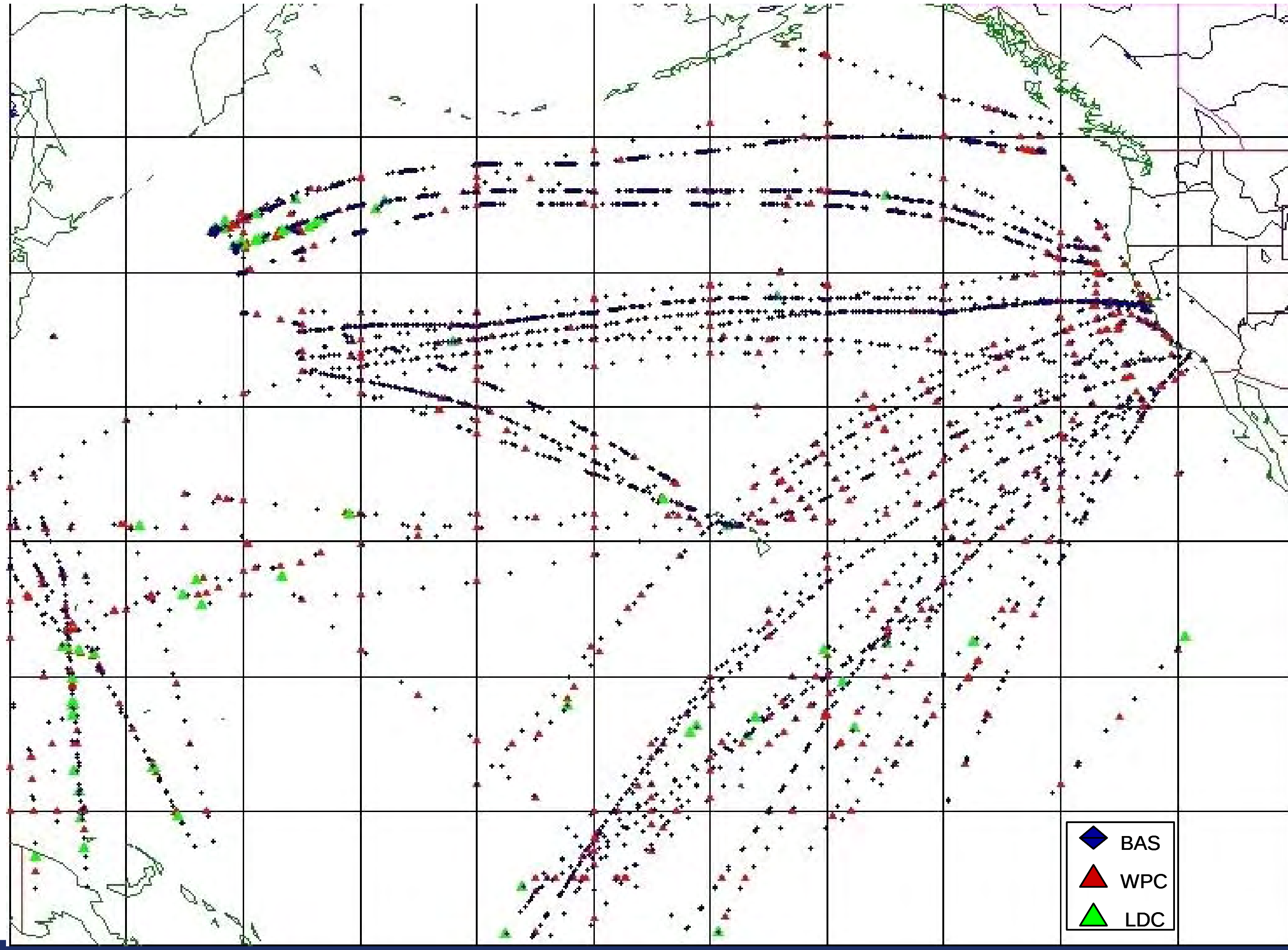

Proportion of ADS-C Downlink Message Traffic by Communication Provider
1
0.8
0.6
0.4
0.2
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG*
Service Provider 2
Service Provider 1
BOTH
UNKNOWN


Average Number of ADS Flights Per Day by Basic Periodic Report Interval (2006)
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
832
1600


AVERAGE DOWNLINK MESSAGES PER DAY BY MESSAGE TYPE (2006)
Average Messages per Day
8000
6000
4000
2000
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
LDC
WPC
BAS
ACK


AVERAGE UPLINK MESSAGES PER DAY BY MESSAGE TYPE (2006)
Average Messages per Day
1500
1000
500
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
PER
EVT
CTC

Location of ADS-C Position Reports – 15 September 2006



Federal Aviation Administration

IP/8, A Summary of the Issues of Concern and Anomalies Discovered During the Operational-Trial Use of 30-NM Lateral and Longitudinal Separation Standards in the Oakland Flight Information Region

RASMAG/6
Bangkok, Thailand
6 – 10 November 2006

Introduction

- The U.S. Federal Aviation Administration (FAA) began use of 30-nm lateral and longitudinal separation standards in a portion of the Oakland Flight Information Region (FIR) on 22 December 2005
- Introduction of these separation minima were made on an operational trial basis, accompanied by data collection, analysis and review of results
- The purpose of this information paper is to present anomalies, or unanticipated differences in certain aspects of system performance, uncovered to date in the course of the operational trial

Background

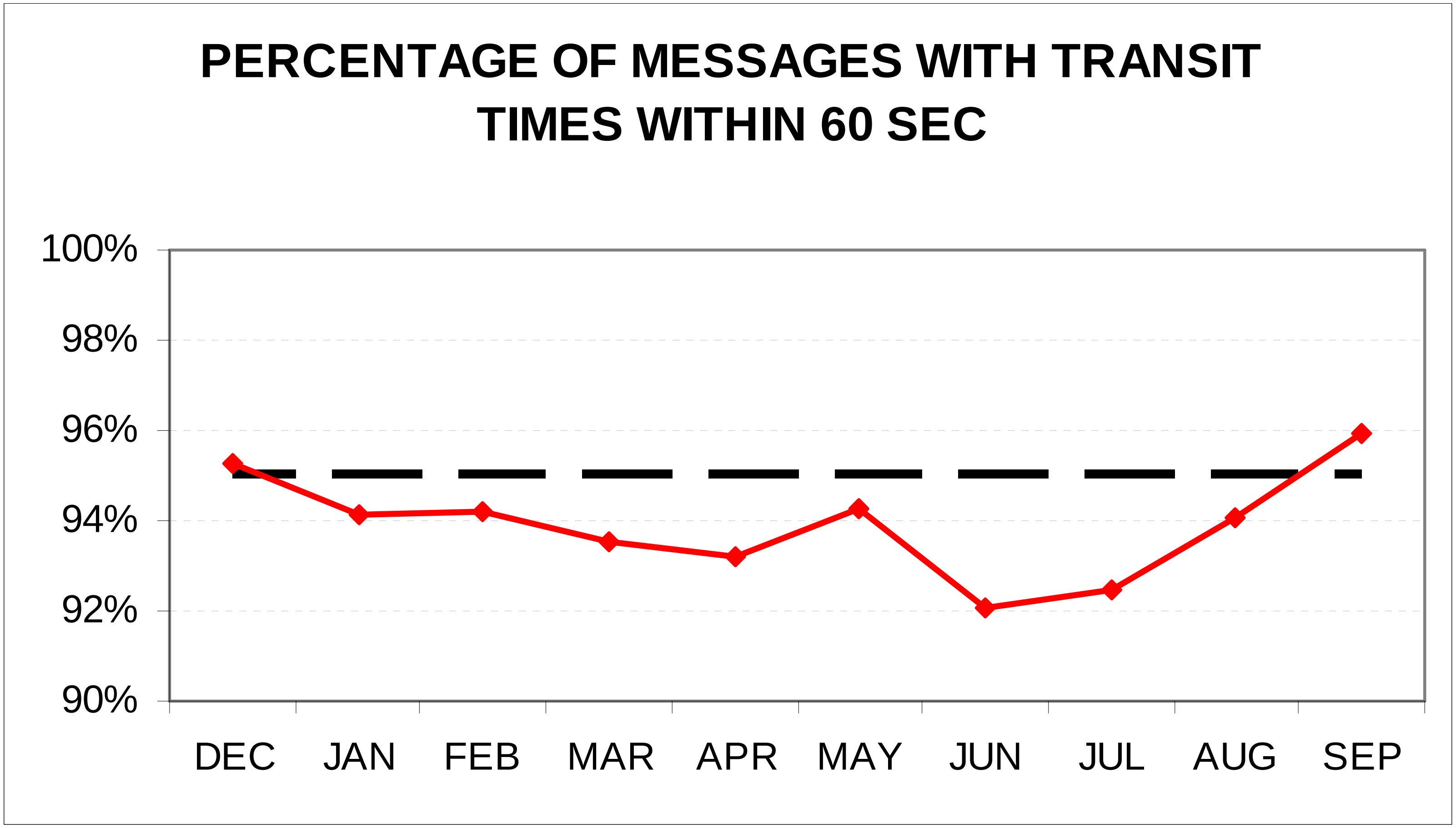
- The FAA introduced 30-nm lateral and longitudinal separation standards in Oceanic Control Sector 3 (OC3) of the Oakland FIR, following applicable ICAO requirements set out in Annex 11 and the PANS ATM, between pairs of aircraft with State Approval for RNP-4 and appropriate data link operations

- As a practical matter, the operational-trial use of the 30-nm lateral and longitudinal separation minima is limited to aircraft equipped with the FANS package and approved for RNP-4 operation.

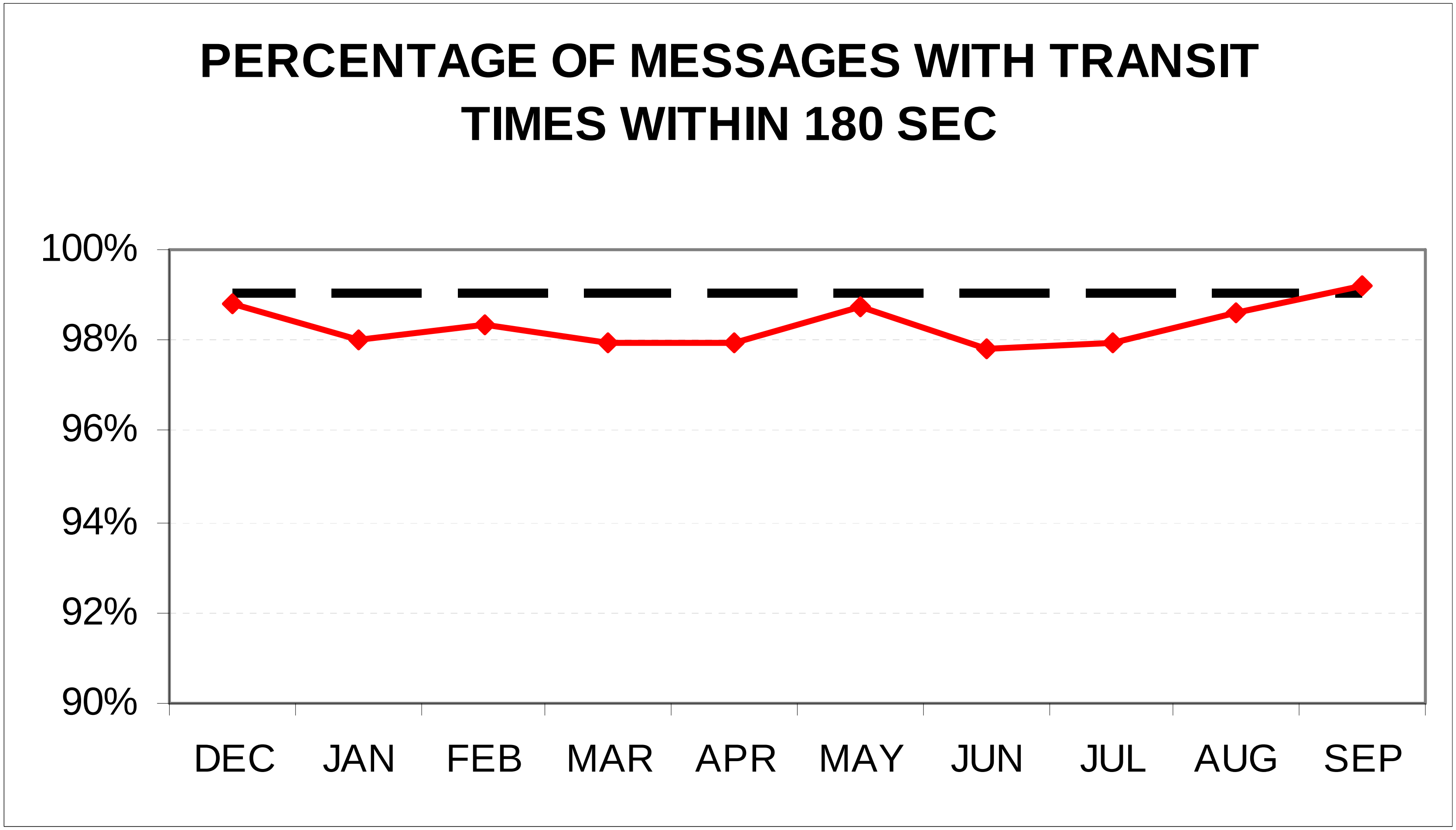
Background

- The FAA has formed a Scrutiny Group (SG) in order to review the results of system performance during the operational trial
- At each of its 4 meetings, the SG has agreed to a list action items requiring further investigation
- Typically, one of these action items arises from SG agreement that some aspect of observed system performance presented by the Technical Center does not appear to conform to expectations based on equipment requirements or approved procedures

Observed Downlink Transit Times for ADS-C Messages in Relation to FOM Targets



Observed Downlink Transit Times for ADS-C Messages in Relation to FOM Targets

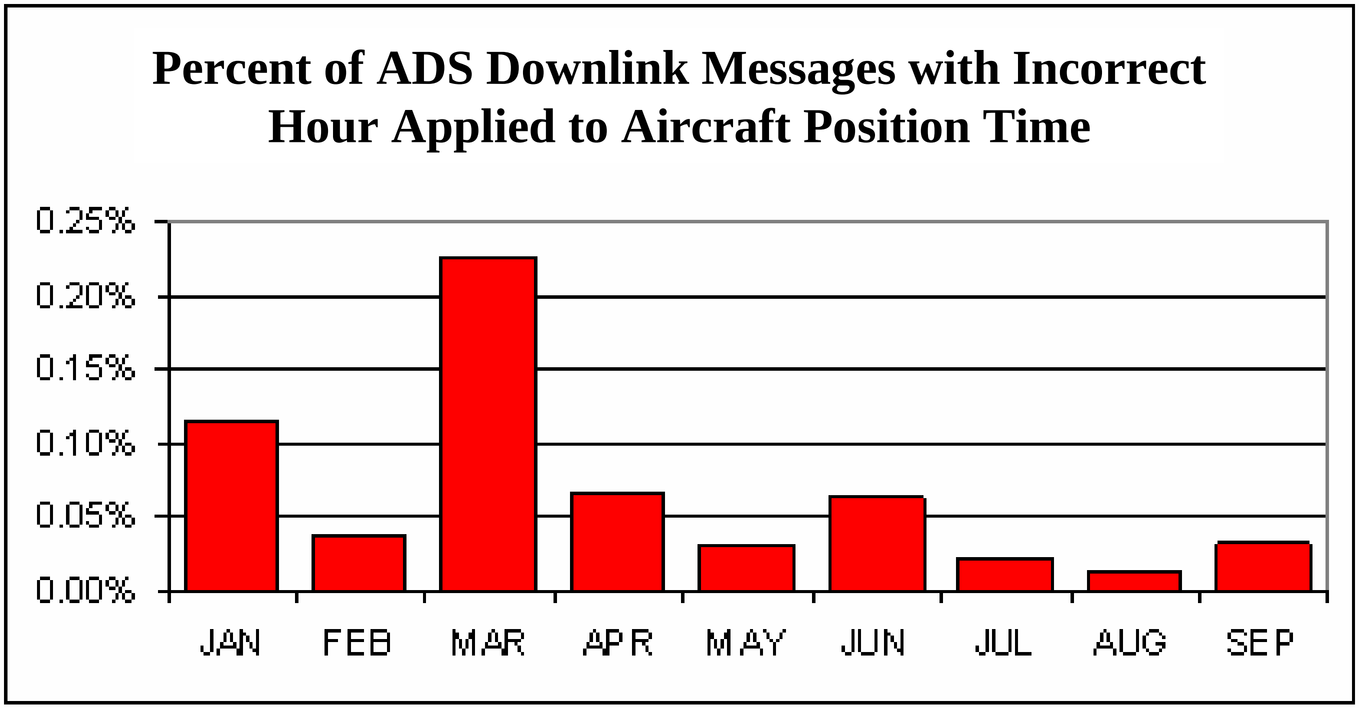


Observed Downlink Transit Times for ADS-C Messages & Related Anomalies

- The ADS output message parameters presented in table 4.5-4 of RTCA DO-258, indicate the range for the time stamp parameter is 0 – 3,599.875 sec
- Due to this range, the largest unit for the aircraft position time and times contained in the predicted route group is minutes; the hour in the time data is not sent from the aircraft
- Ocean21 specialists indicated that Ocean21 applies the hour to the submitted position time and the predicted route group times during the decoding process

Observed Downlink Transit Times for ADS-C Messages & Related Anomalies

- When significant downlink delays are realized, the data show the incorrect hour applied to the position time and the predicted route group times
- A program trouble report (PTR) has been opened by Oakland center for purposes of remedying this problem



Missing Basic Periodic Reports

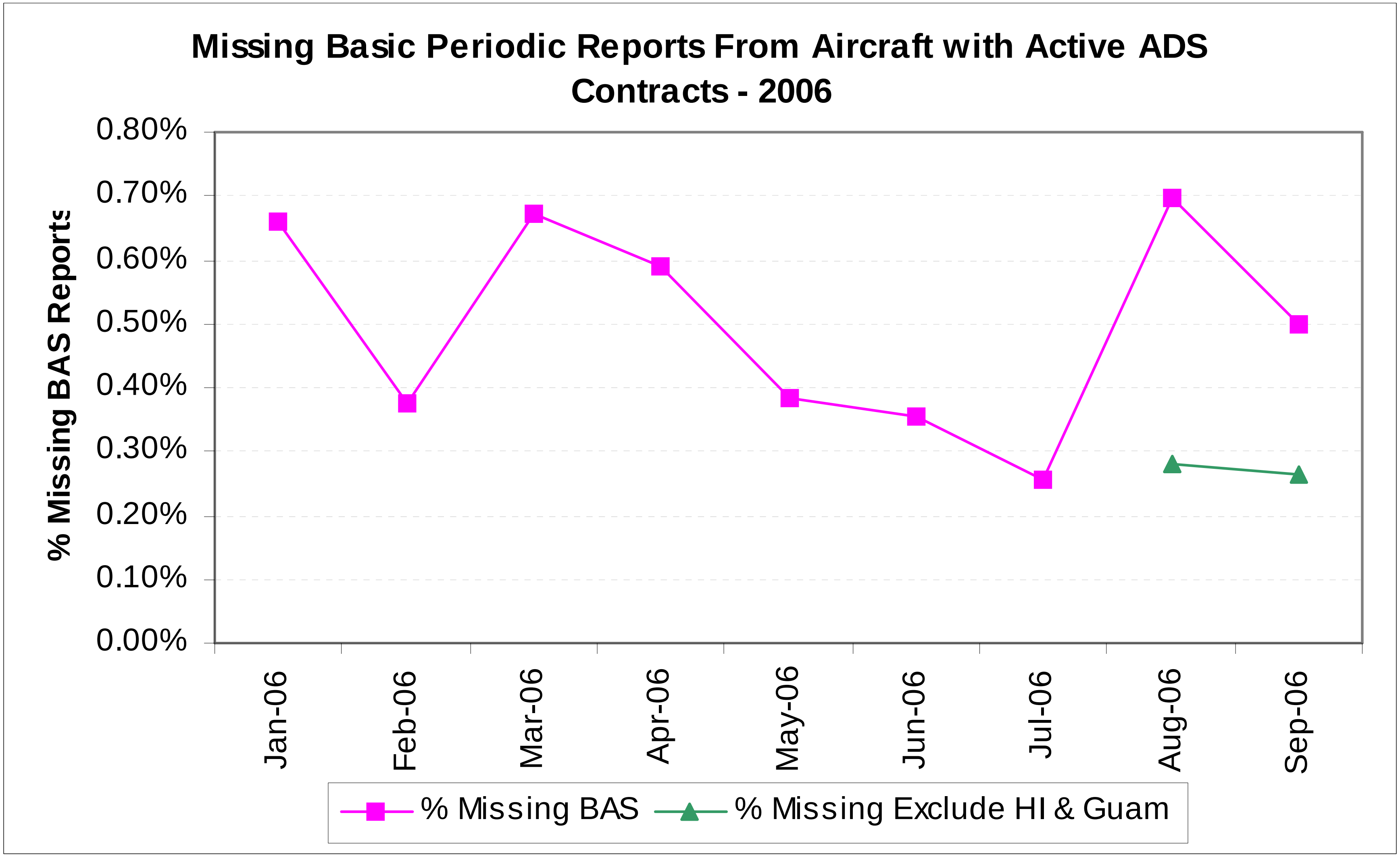
- Analysis includes examination to ensure that the requirements for the implementation and continued safe use of 30-nm longitudinal separation standard contained in the PANS ATM are met
- One such requirement states that when an ADS periodic or waypoint change report is overdue by 3 minutes, a replacement report should be obtained as soon as possible; if overdue by 6 minutes, any potential conflict should be resolved as soon as possible

Missing Basic Periodic Reports

- Each instance of a missing basic periodic report is identified and investigated
- The investigation analyzes the data to determine whether a periodic request report (with interval equal to 0 seconds) was sent approximately 3 minutes after the position report was overdue, this action is termed an ‘interrogation’ during the analyses
- The result of this investigation places each instance into one of three categories:
  - Evidence of 3 minute interrogation and reply observed in data
  - Evidence of 3 minute interrogation but no reply observed in data
  - No evidence of 3 minute interrogation in data

Missing Basic Periodic Reports

- An additional investigation determines if there is evidence that the ADS contract had been cancelled or reset prior to or after the expected time of the missing basic periodic report
- The following presents a summary of missing basic periodic messages including only those messages from aircraft whose ADS contract appeared ‘active’ at the time of the overdue report


Missing Basic Periodic Reports From Aircraft with Active ADS Contracts - 2006
% Missing BAS Reports
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
% Missing BAS
% Missing Exclude HI & Guam

Missing Basic Periodic Reports

- The average percent of missing basic periodic reports from aircraft whose ADS contracts appear ‘active’ is 0.49 which is equivalent to approximately 449 messages a month or 14 messages a day

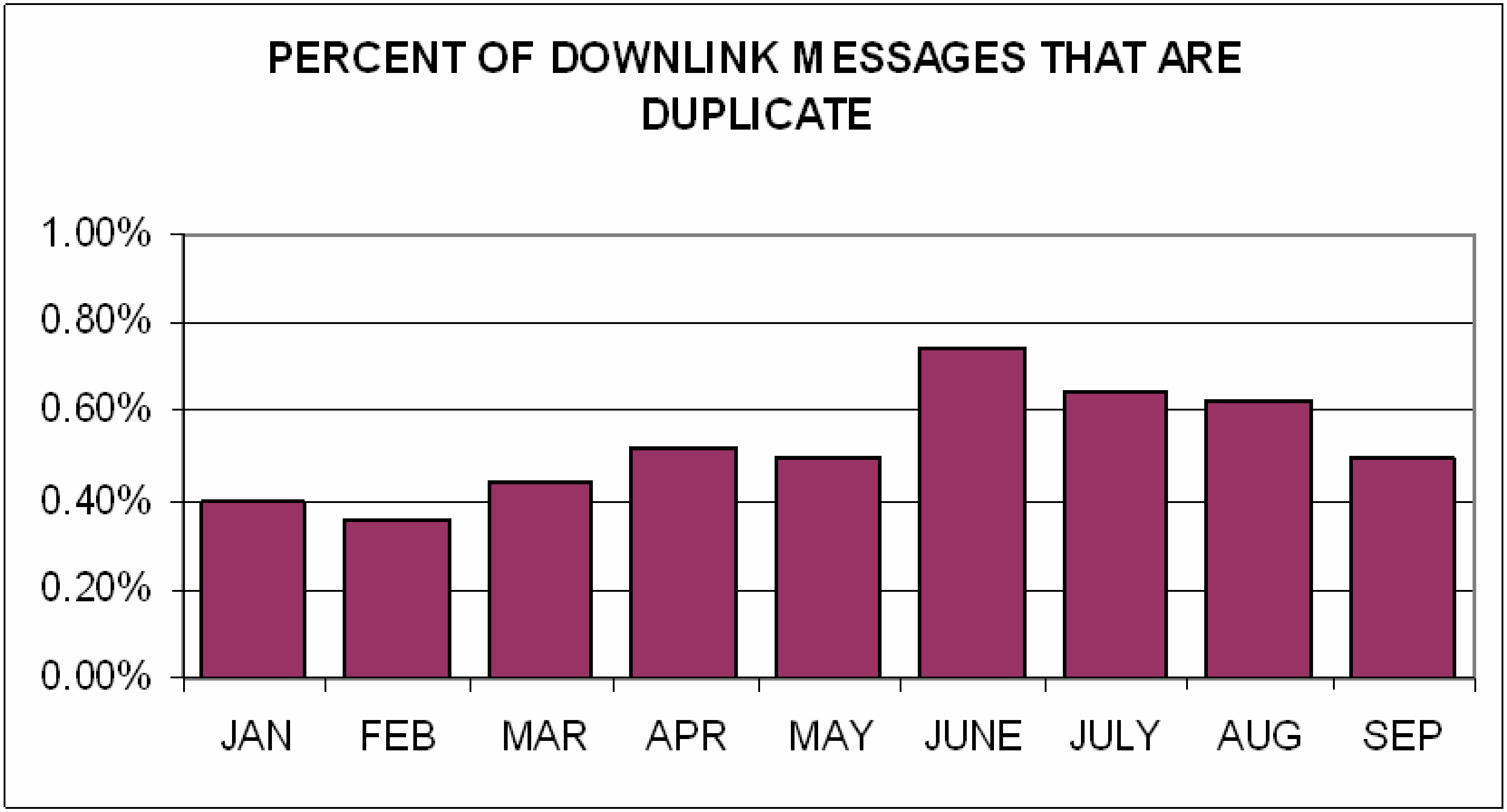
- Basic periodic reports expected when the aircraft may have been operating within Hawaii and/or Guam airspace were removed from the analysis
  - Removing these missing basic periodic reports yields an average percent of missing reports of 0.27, which is equivalent to 270 messages per month or 9 messages a day

- The SG requested that these data continue to be monitored

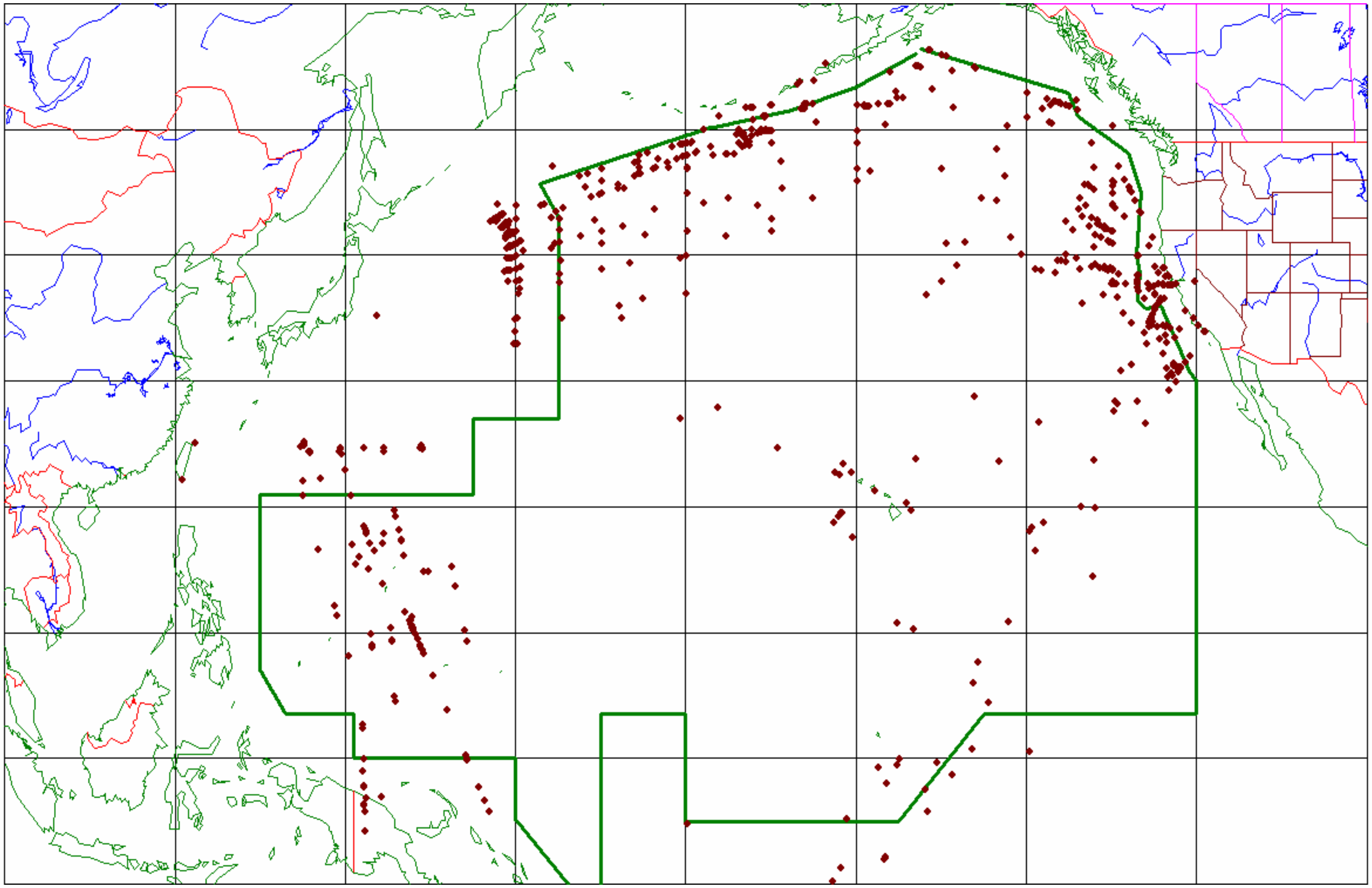
Duplicate ADS Position Reports

- The ADS downlink message types containing position reports include, among others, the basic periodic report, waypoint change report, and the lateral deviation change report
- Analysis uncovered the presence of duplicate ADS downlink messages
- ‘Duplicate’ indicates that the same downlink message was received at least twice from the same aircraft at two separate times

Duplicate ADS Position Reports



Locations of Duplicate ADS Messages – September 2006



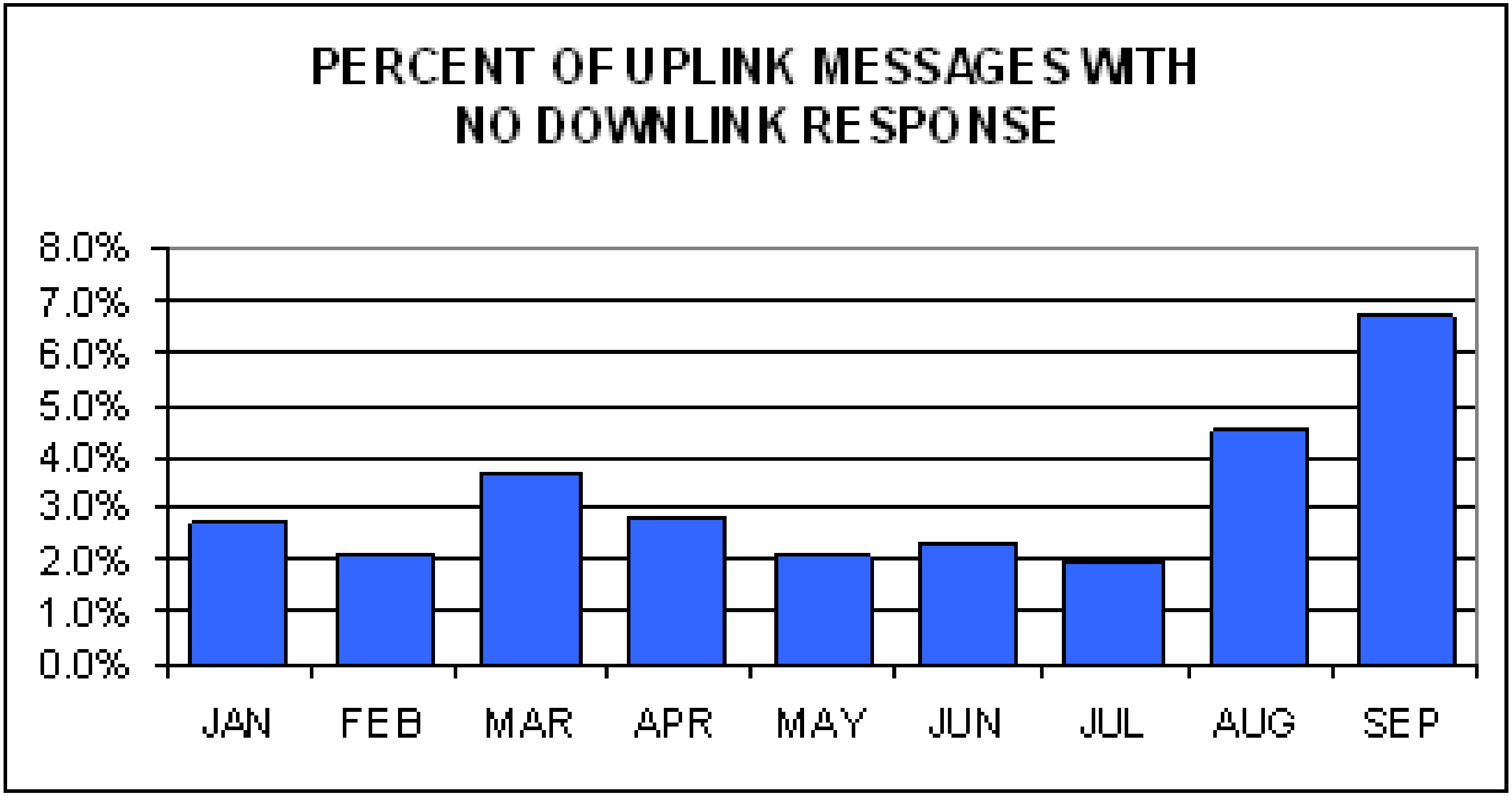
Duplicate ADS Position Reports

- The average percentage of duplicate ADS downlink messages is 0.53, which is equivalent to approximately 765 duplicate ADS messages per month or 25 duplicate ADS messages per day
- The registration marks from the duplicate ADS downlink messages were analyzed and matched to an aircraft type using various sources
- Analysis of these duplicate messages indicates that certain operator/aircraft type combinations predominate
- The results have been referred to the aircraft manufacturer for further examination

ADS Uplink Messages With No Response

- The periodic contract request and event contract request uplink messages are expected to have a corresponding response message
- The ADS uplink messages which do not have a corresponding response (acknowledgement or negative acknowledge message) are summarized to determine the average performance

ADS Uplink Messages With No Response



ADS Uplink Messages With No Response

- The average proportion of ADS uplink messages for which a response was not observed in the data is 2.8 percent or approximately 860 messages per month (29 messages per day)
- Members of the scrutiny group indicated that a ‘no response’ from an aircraft during times of unexpected communication outages or large communication delays may cause the controller to initiate additional uplink report requests
- These additional uplink report requests would potentially inflate the observed number of uplinks with no response
- The SG requested that these data continue to be monitored

RASMAG — TASK LIST

(last updated 10 November, 2006)

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
1/7	Monitor outcome of FLOS discussions at next RVSM TF meeting and report back to RASMAG.	RASMAG/7	Secretariat	Open	~~RASMAG/4 WP/7 refers, RVSMTF/28 scheduled April 2006~~ ~~RASMAG/5 WP/8 refers RVSM/TF/28 held April 2006, unable to reach consensus on alternate FLOS arrangement. Separate body (task force) to be convened by affected States to address this issue.~~ Establishment of the WPAC/SCS RVSM Scrutiny Working Group was endorsed by APANPIRG/17. The first meeting will be held in Jan 2007.
~~1/10~~	~~In accordance with RASMAG TOR, review regional and global airspace and ATM implementation plans to identify requirements for airspace safety monitoring and assessment activities.~~	~~Report Progress to RASMAG/6~~	~~Secretariat, All members~~	~~Open~~ ~~Closed~~	~~Ongoing~~ ~~TOR are adequate to guide the work of RASMAG~~
2/3	Prepare and deliver safety workshop for States.	Report Progress to RASMAG/7	Secretariat All members	Open	~~RASMAG/4 reviewed Seminar held during RASMAG/3 and considered compiling a suitable ATS safety management training aid as the basis for further regional safety management training on video and/or DVD. Feedback requested to Regional Office by 15 December 2005.~~ ~~RASMAG/4 considered outcomes of ATS SMS SIP conducted August 2005 and recommended referral to DGCA/43.~~ ~~RASMAG/5 informed that approval gained for ATS SMS SIP to run in second half of~~

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
					~~2006. In addition 2 X ICAO HQ SMS workshops to be conducted at Regional Office in 2006 and coordination continuing with Hong Kong, China for a SMS workshop in first quarter 2007.~~ Two HQ SMS courses and one ATS SMS SIP were conducted at Regional Office in Sep 2006, coordination continuing with Hong Kong, China for a SMS workshop in first half 2007.
2/4	Develop SMA Handbook.	Report Progress to RASMAG/7	Chairman (R. Butcher), All members Secretariat	Open	~~RASMAG/4 WP/5 refers. Feedback requested to L. McCormick by 15 December 2005.~~ ~~Work progressing on final draft document.~~ Work progressed on the draft document by RASMAG/6, all members to review and provide input to Mr Butcher by end of Jan 2007.
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/7	RASMAG members Secretariat	Open	Referred to RMAs for discussion/action. Additional guidance material included in Amendment 44 to Annex 11, effective November 2006.
3/2	Consider funding issues in respect of the provision of multi national infrastructures e.g. safety monitoring services.	Report Progress to RASMAG/7	RASMAG members Secretariat, including Air Transport Officer	Open	~~**APANPIRG C16/2 Funding arrangements for regional airspace safety monitoring**~~ ~~That, a study group be convened to develop a feasible and sustainable proposal to equip States to organize and finance necessary safety monitoring mechanisms for the provision of safety services for the international airspaces in the Asia/Pacific~~

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
					region and that States be represented at that meeting by their appropriate legal, financial and organizational experts who would be best equipped and empowered to resolve any difficulties. The study group should report to RASMAG not later than the end of June 2006. Initial Study Group meeting combined with RASMAG/5. RASMAG/5 developed and circulated draft Working Paper for APANPIRG/17 proposing a way forward in accordance with global guidance. APANPIRG Decision 17/47 establishes Regional Airspace Safety Monitoring Committees Task Force, first meeting Feb 2007. Also Secretariat to prepare a Discussion Paper for presentation at 43rd DGCA Conference, Dec 2006.
5/1	Review outcomes of DGCA/06 in respect to implementation of Safety Management Systems and identify any matters within the scope of RASMAG to address.	Report to RASMAG/6	All	Open Closed	RASMAG/5 reviewed the outcomes of DGCA/06 and significant issues from DGCA/06 are being progressed via ALLPIRG/5 Conclusions. RASMAG/6 reviewed ALLPIRG/5 Conclusions accordingly..
5/2	Develop a paper that proposes consideration of the matters discussed and agreed by the tripartite meeting of Asia Pacific RMAs and recorded in the RASMAG/4 meeting report. Also include material from the RASMAG/6 Extraordinary meeting of RMAs	Report to Global RMA meeting proposed by ALLPIRG/5 Conclusion 5/12 Report to SASP Nov 2006 Meeting	Asia Pacific RMAs	Open	

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
5/4	Develop guidance on ADS/CPDLC ground system minimum equipment requirements and deployment considerations. Review draft Data Link Guidance Material and provide feedback to primary authors in Japan and New Zealand	Feedback by end July 2006 direct to Japan and New Zealand Report progress to RASMAG/6	New Zealand (T. Farmer), Japan (Y Nakatsuji, H Matsuda) All members, Secretariat	Open	Draft Guidance Material now mature, to be circulated to ISPACG, IPACG, FIT-SEA, FIT-BOB and ASIOACG during 2007 for comment..
~~5/3~~	~~Australia to assist with Human Factors input to the data link draft guidance material~~	~~Feedback by end July 2006 direct to Japan and New Zealand~~	~~Australia~~	~~Open Closed~~	~~Incorporated into Guidance Material~~
~~5/4~~	~~Regional Office to coordinate with the Cairo Office of ICAO to establish whether Pakistan should be covered by the MAAR or the MID RMA~~	~~Report to RASMAG/6~~	~~Regional Office~~	~~Open Closed~~	~~Coordination with Cairo Office shows Pakistan is the responsibility of MAAR. Regional Office will action directly with MAAR and Pakistan~~
5/5	Regional Office to coordinate with the RNP-SEA/TF to ensure inclusion of safety assessment requirements in the Task Force TOR	Report to RASMAG/7	Regional Office	Open	Next RNP-SEA/TF meeting scheduled March 2007
~~5/6~~	~~States review availability of dedicated ATS SMS Official to assist with the conduct of the Regional Office SMS SIP in last quarter of 2006~~	~~Respond to Regional Office by 31 July 2006~~	~~States~~	~~Open Closed~~	~~SIP was conducted September 2006, no State official made available.~~
~~5/7~~	~~Consider the validity of the Scrutiny Group mechanism adopted by the United States 30/30 Scrutiny Group for application in the WPAC/SCS Area~~	~~Review during RASMAG/6~~	~~RASMAG/6~~	~~Open Closed~~	~~APANPIRG Decision 17/5 established RVSM Scrutiny Group for WPAC/SCS area, first meeting of WPAC/SCS RSG Jan 2007.~~
6/1	Create common template for all Asia Pacific RMA reporting based on current MAAR template	Report to RASMAG/7	Asia Pacific RMAs	Open	

ACTION ITEM	DESCRIPTION	TIME FRAME	RESPONSIBLE PARTY	STATUS	REMARKS
6/2	Implement single annual consolidated Asia Pacific RMAs report based on 31 March data for consideration by May/June RASMAG prior to August/September APANPIRG	Report to RASMAG/7	Asia Pacific RMAs	Open	
6/3	Chairman to coordinate with Airservices Australia to provide briefing in relation to previous methodology for SCS horizontal assessment to MAAR representatives at November SASP meeting in Australia.	Report to RASMAG/7	Chairman, MAAR	Open	

……………………………

International Civil Aviation Organization | Organisation de l'aviation civile internationale | Organización de Aviación Civil Internacional | Международная организация гражданской авиации | منظمة الطيران المدني الدولي | 国际民用航空组织

Ref.: T3/4.4 – AP099/06 (ATM)

10 October 2006

Subject: Wake turbulence aspects of Airbus A380-800 aircraft

Action Required: Note the guidance in the Attachment

Sir/Madam,

1. I wish to refer to guidance issued in November 2005 by this office Ref: T3/4.4 – AP111/05 (ATM) on the subject of Airbus A380 wake vortex aspects. You will recall that an ad hoc group of experts under the auspices of the United States Federal Aviation Administration, the European Organisation for the Safety of Air Navigation (Eurocontrol), the Joint Aviation Authorities and the manufacturer were studying the wake vortex aspects of this new aircraft. As their work was still in progress, and data collection, processing and analysis were still ongoing, the recommendations made at that time were necessarily conservative.

2. The ad hoc group has now recommended more specific guidance, based on the completed flight test programme. Accordingly, revised guidance related to wake turbulence aspects of the Airbus A380-800 aircraft is attached. I strongly encourage you to implement this revised guidance as soon as possible. All guidance previously issued on the subject of Airbus A380 wake vortex aspects is hereby superseded.

3. It is anticipated that the group will undertake additional studies with a view to further refinement of this guidance on the basis of operational experience. A review of the current wake turbulence categorization scheme by the ad hoc group is also foreseen. A proposal for amendment of the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) will follow in due course and, in accordance with the established procedure, States and international organizations will be consulted.

Accept, Sir/Madam, the assurances of my highest consideration.

L.B. Shah
Regional Director

Attachment:
Guidance on A380-800 Wake Vortex Aspects

Asia and Pacific Office
252/1 Vibhavadi Rangsit Road
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Thailand

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Tel.: +66 (2) 537-8189
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E-mail: icao_apac@bangkok.icao.int
AFTN: VTBBICOX

ATTACHMENT to T3/4.4 – AP099/06 (ATM)

GUIDANCE ON A380-800 WAKE VORTEX ASPECTS

1. INTRODUCTION

This guidance is based on the current outcome of work by an ad hoc group of experts under the auspices of the United States Federal Aviation Administration, the European Organisation for the Safety of Air Navigation (Eurocontrol), the Joint Aviation Authorities and the manufacturer. Work is continuing, and it is anticipated that the group will undertake additional studies with a view to further refinement of this guidance on the basis of operational experience. A review by the ad hoc group of the current wake turbulence categorization scheme is also foreseen.

The Airbus A380-800, with a maximum take-off mass in the order of 560 000 kg, will be the largest passenger aircraft ever to enter into revenue service. The aircraft is in the HEAVY wake turbulence category and the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444) apply. However, as vortices generated by the A380-800 are more substantial than for other aircraft in the HEAVY wake turbulence category, this guidance recommends an increase in relation to the wake turbulence separation minima published in the PANS-ATM. This is intended to ensure that aircraft operating near an A380-800 do not encounter wake vortices of a greater magnitude than are generated by other aircraft in the HEAVY wake turbulence category. States are strongly encouraged to implement this guidance pending an amendment to the PANS-ATM.

Note. — For ease of reference, related PANS-ATM provisions are indicated below.

2. INDICATION OF AIRCRAFT TYPE
(PANS-ATM 4.9.2 and Appendix 2)

2.1 For A380-800 aircraft the letter "J" should be entered into the space allocated to wake turbulence under Item 9 of the ICAO flight plan.

2.2 For A380-800 aircraft the expression "SUPER" should be included immediately after the aircraft call sign in the initial radiotelephony contact between such aircraft and ATS units.

3. NON-RADAR WAKE TURBULENCE LONGITUDINAL SEPARATION MINIMA
(PANS-ATM 5.8.2, 5.8.3, 5.8.4 and 5.8.5)

3.1 Arriving aircraft

The following non-radar separation minima should be applied to aircraft landing behind an A380-800 aircraft:

a) MEDIUM aircraft behind an A380-800 aircraft — 3 minutes;

b) LIGHT aircraft behind an A380-800 aircraft — 4 minutes.

3.2 Departing aircraft

3.2.1 A minimum separation of 3 minutes should be applied for a LIGHT or MEDIUM aircraft and 2 minutes for a non-A380-800 HEAVY aircraft taking off behind an A380-800 aircraft when the aircraft are using:

a) the same runway;

b) parallel runways separated by less than 760 m (2 500 ft);

c) crossing runways if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 300 m (1 000 ft) below;

d) parallel runways separated by 760 m (2 500 ft) or more, if the projected flight path of the second aircraft will cross the projected flight path of the first aircraft at the same altitude or less than 300 m (1 000 ft) below.

3.2.2 A separation minimum of 4 minutes should be applied for a LIGHT or MEDIUM aircraft when taking off behind an A380-800 aircraft from:

a) an intermediate part of the same runway; or

b) an intermediate part of a parallel runway separated by less than 760 m (2 500 ft).

3.3 Displaced landing threshold

A separation minimum of 3 minutes should be applied between a LIGHT or MEDIUM aircraft and an A380-800 aircraft when operating on a runway with a displaced landing threshold when:

a) a departing LIGHT or MEDIUM aircraft follows an A380-800 aircraft arrival; or

b) an arriving LIGHT or MEDIUM aircraft follows an A380-800 aircraft departure if the projected flight paths are expected to cross.

3.4 Opposite direction

A separation minimum of 3 minutes should be applied between a LIGHT or MEDIUM aircraft and an A380-800 aircraft when the A380-800 aircraft is making a low or missed approach and the LIGHT or MEDIUM aircraft is:

a) utilizing an opposite-direction runway for take-off; or

b) landing on the same runway in the opposite direction, or on a parallel opposite-direction runway separated by less than 760 m (2 500 ft).

4. RADAR WAKE TURBULENCE SEPARATION MINIMA
(PANS-ATM 8.7.4.4 and 8.7.4.4.1)

4.1 The following wake turbulence radar separation minima should be applied to aircraft in the approach and departure phases of flight in the circumstances given in 4.2.

Preceding aircraft	*Succeeding aircraft*	*Wake turbulence radar separation minima*
A380-800	A380-800	7.4 km (4.0 NM)
A380-800	Non-A380-800 HEAVY	11.1 km (6.0 NM)
A380-800	MEDIUM	14.8 km (8.0 NM)
A380-800	LIGHT	18.5 km (10.0 NM)

Note. — Although no wake constraint for the A380-800 as a succeeding aircraft was recommended by the ad hoc group, the guidance above indicates a wake turbulence separation minimum of 7.4 km (4.0 NM) between two A380-800 aircraft, as this is the minimum between two HEAVY aircraft prescribed by the PANS-ATM. The recommendation of the ad hoc group will be taken into account during the development of a proposal for amendment to the PANS-ATM.

4.2 The minima set out in 4.1 should be applied when:

a) an aircraft is operating directly behind an A380-800 aircraft at the same altitude or less than 300 m (1 000 ft) below; or

b) both aircraft are using the same runway, or parallel runways separated by less than 760 m; or

c) an aircraft is crossing behind an A380-800 aircraft, at the same altitude or less than 300 m (1 000 ft) below.

— END —