INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA AND PACIFIC OFFICE

REPORT OF THE THIRD MEETING OF ICAO SOUTH-EAST ASIA REQUIRED NAVIGATION PERFORMANCE IMPLEMENTATION TASK FORCE (RNP-SEA/TF/3)

BANGKOK, THAILAND

4 – 6 June 2008

The views expressed in this report should be taken as those of the Task Force and not of the Organization

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Page

History of the Meeting

Report of the Meeting

Appendices

1.1 Introduction

1.1.1 The third meeting of ICAO South-East Asia Required Navigation Performance Implementation Task Force (RNP-SEA/TF/3) was held at ICAO Asia and Pacific Office, Bangkok, Thailand from 4 to 6 June 2008.

1.2 Attendance

1.2.1 RNP-SEA/TF/3 was attended by 21 participants from China, Hong Kong China, Malaysia, Singapore, Thailand, IATA and IFALPA. A complete list of participants is at **Appendix A** to this Report.

1.3 Officers and Secretariat

1.3.1 Mr. Peter E. Rabot, Head (School of ATS), Singapore Aviation Academy, Civil Aviation Authority of Singapore (CAAS) continued as the Chairperson of the Task Force. Mr. Kyotaro Harano, Regional Officer, Air Traffic Management (ATM), ICAO Asia and Pacific Office served as the Secretary for the meeting.

1.4 Opening of RNP-SEA/TF/3

1.4.1 Mr. Peter E. Rabot extended a warm welcome to all of the participants. This was the third meeting and, as the invitation letter to States highlighted, was for the purpose of taking a "Go/No-Go" decision by the Task Force to implement RNP 10 based 50 NM/50 NM separation on the South China Sea routes L642 and M771.

1.4.2 Mr. Rabot emphasized that traffic volume continued to increase across the Region. It was therefore imperative that the Task Force swiftly implement the reduced 50 NM/50 NM separations on these two routes as the immediate task. He hoped that once RNP-SEA/TF has completed this, the Task Force could move on to similar initiatives with the other sets of parallel routes over the South China Sea.

1.4.3 Mr. Rabot expressed that the future work of the Task Force would encompass further reduction in horizontal separation to improve airspace capacity within a safe environment. At the moment in time, the Task Force was focusing on the implementation of RNP 10 operations but, in the hopefully not to distant future, the Task Force should be looking and discussing further enhancements to airspace capacity such as RNP 4 operations. Finally, he wished all a fruitful meeting and a pleasant stay in Bangkok.

1.4.4 On behalf of Mr. Mokhtar A. Awan, Regional Director, ICAO Asia and Pacific Office, Mr. Kyotaro Harano welcomed all the participants to the meeting. He recognized that Singapore hosted the first and the second meetings in Singapore and this was the first time for the Task Force to meet in Bangkok. He wished everyone a pleasant stay at Bangkok.

1.4.1 Mr. Harano emphasized that benefits of the reduction of the longitudinal separation were significant, in particular, for the reduction in ground delays and the better management of air traffic on major ATS routes. He said that the Task Force had been trying to ensure that all the key factors were covered since the first meeting in order to realize the benefits. Also, the Task Force had addressed all the requirements for reducing longitudinal separation such as communication requirement, navigation performance and safety assessment. The Task Force had been cooperating

and working closely together and had all the information before them that was necessary to make the Go/No-Go decision at this meeting.

1.4.2 Mr. Harano expected that this Go/No-Go meeting would ensure that all the key factors were covered to implement the reduced longitudinal separation. He wished all concerned to continue cooperating and working closely so that the critical elements of reduced separation could be addressed, to allow for the implementation as scheduled on 2 July 2008.

1.5 Documentation and Working Language

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

1.5.2 Nine (9) Working Papers and seven (7) Information Papers were presented to RNP-SEA/TF/3. A list of papers is included at **Appendix B** to this Report.

Agenda Item 1: Adoption of Agenda

Adoption of Agenda

1.1 The meeting reviewed the provisional agenda and adopted it as follows:

Agenda Item 1: Adoption of Agenda

Agenda Item 2: Review Outcomes of Related Meetings

Agenda Item 3: Safety Analysis and Airspace Monitoring Issues

Agenda Item 4: Implementation Management Considerations

Agenda Item 5: Update RNP-SEA/TF Task List

Agenda Item 6: Any Other Business

Agenda Item 7: Date and Venue for the RNP-SEA/TF/4 Meeting

Review of the Terms of Reference (TOR) for RNP-SEA/TF amended by SEACG/15

1.2 The 15th meeting of South-East Asia ATS Co-ordination Group (SEACG/15, May 2008) agreed with the proposal of amendment to the TOR of the Task Force to add the new item on safety assessment and monitoring and adopted the amended TOR as follows:

Terms of Reference of the South-East Asia RNP Implementation Task Force

The objective of the Task Force is to:

Develop strategic, benefits-driven implementation plans in collaboration with stakeholders, to improve en-route airspace efficiency by means of reduced horizontal separation based on RNP operations within the Southeast Asia area, ensuring inter-regional harmonization.

To meet this objective the Task Force shall:

a) Review the current South China Sea route structure and examine its suitability for application of reduced horizontal separation based on RNP operations.

b) Identify routes where the application of reduced horizontal separation would bring immediate operational efficiency

c) Determine the reduced horizontal separation required, taking into account the aircraft approval status of the traffic operating on the relevant routes, capacity increase desired, and communication and surveillance capability of ATS providers.

d) Examine the possibility of a phased implementation of reduced horizontal separation based on RNP operations and to detail the phases required and the areas/routes concerned.

e) Develop the necessary strategic plans to implement the agreed horizontal separation taking into account airspace user requirements, the need for inter-regional harmonization, and ICAO Standard and Recommended Practices.

f) Explore the possibility of further harnessing operational efficiency of the routes through re-reconfiguration and enhanced surveillance.

g) Ensure the conduct of Annex 11 compliant pre-implementation safety assessments and make arrangements for States to conduct ongoing post-implementation safety monitoring in accordance with ICAO provisions.

~~g)~~h) Consider setting up appropriate teams/groups which might but not necessarily, include the entire Task Force, to address and implement specific agreed measures within their airspace; and

~~h)~~i) Cooperate with other Task Forces and groups which are involved with similar work in the adjacent airspace in order to achieve harmonized inter-regional solutions.

Scope of Initial Work

The Task Force shall adopt a phase-by-phase approach, beginning with the 50 lateral/50 longitudinal separations based on RNP 10 operations on RNAV routes L642 and M771 as Phase 1.

The Task Force reports to the South East Asia ATS Coordination Group (SEACG).

(Adopted by the 13th meeting of SEACG, 2006; amended by the 15th meeting, 2008)

Agenda Item 2: Review Outcomes of Related Meetings

Review Outcomes of the 15th Meeting of Southeast Asia ATS Coordination Group

2.1 The meeting reviewed the outcomes of the 15th meeting of SEACG (SEACG/15, May 2008).

Review of FIT-SEA/7 and 8

2.2 SEACG/15 reviewed outcomes of the seventh meeting of FANS Implementation Team, South-East Asia (FIT-SEA/7, January-February 2008) and the eighth meeting of FIT-SEA (FIT-SEA/8, May 2008). SEACG/15 agreed with the draft recommendation by FIT-SEA/7 and developed the recommendation to be considered by the 18th meeting of ATM/AIS/SAR Sub-Group (ATM/AIS/SAR/SG/18) scheduled in June 2008.

Summary of the Second Meeting of South-East Asia Required Navigation Performance Implementation Task Force (RNP-SEA/TF/2)

2.3 SEACG/15 reviewed the outcomes of RNP-SEA/TF/2 (March 2008, Singapore) and noted the actions being taken by RNP-SEA/TF as follows;

a) The ATS route re-alignment would not be considered for the implementation of RNP 10 (50 NM/50 NM) separations. The current spacing of 60 NM between the trunk routes would be kept as it is until the next step of RNP 4 is introduced. This would allow for simply establishing additional routes between the current routes.

b.) The final decision to Go/No-Go of the RNP 10 based reduced separations (50 NM/50 NM) for L642 and M771 would be made at RNP-SEA/TF/3 scheduled from 4 to 6 June 2008 at the Regional Office in Bangkok.

ATS Route Catalogue

2.4 SEACG/15 was reminded and confirmed that the *Asia/Pacific ATS Route Catalogue* does not replace the Basic Air Navigation Plan (BANP, Doc 9673) and that without a formal amendment to the BANP, inclusion in the Catalogue does not affect the status of the routes required by the BANP.

Extension of the RNAV Route N884 into the Fukuoka FIR

2.5 Japan reported that the RNAV route N884 would be extended into the Fukuoka Flight Information Region (FIR) at 2100 UTC, 2 July 2008. The extended segment was from Cabanatuan (CAB) in the Manila FIR to ALBAX in the Fukuoka FIR. This RNAV route would be unidirectional and available only for northeast-bound aircraft which are approved for RNP 10. SEACG/15 was informed that the current ATS route B462 would remain bidirectional.

Collection of Information on Wake Vortex

2.6 SEACG/15 was informed that the A380 Wake Vortex Steering Group had been created as a result of wake turbulence concerns regarding the Airbus A380-800 entering into service. The Steering Group considered that an overall review of wake turbulence provisions including the current wake turbulence categorization scheme in the *Procedures for Air Navigation Services – Air Traffic Management* (PANS-ATM, Doc 4444) should be undertaken. In order to provide a sound basis for any necessary amendment to PANS-ATM, the Steering Group had developed reporting forms for the collection and analysis of information on wake vortex encounters of all aircraft types on a worldwide basis.

Review Outcomes of the Eighth Meeting of FANS Implementation Team, South-East Asia (FIT-SEA/8)

2.7 The meeting reviewed the outcomes of FIT-SEA/8 held at the Regional Office in conjunction with SEACG/15.

Central Reporting Agency (CRA)

2.8 FIT-SEA/8 was informed that the latest figures provided by Ho Chi Minh to FIT-SEA CRA indicated the 95 percentile at 59 seconds and the 99 percentile at 2 minutes and 9 seconds.

Review ADS/CPDLC Implementation

2.9 Viet Nam reported that Civil Aviation Administration of Vietnam (CAAV) proceeded to ADS/CPDLC regular operations successfully on eight oceanic RNAV routes of L625, L628, L642, M765, M768, M771, N500 and N892 on 10 April 2008 at 0001 UTC.

MTSAT Presentation by Japan

2.10 Japan provided FIT-SEA/8 with the information on the current status and the availability of MTSAT of Japan. The information had been presented by Japan Civil Aviation Bureau (JCAB) at the 28th meeting of the Informal Pacific ATC Coordinating Group (IPACG/28, May 2008) in Las Vegas.

Summary of the Second Meeting of the Performance Based Navigation Task Force

2.11 The meeting reviewed the summary of the second meeting of the Performance Based Navigation Task Force (PBN/TF/2, April 2008) held at the Regional Office, Bangkok.

2.12 ICAO updated PBN/TF/2 on the current status of PBN-related documentation in ICAO. The draft *RNP AR Procedure Design Manual* (Doc 9905) and draft *Quality Assurance Manual for Flight Procedure Design* (Doc 9906), Volume 1, Flight Procedure Design Quality Assurance Systems; Volume 2, Flight Procedure Designer Training; and Volume 3, Flight Procedure Design Software Validation had recently been approved for posting on the ICAO-NET and on the public website (http://www.icao.int/pbn). ICAO had planned to send the *RNP AR Procedure Design Manual* to States under a State letter, subject to the Secretary General's approval, so that the States could begin to immediately use the criteria.

2.13 Eleven States presented information to PBN/TF/2 regarding the status of PBN implementation in their respective State, five of which were SEACG States as summarized below:

a) **Hong Kong, China** Hong Kong, China had implemented RNAV (GNSS) standard instrument departures (SIDs) since July 2005. Recognizing the potential benefits of PBN applications and to support PBN application, Hong Kong Civil Aviation Department (HKCAD) also planed to implement 2 RNAV (GNSS) non-precision approach procedures in 2008.

b) **Japan** Japan had implemented PBN-based RNAV 1 standard instrument departures (SIDs)/standard instrument arrivals (STARs) since 27 September 2007. RNAV routes for en-route previously being promulgated in the Japan AIP required RNAV 5 operational approvals from 13 March 2008. In addition, PBN/TF/2 was informed that Japan planned to replace RNAV (GNSS) approaches which currently did not require RNP 0.3 with RNP approaches in 2008, and implement RNP 4 operation in the oceanic airspace in the middle of 2008.

c) **Malaysia** Pre-PBN navigation specification was being implemented, and RNP10 routes had been implemented in the South China Sea and the Bay of Bengal areas, and RNAV STARs had been implemented at some major airports. RNAV approach procedures based on VOR/DME and GNSS have also been published for Kuala Lumpur International Airport and at some major airports. The non-precision approach procedures are supplemental to the precision approach procedures available. World Geodetic System – 1984 had been fully implemented since 2005.

d) **Philippines** Ground-based facilities would be used until 2015, and then gradually withdrawn. GNSS Signal Monitoring System would be installed in Manila and would have the capability to predict GNSS outages. Since the implementation of CNS/ATM was set to be completed in 2010–2012, the PBN implementation would coincide with this project. However, areas

which has immediate needs and where traffic was higher would be prioritized. RNAV 5 would be implemented on busy domestic routes. RNAV 1/RNAV 2 SID/STAR would be initially implemented at Manila Terminal Area, then to other major airports (Clark, Subic and Mactan). The existing approach procedures would be redefined to align with the PBN concept, i.e. RNP 0.3 approach procedures in Clark, Mactan, Manila and Subic Airports. The regional RNP 10 routes would also be redefined to align with the PBN concept. It was expected that navigation with the use of GNSS would be fully implemented for en-route, terminal and approach operations in the future.

e) **Singapore** RNP 10 (80 NM longitudinal and 60 NM lateral) en-route operation was implemented in the South China Sea in 2001. Plans included the aligning of current RNAV SIDs/STARs to PBN navigation specifications (RNAV 1, for example), extending of Baro-VNAV application to other feasible runway ends, and to update en-route RNAV 10 application to 50/50 operation. In view of the Region's fast traffic growth and medium to long term PBN targets, Singapore would consider replacing RNAV 10 routes with RNP 4 routes with 30/30 operation wherever feasible.

Agenda Item 3: Safety Analysis and Airspace Monitoring Issues

Revised Operational Letter of Agreement for Monitoring Aircraft Gross Navigational Errors in the South China Sea Area

3.1 Singapore presented the meeting with the draft Operational Letter of Agreement (LOA) for the monitoring of aircraft gross navigational errors in the South China Sea area and States concerned were requested to provide the names of the signatory (including their appointments and administration) in order for Singapore to prepare the LOA for signing at ATM/AIS/SAR/SG/18 scheduled from 23 to 27 June 2008. Singapore also informed the meeting that, arising from the ninth meeting of the Regional Airspace Monitoring Advisory Group (RASMAG/9, May 2008), some amendments to the draft Operational LOA were required. Singapore would finalize the Operational Letter of Agreement as soon as possible in consultation with the Regional Office and circulate it to States concerned for their comments before ATM/AIS/SAR/SG/18.

Safety Assessment for the Implementation of RNP 10 (50 NM/50 NM) Operations

3.2 Singapore presented the meeting with the safety assessment of implementing 50 NM lateral and 50 NM longitudinal separation on RNAV routes L642 and M771.

3.3 The safety assessment was an examination of operations on L642 and M771 based on the December 2007 traffic sample data (TSD) provided by the four FIRs – Ho Chi Minh, Hong Kong, Sanya and Singapore - having control responsibility for the routes. The safety assessment had been conducted using the internationally applied collision risk methodology which has supported airspace separation changes in several ICAO regions. As applied to a proposed separation change, the methodology consists of estimating the risk of midair collision for the proposed standard and comparing the risk estimate to a safety goal, the Target Level of Safety (TLS), which is a value of risk agreed as tolerable by decision makers. If the estimated risk is less than the TLS, the outcome of applying the methodology is to support the proposed change. Also APANPIRG has adopted the value 5×10^{-9} fatal accidents per flight hour as the TLS for each separation dimension – lateral, longitudinal and vertical – in the Asia and Pacific Region.

Outcome of the Lateral Safety Assessment

3.4 The meeting was informed that monitoring of lateral deviations was continuous since the November 2001 introduction of the South China Sea RNAV routes, with the criterion to identify a large lateral deviation set at 15 NM in magnitude. Singapore had acted as the coordinator of this monitoring program, collecting records of traffic movements and large lateral deviations from all FIRs where monitoring takes place. To date, there has been no report of a large lateral deviation for aircraft operating on either L642 or M771.

3.5 The meeting also noted that the number of flights observed in the merged December 2007 TSD from the Hong Kong and the Singapore FIRs was 5 743. Assuming that December 2007 is a month representative of the traffic counts on L642 and M771, it is reasonable to conclude that there would be, in a year, about 70,000 flights available for monitoring on the two routes. The value required value of $P_y(50)$ - 2.69×10^{-9}, implies that it would be necessary to have many years of navigational performance observations from the monitoring program in order to show with high confidence that the TLS is being met.

3.6 As noted in the discussion of the required value of $P_y(50)$, taking the approach of demonstrating compliance with the TLS through analysis of 15 NM or greater errors overcomes this problem. The approach was based on a statistical technique known as sequential sampling and employs a control chart of the type that is used in monitoring the manufacturing quality of many industrial processes. In such an environment, a manufacturer always wants to know if the product manufactured meets the company's standards for quality. As proposed for application in the case of introducing the 50 NM lateral separation standard on L642 and M771, the product is system safety, as demonstrated by compliance of risk with the TLS, and the standard for quality is an acceptably low rate of occurrence of 15 NM or greater lateral deviations.

3.7 Also, the meeting noted a control chart as shown in Figure 1 below which mechanizes the sequential sampling process using the agreed parameter values, with the assumption that decision-makers want to have 95 percent statistical confidence that the TLS is met. The chart permits plotting of the number of reported 15 NM or greater errors on the vertical axis against numbers of flights monitored on the horizontal axis.

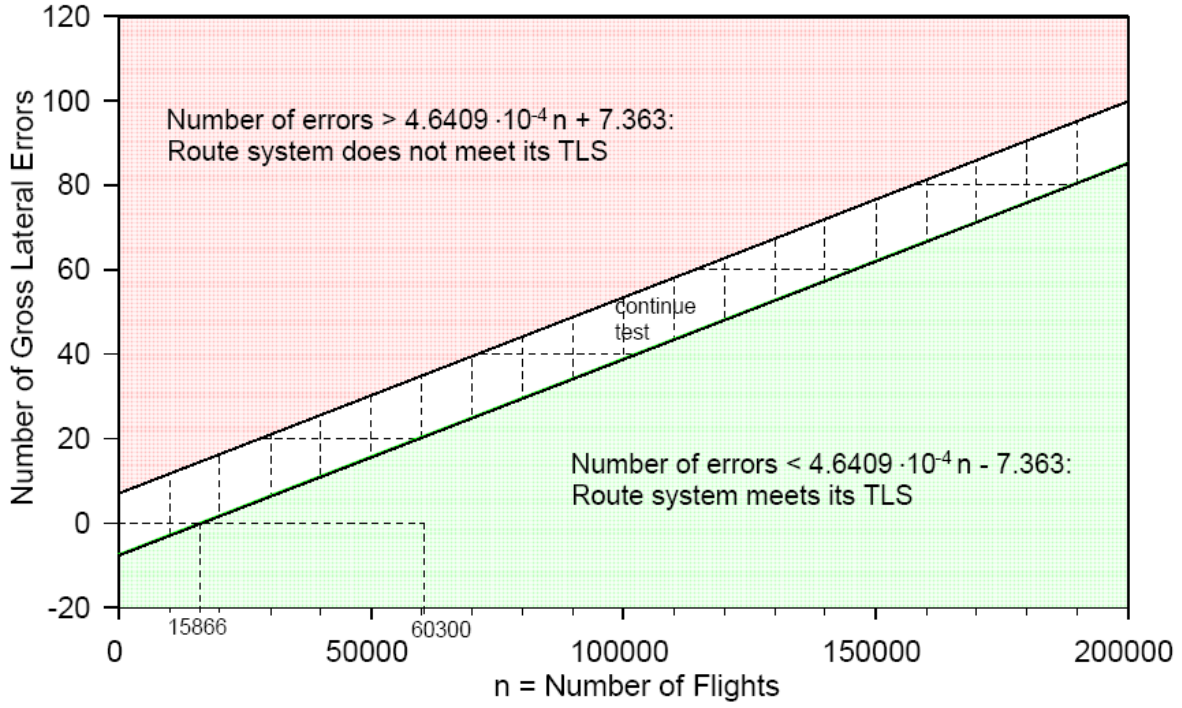

Figure 1: Sequential Sampling Approach to Demonstrating That Lateral Collision Risk for 50 NM Lateral Separation Standard Applied to L642/M771 Complies With TLS

3.8 The meeting was advised that the two straight lines of identical slope in the figure divide the chart into three regions, corresponding to the three decisions possible after entering each monitoring observation (number of 15 NM or greater errors reported and number of flights monitored) onto the chart:

a) the number of 15 NM or greater errors recorded during observation of the total number of flights monitored leads to the conclusion that the TLS is met (the plot of 15 NM or greater errors versus number of monitored flights is within the region below the lower sloped line),

b) the total number of flights monitored is not yet sufficient to conclude that the TLS is met (the plot of 15 NM or greater errors versus number of monitored flights is between the two sloped lines), or

c) navigational performance, as measured by the number of 15 NM or greater errors recorded for the number of flights monitored, is not adequate to meet the TLS and, therefore, investigations must be done to look for any sources of systematic error which, if found, must be eliminated (the plot of 15 NM or greater errors versus number of monitored flights enters the region above the upper sloped line).

3.9 From the control chart as shown in figure 1, if there are no 15 NM or greater lateral errors reported after roughly 15 000 flights, the plot of 15 NM or greater errors versus number of monitored flights enters the “meets the TLS” region of the chart. The cumulative total of flights monitored on L642 and M771 for the period 1 January 2007 through 30 April 2008 is slightly more than 60 000. During this period, no 15 NM or greater errors were reported to Singapore for either route. As a result, it was concluded with 95 percent statistical confidence that the proposed 50 NM lateral separation standard for route-pair L642/M771 met the TLS.

3.10 As a result, the assessment of the risk of introducing a 50NM lateral separation standard between L642 and M771 supports the decision to proceed with implementation.

Outcome of the Longitudinal Safety Assessment

3.11 Given the values of $P_y(0)$, $P_z(0)$ and other risk model parameters, the value of the summation of $[Q(s) \cdot P(S \geq s)]$ for all values of 's'needed to meet the TLS is 4.7×10^{-8} for a value of T equal to 30 minutes, the interval between position updates allowing air traffic control to intervene, if necessary, to increase separation.

3.12 The meeting took into account that implementation of a 50 NM longitudinal separation standard would result in the application of a distance-based separation on L642 and M771. All data describing the results of current longitudinal separation practice which were available for the safety assessment are in units of time. As a result, the safety assessment will examine the likelihood that a 6-minute longitudinal separation standard will meet the TLS.

3.13 The meeting noted that results from the South China Sea monitoring program indicated that there was no unexpected change in longitudinal separation of three minutes or more observed for pairs of aircraft during the period from 1 January 2007 through 30 April 2008. These results indicate, further, that there was no instance of a significant individual-aircraft longitudinal error – defined as a 3-minute or greater unexpected deviation between a pilot forecast of next waypoint and the actual report at that fix – reported for any of the 60, 330 flights monitored on L642 or M771 during the period.

3.14 The fact that there were no individual-aircraft unexpected changes in longitudinal position reported in 60, 330 flights does not mean that the rate at which such errors occur is 0.0. Rather, the conclusion to be drawn from the monitoring data is that the true rate of occurrence of significant individual-aircraft longitudinal errors is so small that none were produced in slightly more than 60,000 operations.

3.15 Given the monitoring program results showing that they are rare events, the probability of occurrence of significant individual-aircraft longitudinal errors can be described by a Poisson distribution, where it is assumed that the rate of significant longitudinal errors decreases as the number of flights increase in a way that keeps the product of the two constant. Assuming that each flight is an independent opportunity for a significant individual-aircraft longitudinal error, no occurrence of this event in 60,300 operations is, with 95 percent statistical confidence, consistent with a true rate of occurrence of 8.51×10^{-7} significant longitudinal errors per flight, or less. It is not possible for a pair of aircraft to lose 6 minutes of separation, the equivalent of 50 NM, unless there is an unexpected change in longitudinal position of 3 minutes or more associated with at least one aircraft. As a result, this monitoring-program finding can provide insight into the value of $P(S \geq s)$, the probability that an aircraft pair loses at least as much as longitudinal separation as it has on entering a route.

3.16 Given the sparse data from the monitoring program, it is not possible to propose a probability distribution that characterizes the occurrence of 3-minute or greater individual-aircraft longitudinal errors, that is, the probability of a 3-minute error, 4-minute error, 5-minute error and so on. In attempting to estimate $P(S \geq s)$, it will be assumed that a significant individual-aircraft longitudinal error is equally likely to contribute to an unexpected gain or loss of separation between an aircraft pair. Taking a conservative view, it will be assumed that it is possible to have a significant individual-aircraft longitudinal error as large as 6 minutes, which would require a 100-knot unexpected speed difference from that used by air traffic control to plan separation with other aircraft.

Again to be conservative, it will be assumed that 3-minute, 4-minute, 5-minute and 6-minute significant individual-aircraft longitudinal errors are equally likely.
As a result:

$$P(\text{3-minute significant individual-aircraft longitudinal error}) = 0.25*8.51 \times 10^{-7}$$
$$= 2.13 \times 10^{-7}$$
$$= P(\text{4-minute error}) = P(\text{5-minute error}) = P(\text{6-minute error})$$

3.17 Again, to be conservative, it will also be assumed that the probability of a zero-minute, 1-minute and 2-minute unexpected losses or gains in separation due to significant individual-aircraft longitudinal error will be identical and equal to $(0.2 - 8.51 \times 10^{-7}) = 0.2$. In contrast, it will be recalled from the data of table 5 that only 3 of the 1392 pairs examined in the December 2007 TSD evidenced final separations below 10 minutes, with the smallest final separation being 8 minutes.

3.18 Finally, it will be assumed that, because of the lack of information to correct adequately the initial separations for Mach number, the observed frequency of 9-minute separations can be added to the 10-minute initial separations count. As a result, when considered to represent the distribution of initial separations for L642 and M771 after 50 NM separation is applied, the frequency values of initial separations of 5 minutes or less will all be 0.0.

3.19 With these assumptions, the meeting was informed that 12 minutes was the maximum initial longitudinal separation value which can be lost due to unexpected individual aircraft longitudinal errors, and would result only when the lead aircraft of a pair loses 6 minutes and the other gains 6 minutes. Because individual aircraft longitudinal errors are assumed independent between aircraft, the probability that this would happen is the product of the probabilities that each aircraft would have a significant longitudinal error of 6 minutes, or,

$$P(S \geq 12) = P(S = 12) = (2.13 \times 10^{-7}) \bullet (2.13 \times 10^{-7}) = 4.5 \times 10^{-14}$$

3.20 This probability is so small that it can be neglected. Likewise, the contribution to summation of $[Q(s) \cdot P(S \geq s)]$ for all values of 's' made by initial separation values of 11 minutes, 10 minutes and 9 minutes can be disregarded.

3.21 As a result, only 8 minutes, 7 minutes and 6 minutes initial separation values require examination in light of unexpected losses or gains in separation due to significant individual-aircraft longitudinal error. Assuming that Aircraft 1 is following Aircraft 2, the combinations of unexpected losses or gains in separation necessary for two aircraft to lose 8 minutes of initial separation are shown in table 1:

Aircraft 1 Unexpected Gain (+) or Loss (-) (minutes)	Aircraft 2 Unexpected Gain (+) or Loss (-) (minutes)	Resulting Separation (minutes)
+6	-2	0
+5	-3	0
+4	-4	0
+3	-5	0
+2	-6	0

Table 1. All Combinations of Unexpected Separation Loss and Gain Resulting in Loss of Exactly 8 Minutes Initial Separation

3.22 The meeting also noted that the value P(S = 8 minutes) was the sum of the products of the probabilities of separation loss and gain in the rows of the table. For example, the contribution to P(S = 8) of the first row is:

$$(2.13 \times 10^{-7}) \bullet (0.2) = 4.26 \times 10^{-8}$$

3.23 The contribution of the last row is also 4.26×10^{-8}. The contribution of the products of the probabilities in the other rows is the negligible value 4.5×10^{-14}. Thus, the value of P(S = 8 minutes) is $2 \bullet 4.26 \times 10^{-8}$, or 8.52×10^{-8}.

3.24 The value of P(S = 7) can be determined in a similar manner and is $4 \bullet 4.26 \times 10^{-8} = 1.7 \times 10^{-7}$. The value for P(S = 6) is $8 \bullet 4.26 \times 10^{-8} = 3.41 \times 10^{-7}$.

3.25 Using the relative frequencies of initial separation values determined from the data, it is now possible to calculate the quantity summation of $[Q(s) \cdot P(S \geq s)]$ for all values of 's'. Table 2 shows the results.

Initial Separation, s (minutes)	Proportion of initial separations, corrected for Mach number, with separation s, Q(s)	$P(S \geq s)$	$Q(s) \bullet P(S \geq s)$
6	0.011	$(3.41 \times 10^{-7} + 1.7 \times 10^{-7} + 8.52 \times 10^{-8})$	6.85×10^{-9}
7	0.015	$(1.7 \times 10^{-7} + 8.52 \times 10^{-8})$	3.85×10^{-9}
8	0.027	8.52×10^{-8}	2.26×10^{-9}
9 and beyond	0.018	0.0	0.0
Sum $Q(s) \bullet P(S \geq s)$			1.30×10^{-8}

Table 2. Computation of the Summation of $Q(s) \bullet P(S \geq s)$ for All Values of Initial Separation, s

3.26 The resulting value for summation of $[Q(s) \cdot P(S \geq s)]$ for all values of s, 1.30×10^{-8}, is less than the value of 2.3×10^{-8} required to meet the TLS. When the summation value computed in Table 2 is substituted into the expression for P_x and used in the model, the resulting value of longitudinal collision risk is 2.8×10^{-9} fatal accidents per flight hour, which satisfies the TLS.

3.27 The monitoring program has shown considerable value as source material for the safety assessment. The meeting agreed to re-emphasize its importance to all signatories of the Operational Letter of Agreement on the monitoring of aircraft gross navigation errors in the South China Sea area.

3.28 The meeting reviewed the safety assessment documentation and agreed that the assumptions made were reasonable. The meeting also agreed that the safety assessment was robust and the safety assessment supports the implementation of RNP10 (50/50NM) horizontal separation on L642 and M771.

3.29 The meeting thanked Singapore for the professional, thorough and comprehensive safety assessment which resulted in a positive outcome. The PowerPoint presentation associated with the safety assessment by Singapore is in **Appendix C** to this Report.

3.30 The meeting also noted that RASMAG/9 (May 2008) had also reviewed the lateral and longitudinal safety assessments for 50/50 implementation on L642& M771. RASMAG/9 noted and appreciated the many aspects that had been covered, recognizing that the assumptions that had been made were reasonable, agreeing that the safety assessment was robust and fully endorsing the outcomes. RASMAG/9 confirmed that from the aspect of the safety assessment, there was no impediment to the implementation of 50NM/50NM as planned by the RNP-SEA/TF.

Agenda Item 4: Implementation Management Considerations

Amendment Proposal to the Regional Supplementary Procedures (SUPPS, Doc 7030)

4.1 The meeting was informed that the proposed amendment to SUPPS was circulated to States and international organizations by the Regional Office with the State letter Ref: T 3/08.12 – AP047/08 (ATM) on 16 April 2008.

Implementation of RNP 10 (50/50) Horizontal Separations on L642 and M771 (Operational Plan)

4.2 Singapore presented the meeting on their efforts to implement RNP 10 operations on L642 and M771 in the Singapore FIR to enhance safety, increase capacity and efficiency. RNP-SEA/TF/2 created the table on "Understanding the Operational Concept and Implementation Requirements" for RNP10 operations on L642 and M771 where Singapore indicated that CPDLC would be the primary communication between ATC and pilots for FANS 1/A aircraft.

4.3 It was noted that direct controller-pilot communication (DCPC) was an operational communication requirement for the implementation of reduced longitudinal separation from 80 NM to 50 NM based on RNP 10 operations. Currently, within the Singapore FIR and outside the VHF range, CPDLC is used as a communications tool. With the introduction of reduced horizontal separation minima, the 50 NM longitudinal separation minima would be applied between RNP 10-approved aircraft logon to CPDLC or within VHF radio range, operating at FL 290 and above. This would ensure that good communication link exists throughout the period of application of the minima.

4.4 Capacity for these two routes would increase as a result of this longitudinal separation minimum reduction. In order to fully utilise this increased capacity, controllers have to be able to pack aircraft using this (50 NM longitudinal) minimum. As an example, assigning the same level to non-CPDLC equipped aircraft intersperse with CPDLC equipped aircraft would result in a lower occupancy rate because of greater separation minimum (e.g. 80 NM). To alleviate this, tactical changes to flight level assignments would be necessary. It would also improve chances of applying the RNP 10 50 NM longitudinal separation minimum.

4.5 Singapore had been encouraging operators operating out of Changi Airport and intending to fly on RNAV routes L642 and M771 to be equipped with ADS/CPDLC. This would allow operators to operate at close to or optimum flight level with less delay thereby reducing operating costs. In the near future, ADS/CPDLC would have to be used when applying 30NM/30NM horizontal separation minima between RNP 4 approved aircraft.

4.6 The application of 50 NM lateral separation would be applied between RNP 10 approved aircraft operating at FL 290 and above. As such, up to 10 NM lateral deviation in the direction of either L642 or M771 could be approved without having to apply vertical separation as per current arrangement. This would be applicable for all RNP 10-approved aircraft.

4.7 Singapore is currently training their controllers on the application of 50 NM distance-based longitudinal separation to meet the targeted implementation date of 2 July 2008 and ensure that the minimum longitudinal distance between the RNP 10 approved aircraft would not be infringed.

Review of the Ninth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/9)

4.8 The meeting reviewed the outcomes of the ninth meeting of RASMAG/9 held in Bangkok, Thailand at the Regional Office.

Airspace Safety Monitoring Activities/Requirements in the Asia/Pacific Region

4.9 RASMAG/9 was of view that all the information available to the safety assessment on 50/50 separation on L642 and M771 had indicated that the factors affecting risk – such as along-track position keeping and loss of planned separation between pairs of co-altitude aircraft – were consistent with those leading to TLS compliance. In light of risk estimates and the ongoing program for monitoring navigational performance, the safety assessment supports introduction of 50 NM lateral and longitudinal separation standards on L642 and M771.

4.10 With reference to SMA, RASMAG/9 noted that Singapore had adopted the title *"South East Asia Safety Monitoring Agency"* (SEASMA) as the name for the SMA. With assistance from CSSI, SEASMA had prepared both an interim and the final safety assessment to support the 50 NM/50 NM implementation.

4.11 When considering whether "APANPIRG Approval" was required for SMAs, RASMAG/9 recognized that the RMA requirements were precipitated, in part, by the Standard in Annex 11 – *Air Traffic Services* that required RVSM monitoring to be conducted on a 'regional' basis – Annex 11, paragraph 3.3.5.1 refers. However, although horizontal monitoring was also required under ICAO provisions, the stipulation that the monitoring be conducted on a regional basis was not made – meaning that each State has an individual responsibility and could conduct the monitoring on an individual basis. Notwithstanding, RASMAG/9 recognized that for many of the States with smaller airspaces to conduct horizontal monitoring individually would not be as efficient and effective as working together in a sub-regional manner. Therefore, as the responsibility level was higher, it was felt logical that an "APANPIRG Approval" was justified not only for RMAs but also for SMAs. RASMAG/9 would continue discussions in this regard, with the intention of adopting a final position during the December 2008 RASMAG/10 meeting.

Agenda Item 5: Update RNP-SEA/TF Task List

5.1 The meeting reviewed and updated the RNP-SEA/TF Task List as in **Appendix D** to this Report.

Go/No-Go Decision by the Meeting

5.2 The meeting recalled that the Special Coordination Meeting (September 2007, Singapore) developed a list of the critical activities which was subsequently accepted by RNP-SEA/TF/2, that would need to be completed for the implementation of RNP10 50/50 on L642 and M771. Accordingly, the meeting considered that the actions required would encompass at least the following activities:

a) Identify operational needs;
b) Complete safety assessment for reduced horizontal separation;

c) Feasibility Analysis of operational factors;
d) Determination of requirements (airborne and ground system);
e) Aircraft and Operator approval requirements;
f) Identification of transition areas;
g) Perform necessary industry and international coordination;
h) Completion of controller training; and
i) Completion of amendments to operational Letters of Agreement.

5.3 With regard to g) above, Singapore considered that States involved would need to announce the implementation of the 50 NM/50 NM separation standards on L642 and M771 on 2 July 2008 and the amendments to AIP as the AIP Singapore has reference to the 60 NM separation standards on the six trunk routes. Hong Kong, China considered that the issuance of NOTAM was not necessary and the pertinent changes would be incorporated in a regular AIP amendment. After discussion, the meeting agreed that additional AUIS information to support the implementation was not necessary and updates to AIP could be made subsequently as part of the normal amendment process.

5.4 The meeting noted that training for controllers was currently on-going and will be completed before the implementation date. Amendments to Operational LOAs between ACCs had either been signed or were in the process of being signed.

5.5 The meeting agreed that most of the activities had since been completed with only a few matters to be followed up by States before the implementation date.

5.6 In view of the above, the meeting agreed to a 'Go" decision for the implementation of RNP10 (50 NM/50 NM) reduced horizontal separation on L642 and M771 at 2100 UTC, 2 July 2008 as planned. The meeting noted that this was a concurrent implementation with the revised flight level arrangements for the WPAC/SCS area that would also be implemented at the same time.

5.7 Recalling that this 50 NM/50 NM implementation had been planned for a couple of years ago by States concerned, IATA expressed appreciation to the work undertaken by the States and the Task Force. IATA suggested that the data on the actual flight level use at the 90 day review meeting would be useful to compare the benefit derived from the implementation of the reduced separation.

Agenda Item 6: Any Other Business

Data Link Implementation Table for Capacity Planning

6.1 The meeting recognized that SITA wished to obtain from customer airlines and air navigation service providers their planned FANS activities and to feed traffic forecast model to assist themselves to provide the required level of performance for their customers. The meeting noted their planned FANS activities in the Data Link Implementation Table for Capacity Planning.

Proposal for the Amendment of Annexes 4, 11 and 15, PANS-ABC, PANS-ATM, and PANS-OPS

6.2 The meeting noted that the Air Navigation Commission, on 13 December 2007, considered proposals developed by the Instrument Flight Procedures Panel (IFPP) first working group of the whole meeting to amend Annex 4 — *Aeronautical Charts*; Annex 11 — *Air Traffic Services*; Annex 15 — *Aeronautical Information Services*; the *Procedures for Air Navigation Services — ICAO Abbreviations and Codes* (PANS-ABC, Doc 8400); the *Procedures for Air Navigation Services — Air*

Traffic Management (PANS-ATM, Doc 4444); and the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168), Volume I — *Flight Procedures* and Volume II — *Construction of Visual and Instrument Flight Procedures* relating to instrument flight procedures, and authorized their transmission to Contracting States and appropriate international organizations for comments.

6.3 The amendment proposal to Annex 4 relates to the charting of flight procedures and amends the hierarchy in which the significant point in RNAV shall appear on RNAV charts. As a result of this amendment to Annex 4, consequential amendments are required to Annex 11 and the PANS-ATM.

Agenda Item 7: Date and Venue for the Next Meeting

7.1 The meeting agreed tentatively on the future work programme of the Task Force as follows:

RNP-SEA/TF/4 (90 days review meeting)	5 - 7 November 2008	Singapore
RNP-SEA/TF/5	February 2009	TBD

7.2 The 90-day review meeting will include a review of the safety assessment after the implementation of the 50 NM horizontal separations. When the review meeting finds that the 50 NM longitudinal and lateral separation standards are successfully implemented on L642 and M771, the Task Force will continue its work to address other routes in the Region as agreed at RNP/TF/1.

8. Closing of the Meeting

8.1 Before bringing the meeting to a close, Mr. Peter Rabot thanked all for their valuable inputs, views and cooperation in discussing the agenda items in an open and friendly manner. He especially thanked the Regional Office for their secretariat support and logistical arrangements for the meeting.

8.2 He added that decision to go ahead with the implementation of RNP 10 50/50 NM on L642 and M771 was indeed a positive step to enhancing efficiency of operations on these routes and that efficiency gains of this nature could reasonably be expected to result in direct consequential environmental benefits

8.3 He wished all a safe journey home and looked forward to seeing everyone at the Task Force/4 meeting in November 2008.

8.4 On behalf of the RNP-SEA/TF, Mr. Harano thanked all delegates for their participation. He was grateful to the meeting for their excellent job contributed to the meeting.

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LIST OF PARTICIPANTS

STATE/NAME	DESIGNATION/ADDRESS	CONTACT DETAILS
CHINA		
Ms. Zhang Ying	Engineer of Airspace Management Division Air Traffic Management Bureau, CAAC No.12 East Sanhuan Road Middle Chaoyang District, Beijing 100022 People's Republic of China	Tel: +86-10-8778 6837 Fax: +86-10-8778 6830 E-mail: zhangying@atmb.net.cn
Ms. Xu Rong	Engineer of Air Traffic Control Division Middle South Regional Air Traffic Management Bureau, CAAC People's Republic of China	Tel: +86-020-8612 0836 E-mail: atc@atmb.org
Mr. Yu Peng	Director of Sanya ACC Hainan Air Traffic Management Sub-Bureau Central South Regional Air Traffic Management Bureau, CAAC People's Republic of China	Tel: +86-898-6575 1114 E-mail: ccatcyp@263.net
HONG KONG, CHINA		
Mr. Lucius Fan	Senior Safety and Quality Officer Civil Aviation Department ATMD, 4/F, ATC Complex 1 Control Tower Road Hong Kong International Airport Lantau Hong Kong, China	Tel: 852-2910 6448 Fax: 852-2910 0186 E-mail: lwcfan@cad.gov.hk
MALAYSIA		
Mr. Tan Jee Leng	Deputy Director, Air Traffic Control Centre Department of Civil Aviation Jabatan Penerbangan Awam Pusat Kawalan Trafik Udara Blok A, Kompleks Kawalan Trafik Udara Lapangan Terbang Sultan Abdul Aziz Shah 47200 Subang, Selangor Darul Ehsan Malaysia	Tel: 603-7846 5233 Fax: 603-7845 6590 E-mail: tanjl@dca.gov.my
Mr. Chars Wong	Senior ATCO, Air Traffic Control Centre Department of Civil Aviation Jabatan Penerbangan Awam Pusat Kawalan Trafik Udara 88618 Kota Kinabalu Sabah Malaysia	Tel: 6088-224404 Fax: 6088-219170 E-mail: chars@dca.gov.my
SINGAPORE		
Mr. Peter Rabot	Head (School of ATS) Civil Aviation Authority of Singapore Singapore Changi Airport P.O. Box 1 Singapore 918141	Tel: 65 6540 6247 Fax: 65 6542 9890 E-mail: peter_rabot@caas.gov.sg

STATE/NAME	DESIGNATION/ADDRESS	CONTACT DETAILS
Mr. Heng Cher Sian Edmund	Project Officer (Air Traffic Management) Civil Aviation Authority of Singapore Singapore Changi Airport PO Box 1 Singapore 918141	Tel: 65 6541 2457 Fax: 65 6545 6516 E-mail: edmund_heng@caas.gov.sg
Mr. Ang Poh Meng	Air Traffic Control Officer Air Traffic Services Division Civil Aviation Authority of Singapore Singapore Changi Airport PO Box 1 Singapore 918141	Tel: 65 6541 2686 Fax: 65 6545 6252
Mr. Brian Colamosca	Technical LEAD CSSI, Inc. 400 Virginia Ave, SW Washington, D.C. 20024 U.S.A.	Tel: 1-609-407 9173 Fax: 1-609-407 9356 E-mail: bcolamosca@cssiinc.com
THAILAND		
Mr. Pawat Harnbumrungkit	Air Transport Technical Officer Airport Standards and Air Navigation Facilitating Division Department of Civil Aviation 71 Soi Ngamduplee, Rama IV Road Tungmahamek Bangkok 10120, Thailand	Tel: +66-2-2870320-9 ext 1165 Fax: +66-2-2868159
Lt.Jg. Yoottakarn Niewpant	Air Traffic Control Expert Airport Standards and Air Navigation Facilitating Division Department of Civil Aviation 71 Soi Ngarmduplee, Tungmahamek Rama IV Rd, Bangkok 10120 Thailand	Tel: 66-2-287 0320 ext 1165 Mobile: 081-7014909 Fax: 66-2-286 8159 E-mail: niewpant@yahoo.com
Ms. Chananya Pinkaewprasert	Air Traffic Control Manager Bangkok Area Control Centre 2 Aeronautical Radio of Thailand Ltd. 102 Ngarmduplee, Tungmahamek Sathorn, Bangkok 10120 Thailand	Tel: 66-2-285 9059 Fax: 66-2-285 9745 E-mail: nanya@aerothai.co.th
Mr. Nuttakajorn Yanpirat	Executive Officer, Systems Engineering ATS Planning Department Aeronautical Radio of Thailand Ltd. 102 Ngarmduplee, Tungmahamek Sathorn, Bangkok 10120 Thailand	Tel: 66-2-287 8268 Fax: 66-2-285 9716 E-mail: nuttakajorn.ya@aerothai.co.th
Capt. Choompol Soodla	Manager, Operations Specification Division International Aviation Affairs and Development Department Thai Airways International Public Company Ltd 89 Vibhavadee Rangsit Rd Bangkok, Thailand	Tel: 66-2-545 2669 Fax: 66-2-545 3849 E-mail: choompol.s@thaiairways.com

STATE/NAME	DESIGNATION/ADDRESS	CONTACT DETAILS
IATA		
Mr. Soon Boon Hai	Assistant Director – Safety, Operations & Infrastructure – Asia/Pacific International Air Transport Association 111 Somerset Road #14-05 Somerset Wing Singapore Power Building Singapore 238164	Tel: +65-6499 2251 Fax: +65-6438 4666 E-mail: soonbh@iata.org
Mr. Owen Dell	Manager International Operations International Affairs Department International Operations Cathay Pacific Airways 9/F, Central Tower, Cathay Pacific City 8 Scenic Road Hong Kong International Airport Lantau Island, Hong Kong, China	Tel: +852-2747 8829 Fax: +852-2141 8829 E-mail: owen_dell@cathaypacific.com
Mr. Yusuke Chaki	Manager, Operations Standards Section Nippon Cargo Airlines Co., Ltd. NCA Global Operations Center Narita International Airport Terminal 2, Narita-shi Chiba 282-0004 Japan	Tel: +81-476-32-9739 Fax: +81-476-32-9788 E-mail: yusuke.chaki@nca.aero
Mr. Tan Cheng Yeow	Flight Operations Technical (SIN-STC 02-A) Singapore Airlines SIA Training Centre 04-C 720 Upper Changi Road East Singapore 486852	Tel: +65-6540 2913 Fax: +65-6543 4053 E-mail: chengyeow_tan@singaporeair.com.sg
IFALPA		
Capt. Tsutomu Ishiyama	IFALPA Regional Vice President/North Pacific Phoenix Bldg. 5-11-4 Haneda, Ota-ku Tokyo 144-0043 Japan	Tel: +81-3-5705 2770 +81-43-461 2307 Fax: +81-3-5707 3274 +81-43-461 2307 E-mail: office30@alpajapan.org Ishiyama-tsutomu@alpajapan.org
Capt. Koichi Sano	Technical Adviser ALPA Japan Phoenix Bldg. 5-11-4 Haneda, Ota-ku Tokyo 144-0043 Japan	Tel: +81-3-5705 2770 +81-45-845 2154 Fax: +81-3-5707 3274 +81-45-845 2154 E-mail: office30@alpajapan.org Sano-koichi@alpajapan.org
ICAO		
Mr. Kyotaro Harano	Regional Officer, ATM ICAO Asia & Pacific Office 252/1 Vibhavadi Rangsit Road Ladyao, Chatuchak Bangkok 10900 Thailand	Tel: 66-2-5378189 Fax: 66-2-5378199 E-mail: kharano@bangkok.icao.int

LIST OF WORKING PAPERS (WPs) AND INFORMATION PAPERS (IPs)

WORKING PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
WP/1	1	Provisional Agenda RNP-SEA/TF/3	Secretariat
WP/2	2	Terms of Reference of the Task Force Amended by the 15th Meeting of South-East Asia ATS Coordination Group (SEACG/15)	Secretariat
WP/3	2	Review Outcomes of the 15th Meeting of Southeast Asia ATS Coordination Group (SEACG/15)	Secretariat
WP/4	2	Review Outcomes of the Eighth Meeting of FANS Implementation Team, South-East Asia (FIT-SEA/8)	Secretariat
WP/5	3	Assessment of the Safety of Implementing 50-NM Lateral and Longitudinal Separation Standards on RNAV Routes L642 and M771	Singapore
WP/6	3	Revised Operational Letter of Agreement (LOA) for Monitoring of Aircraft Gross Navigational Errors in the South China Sea Area	Singapore
WP/7	4	Amendment Proposal to the Regional Supplementary Procedures (Doc 7030)	Secretariat
WP/8	4	Implementation of RNP 10 (50 NM/50 NM) Operations on L642 and M771 in the South China Sea Area	Singapore
WP/9	5	Review of the Task List for Implementation of Required Navigation Performance (RNP)	Chairman

INFORMATION PAPERS

NUMBER	AGENDA	TITLE	PRESENTED BY
IP/1	-	List of Working Papers (WPs) and Information Papers (IPs)	Secretariat
IP/2	2	Summary of the Second Meeting of Asia/Pacific Performance Based Navigation Task Force	Secretariat
IP/3	3	Examination of Operations Conducted on RNAV Routes L642 and M771 Based on December 2007 Traffic Sample Data	Singapore
IP/4	4	Review of the Ninth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/9)	Secretariat
IP/5	4	Review of RASMAG List of Competent Airspace Safety Monitoring Organizations	Secretariat
IP/6	6	Data Link Implementation Table for Capacity Planning	Secretariat
IP/7	6	Proposal for the Amendment of Annexes 4, 11 And 15, PANS-ABC, PANS-ATM and PANS-OPS	Secretariat

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ASSESSMENT OF THE SAFETY OF IMPLEMENTING 50-NM LATERAL AND LONGITUDINAL SEPARATION STANDARDS ON RNAV ROUTES L642 AND M771

RNP-SEA/TF/3
Appendix C to the Report
4 – 6 June 2008
Presented by Singapore

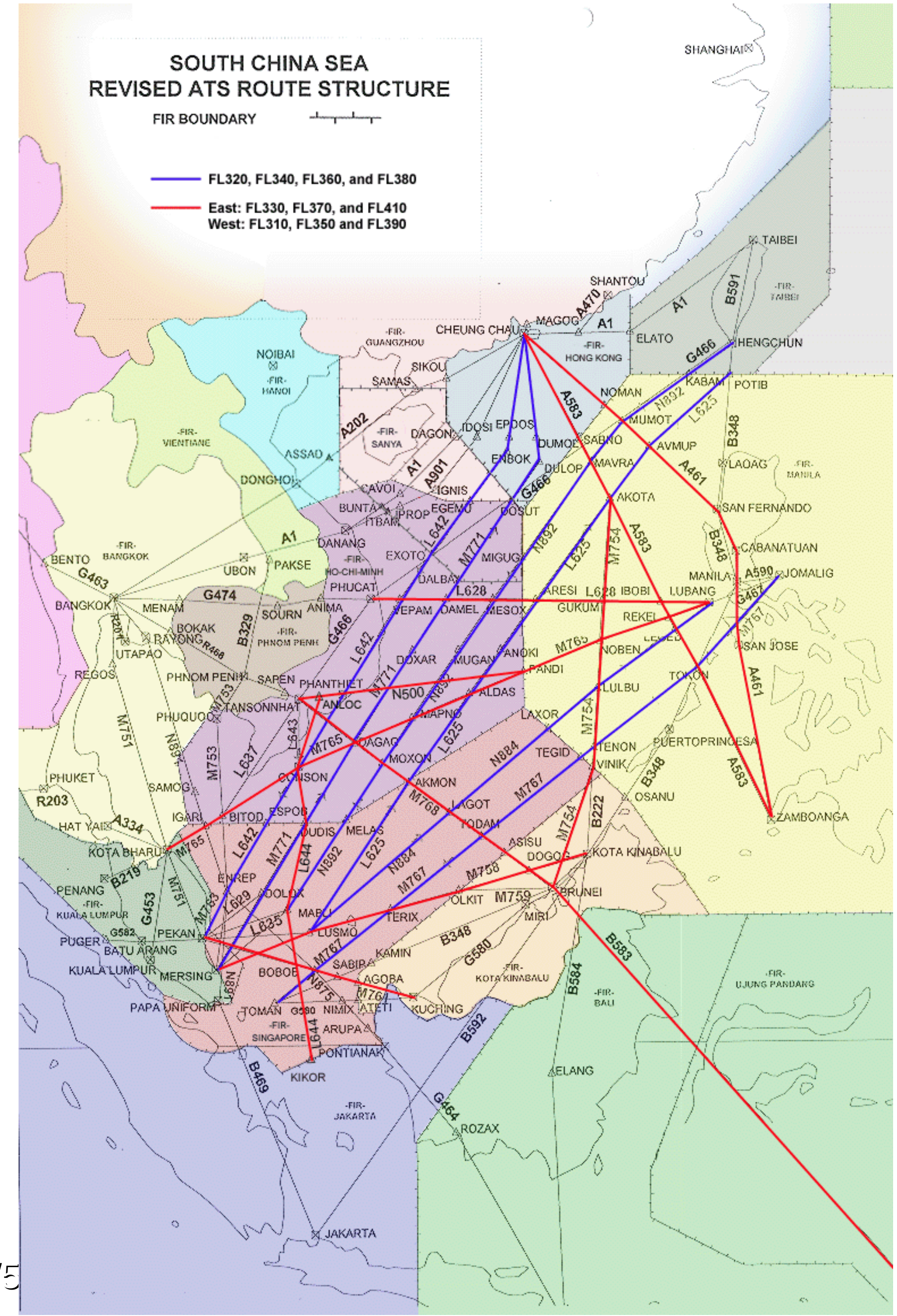
1. Introduction

- Review history of proposal to introduce 50NM lateral and longitudinal separation standards on L642 and M771

- Purpose of WP: Present final safety assessment of proposed change

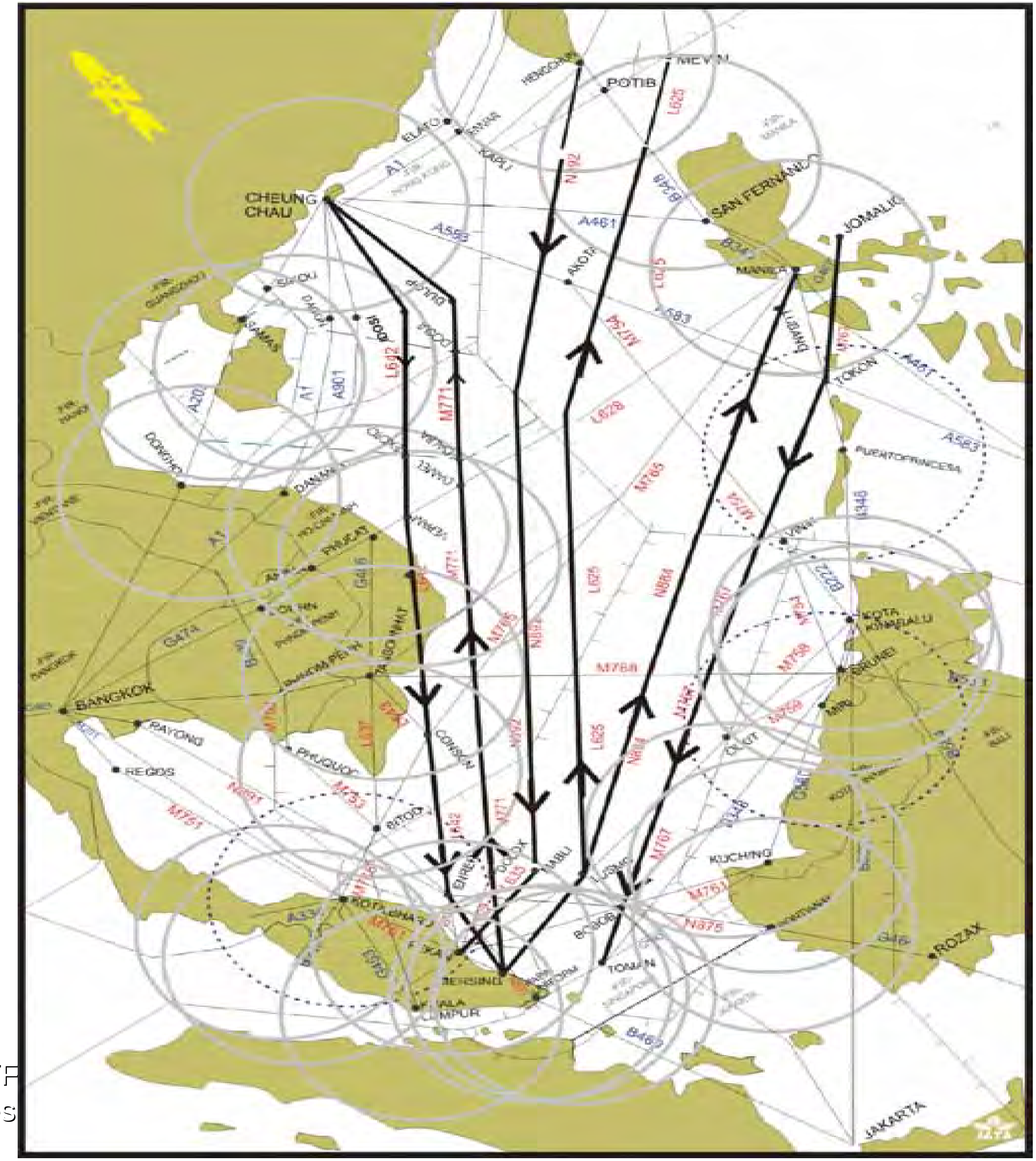
2. Background

- 2.2 Description of South China Sea Airspace
  - RNP 10 approval at or above FL 290
  - Figure 1
  - Current lateral standard: 60 NM
  - Current longitudinal standard: 10 minutes with MNT/80NM RNAV
  - 3 July 2008 FLAS change (WP/5: 5 June)


SOUTH CHINA SEA
REVISED ATS ROUTE STRUCTURE
FIR BOUNDARY
FL320, FL340, FL360, and FL380
East: FL330, FL370, and FL410
West: FL310, FL350 and FL390

2. Background (Continued)

- 2.3 South China Sea Airspace Infrastructure
  - Radar and VHF coverage: Figure 2, updated by discussions at RNP/TF/2
  - Non-radar/non-VHF: 100NM of L642 between ESPOB and ENREP; 100NM of M771 between DOSUT and DOLUX
  - Current longitudinal standard: 10 minutes with MNT/80NM RNAV
  - 3 July 2008 FLAS change



RNP-SEA/TF
Safety Asses

2. Background (Continued)

- 2.4 Operations on L642 and M771
  - RNP-SEA/TF/3-IP/3:
    - Table 1: 10 operators conduct 75 percent of operations
    - Table 2: 15 aircraft types used in 97 percent of operations – A320 is 19 percent of total
  - Effect of 3 July 2008 FLAS change on FL use
    - IP/3: Table 5
  - ADS/CPDLC equipage assessment from IP/3, Table 2: estimate 38 percent of operations conducted by aircraft types not usually ADS/CPDLC equipped

2. Background (Continued)

- 2.5 Operational Concept of 50/50 Application
  - 50NM lateral separation standard: no change to L642 and M771 route locations – use 50NM lateral standard on tactical basis to accommodate weather deviation requests without affecting operations on adjacent route
  - 50NM longitudinal separation standard: rely on extensive radar and VHF coverage to apply 50NM standard to any pair of co-altitude aircraft on either route

2. Background (Continued)

- 2.6 South China Sea Monitoring Program

  – Revised LOA

  – Criterion to report large lateral deviation: 15NM magnitude or more deviation from route centerline

2. Background (Continued)

- 2.6 South China Sea Monitoring Program (continued)
  - Criteria to report large longitudinal error (10 minutes with MNT):
    - Infringement of separation standard
    - Unexpected change of 3 minutes or more in separation between a pair
    - Unexpected difference of 3 minutes or more between individual-aircraft forecast and actual times at fix
  - Criteria to report large longitudinal error (distance-based separation):
    - Infringement of separation standard
    - Unexpected change of 10 NM or more in separation between a pair

3. Discussion

- Safety assessment conducted using internationally applied ICAO collision risk methodology
  - Estimate risk using mathematical model
  - Compare estimated risk to Target Level of Safety (TLS)
  - If risk < TLS value, safety goal met
  - If risk > TLS value, safety goal not met
  - APANPIRG-adopted TLS value: 5×10^{-9} fatal accidents per flight hour

3. Discussion (Continued)

- 3.5 Factors Affecting Risk of Collision in South China Sea Airspace
  - Estimate risk of losing lateral and longitudinal separation standards
    - Risk of horizontal-plane separation loss on intersecting routes is zero because of FLAS
  - Used conservative value of lateral occupancy (aircraft packing at same flight level on adjacent routes)
  - Risk estimates are conservative because no effect of radar-surveillance/VHF-voice coverage taken into account

3. Discussion (Continued)

- 3.5 Factors Affecting Risk of Collision in South China Sea Airspace (continued)
  - Lateral risk estimate is conservative since it is based on 50NM spacing between L642 and M771 when 60NM will actually be used
  - RNP 10 standard leads to roughly 5 NM as required standard deviation of lateral errors from route centerline
    - Singapore ACC radar data shows standard deviation of about 0.5 NM

3. Discussion (Continued)

- 3.6 Collision Risk Model
  - Key assumption: Assume no intervention to maintain separation or to reduce risk
  - Model forms shown in section 3.7 of WP/5
  - Model parameters (terms on right side of equations (1) and (2)) either estimated from data collected in airspace or adopted from use elsewhere

3. Discussion (Continued)

- 3.8 Data Used in safety assessment
  - December 2007 TSDs from Hong Kong, Santa, Ho Chi Minh and Singapore FIRs
  - Eight days of radar data from Singapore ACC
  - January 2007 through April 2008 monitoring program results reported to Singapore

3. Discussion (Continued)

- 3.9 Explanation of Model Parameters and Estimates
  - 3.9.1 Values Common to Lateral and Longitudinal Risk Models
  - 3.9.2 Parameters Used Only in Estimation of Lateral Risk
    - Table 3

3. Discussion (Continued)

- 3.9 Explanation of Model Parameters and Estimates (continued)
  - 3.9.3 Parameters Used Only in Estimation of Longitudinal Risk
    - Probability that two co-altitude same-route aircraft are in lateral overlap, $P_y(0)$ – effect of GPS
    - Relative across-track speed – affected by GPS

3. Discussion (Continued)

- 3.9 Explanation of Model Parameters and Estimates (continued)
  - 3.9.3 Parameters Used Only in Estimation of Longitudinal Risk (continued)
    - Probability that two co-altitude same-route aircraft lose all planned longitudinal separation, P_x

3. Discussion (Continued)

- Probability that two co-altitude same-route aircraft lose all planned longitudinal separation, P_x
  - P_x = (factor dependent on initial separation, s) • (chance of losing all planned initial separation, s, for all possible initial separations)
  - **(factor dependent on initial separation, s)** depends on:
    - The length of time, T, between updates of aircraft position to ATC
      - Take this time to be 30 minutes in safety assessment
    - The relative speed between the two aircraft in a pair so that one overtakes the other within time T

3. Discussion (Continued)

- Probability that two co-altitude same-route aircraft lose all planned longitudinal separation, $P_x(0)$
  - P_x =(factor dependent on initial separation, s) • (chance of losing all planned initial separation, s, for all possible initial separations)
  - **(chance of losing all planned initial separation, s, for all possible initial separations)** = (probability that two aircraft are separated by 10 minutes) • (probability that two aircraft lose at least 10 minutes of initial separation) + (probability that two aircraft are separated by 11 minutes) • (probability that two aircraft lose at least 11 minutes of initial separation) + ….
  - =Σ (probability that two aircraft are separated by s minutes) • (probability that two aircraft lose at least s minutes of initial separation) for all values of s

3. Discussion (Continued)

- Probability that two co-altitude same-route aircraft lose all planned longitudinal separation, $P_x(0)$
  - $=\Sigma$ **(probability that two aircraft are separated by s minutes)** • (probability that two aircraft lose at least s minutes of initial separation) for all values of s
  - Figure 3: initial separations of 1392 pairs
  - Figure 4: initial separations “corrected” for Mach number difference

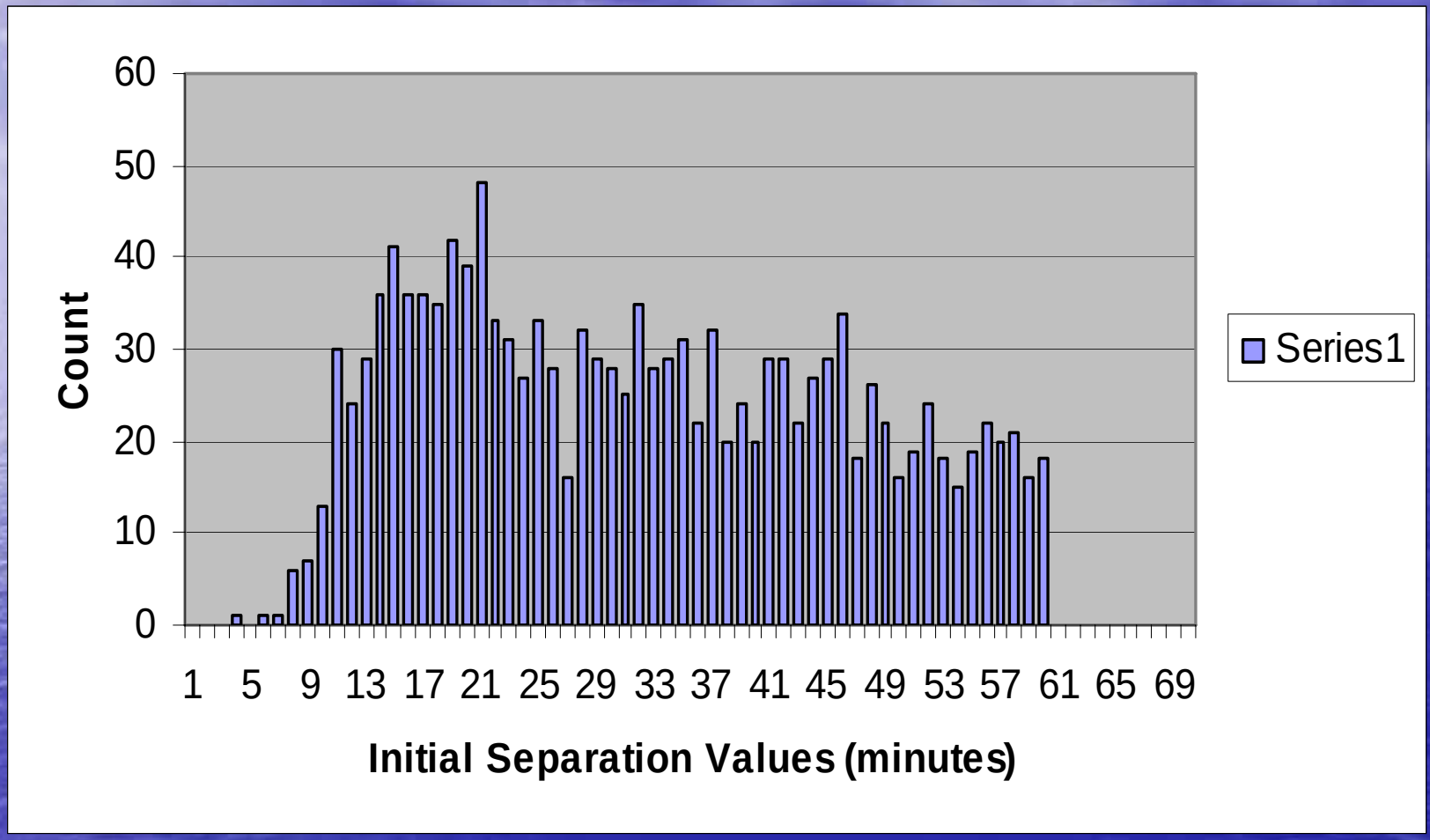

60
50
40
30
20
10
0
Count
1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69
Initial Separation Values (minutes)
Series1

Figure 3

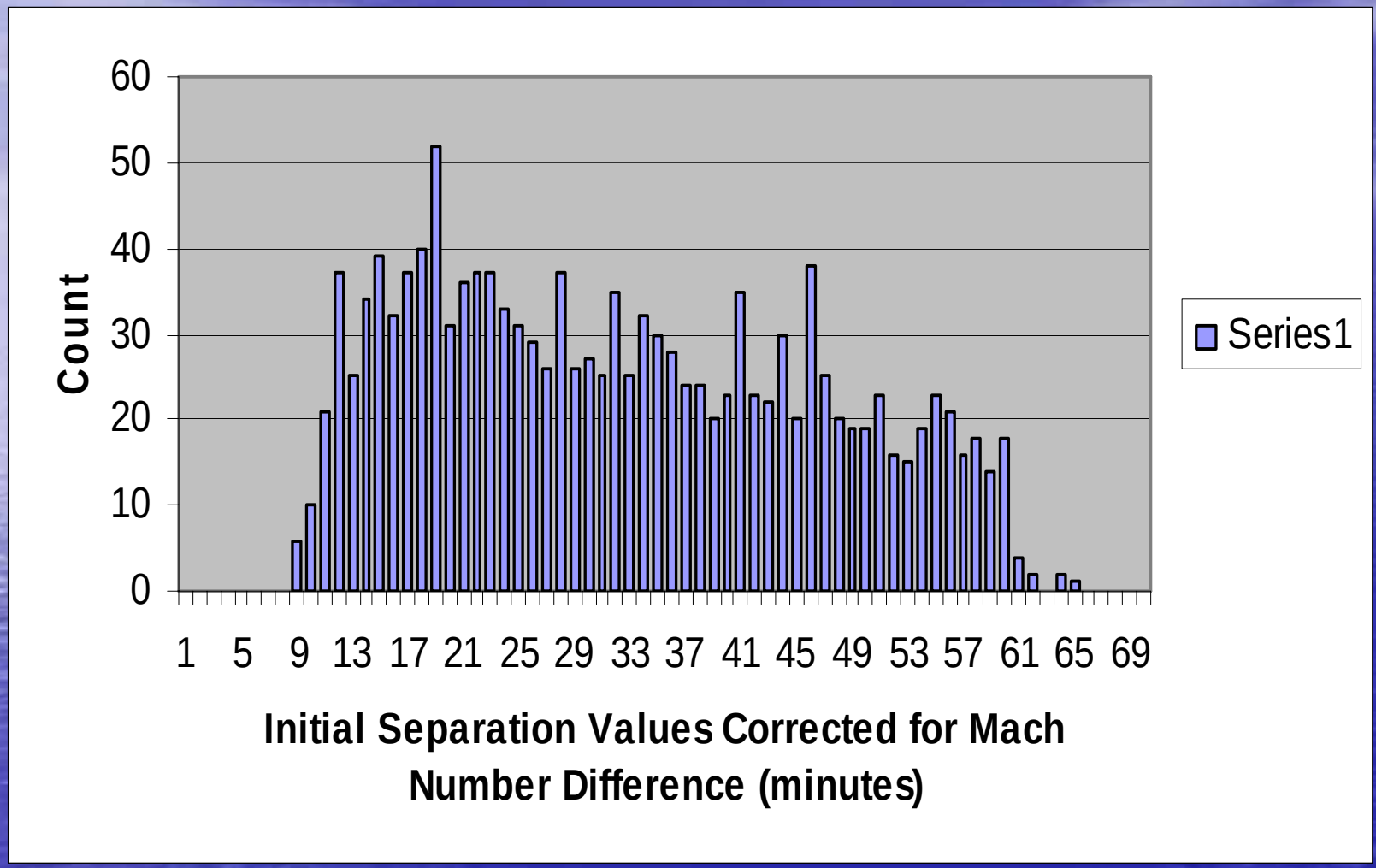

60
50
40
30
20
10
0
Count
1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69
Initial Separation Values Corrected for Mach Number Difference (minutes)
Series1

Figure 4

3. Discussion (Continued)

- Probability that two co-altitude same-route aircraft lose all planned longitudinal separation, $P_x(0)$
  - $=\Sigma$ (probability that two aircraft are separated by s minutes) • **(probability that two aircraft lose at least s minutes of initial separation) for all values of s**
  - Figure 6: separation gain (+) or loss (-) of 1392 pairs
  - Table 5: separation gain (+) or loss (-) of 1392 pairs as function of initial separation

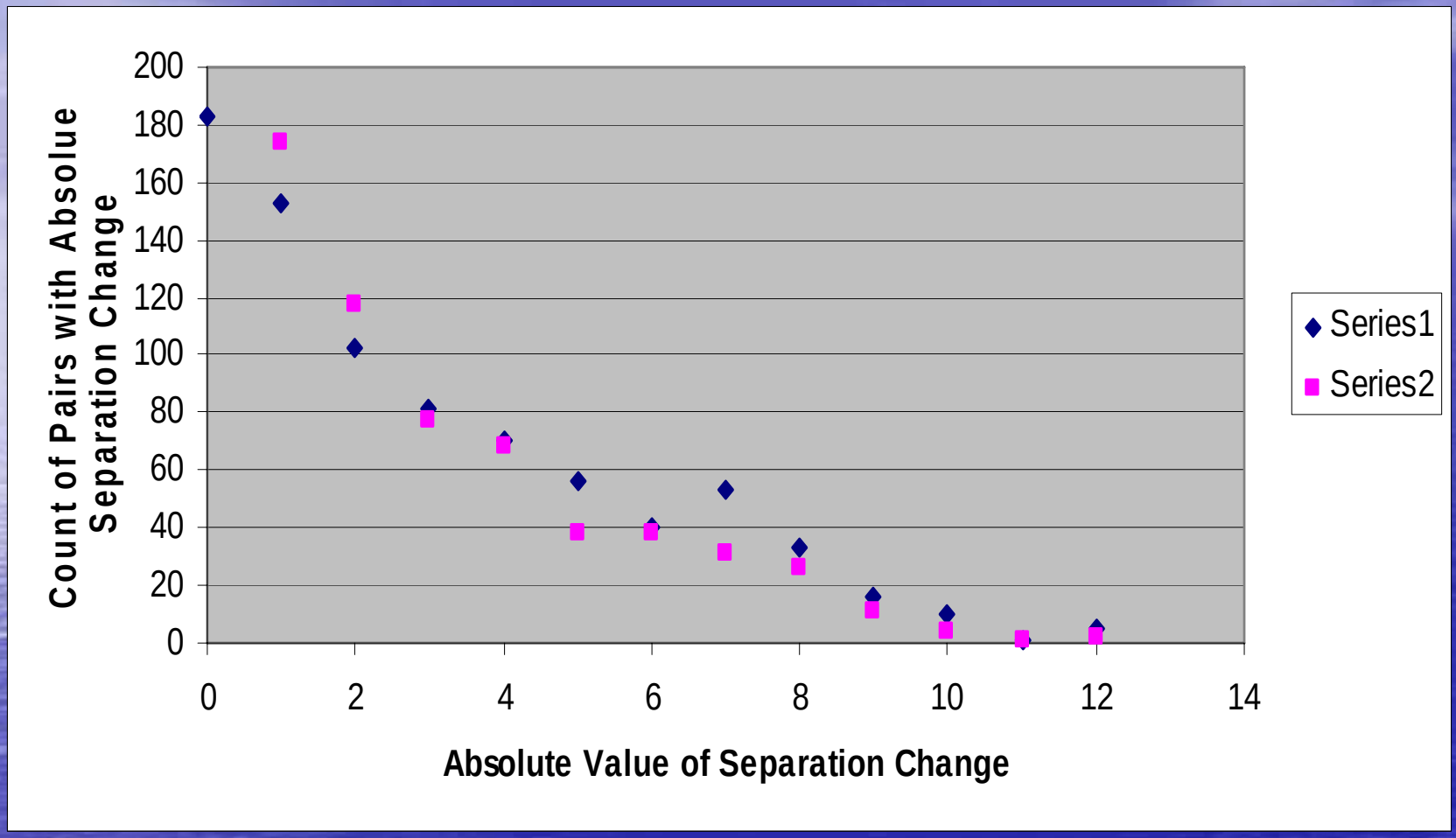

Count of Pairs with Absolue Separation Change
200
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
Absolute Value of Separation Change
Series1
Series2

Figure 6

3. Discussion (Continued)

- 3.10 Outcome of the Lateral Safety Assessment

  – The major focus in lateral risk assessment is the probability that two aircraft lose 50NM of lateral separation, $P_y(50)$

  – Table 3 presents 2.69×10^{-9} as the value of this parameter necessary to meet the TLS

3. Discussion (Continued)

- 3.10 Outcome of the Lateral Safety Assessment (continued)
  - A reasonable estimate of the number of annual flights on L642 and M771 is 70,000
  - It would take many years of data gathering on L642 and M771 to demonstrate that the required value of $P_y(50)$ is met directly

3. Discussion (Continued)

- 3.10 Outcome of the Lateral Safety Assessment (continued)

  – Alternative approach: use a measure which is related to $P_y(50)$ and can be employed to demonstrate TLS compliance

  – This measure is the frequency of 15NM or greater magnitude lateral errors

3. Discussion (Continued)

- 3.10 Outcome of the Lateral Safety Assessment (continued)
  - South China Sea monitoring program has collected information on such errors since November 2001
    - None recorded on L642 or M771
  - Treat demonstration of TLS compliance like industrial quality-control problem: meet company quality standards (meet TLS) by checking number of defective products manufactured (number of 15 NM or greater magnitude errors)

3. Discussion (Continued)

- 3.10 Outcome of the Lateral Safety Assessment (continued)
  - No 15NM or greater magnitude lateral errors on L642 and M771 in 60,000 flights conducted between 1 January 2007 and 30 April 2008
  - Figure 7 presents control-chart approach

3. Discussion (Continued)

- 3.10 Outcome of the Lateral Safety Assessment (continued)
  - Bottom line: plot of number of 15NM or greater magnitude lateral errors versus number of monitored flights is comfortably within the region of chart corresponding to satisfaction of TLA with 95 percent statistical confidence

3. Discussion (Continued)

- 3.11 Outcome of the Longitudinal Safety Assessment (continued)

  – Assume introduction of 50nm longitudinal separation standard will not change:

    - Distribution of initial separations relative to minimum
    - Distribution of loss or gain in separation will be same function of initial separation

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- All performance date expressed in units of minutes
- Assume 50 NM is equivalent to 6 minutes

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- Value of Σ (probability that two aircraft are separated by s minutes) • (probability that two aircraft lose at least s minutes of initial separation) for all values of s necessary to meet TLS is 2.3×10^{-8}

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- How can two aircraft lose 6 minutes (= 50 NM) of longitudinal separation?
- Answer: At least one aircraft exhibits unexpected change in longitudinal performance of 3 minutes or more

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- South China Sea monitoring program results: no unexpected individual-aircraft longitudinal performance (forecast versus actual times over fix) of 3 minutes or more during 60,000 monitored flights

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- Use well-known results to determine that no individual-aircraft longitudinal performance errors of 3 minutes or more in 60,000 flights is equivalent to rate of occurrence of such errors of 8.51×10^{-7} with 95 percent statistical confidence

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- Use this rate together with conservative assumptions about probability that 4-minute or greater, 5-minute or greater and 6-minute or greater unexpected individual-aircraft longitudinal performance errors occur to produce table 7

3. Discussion (Continued)

3.11 Outcome of the Longitudinal Safety Assessment (continued)

- Bottom line: Estimate of longitudinal risk is 2.8×10^{-9} fatal accidents per flight hour, which satisfies the TLS

SN	Activity	Start	Complete	Present Status	Group Responsible
	Identify Operational Need				
~~1~~	~~Agree that an operational needs for a 50 NM horizontal separation in South China Sea area~~	~~13 Mar 06~~	~~13 Mar 06~~	Completed	~~RNP SEA TF~~
~~2~~	~~Seek agreement from Hong Kong China for the implementation of 50 NM horizontal separation on L642 and M771~~	~~25 Sep 07~~	~~25 Sep 07~~	Completed	~~SCM~~
	Safety Assessment				
~~3~~	~~Engage a qualified Horizontal Safety Assessment Expert~~	~~25 Sep 07~~	~~Dec 07~~	Completed	~~SINGAPORE~~
4	States to continue to collect and provide traffic data	25-Sep-07		On-going	STATES
5	States to provide additional data as required by the Horizontal Safety Assessment Expert	25-Sep-07		On-going	STATES
~~6~~	~~Examine history of navigational errors and assess possible impact on safety~~	~~Jan 08~~		~~N/A~~	~~RNP SEA TF~~
~~7~~	~~Confirm collision risk model assumptions/parameters are consistent with airspace where the 50 NM horizontal separation is to be applied~~	~~Jan 08~~	~~6 Mar 08~~	Completed	~~RNP SEA TF~~
~~8~~	~~Conduct simulations to predict occupancy after the 50 NM horizontal separation implementation~~	~~Jan 08~~	~~5 Mar 08~~	Completed	~~SINGAPORE~~
9	Collect weather and turbulence data for analysis	Jan-08		On-going	STATES
10	Report monthly navigational errors (including operational errors) to Monitoring Authority (Singapore)	13-Mar-06		On-going	STATES
11	Collect additional data if required by the Safety Assessment Expert for the safety assessment for the 50 NM horizontal separation implementation	Jan-08		On-going	STATES
	Feasibility Analysis				
12	Examine the operational factors and workload associated with the 50 NM-horizontal separation implementation in South China Sea	13-Mar-06		On-going	STATES
~~13~~	~~Complete feasibility analysis on the 50NM horizontal separation implementation on L642 and M771~~	~~13 Mar 06~~	~~25 Sep 07~~	Completed	~~N/A~~
	Determination of Requirements (airborne & ground systems)				
~~14~~	~~States assess the impact of the 50 NM horizontal separation implementation on controller automation systems and plan for upgrades/modifications~~	~~13 Mar 06~~	~~25 Sep 07~~	Completed	~~N/A~~
	Aircraft & Operator Approval Requirements				
~~15~~	~~Promulgate the operational approval process of RNP 10~~	~~13 Mar 06~~	~~13 Mar 06~~	Completed	~~N/A~~

SN	Activity	Start	Complete	Present Status	Group Responsible
	Perform Rulemaking (if required)				
~~16~~	~~Recommend State airspace regulatory documentation~~	~~13 Mar 06~~	~~13 Mar 06~~	Completed	~~N/A~~
	Perform Necessary Industry & International Co-ordination				
~~17~~	~~Establish target implementation date on the 50NM horizontal separation on L642 and M771~~	~~25 Sep 07~~	~~25 Sep 07~~	Completed (Target Date of Implementation is 2 July 2008)	~~RNP SEA TF~~
18	Report to South-East Asia ATS Coordination Group (SEACG)			On-going	SINGAPORE
~~19~~	~~Prepare draft amendment proposal to amend Doc 7030~~	~~25 Sep 07~~	~~26 Sep 07~~	Completed	~~SCM~~
~~20~~	~~Submit draft amendment proposal to amend Doc 7030 to ICAO~~	~~26 Sep 07~~		~~On-going~~Completed	~~STATES~~
~~21~~	~~Assess need to publish AIP Amendment/Supplement, if necessary, containing the 50 NM horizontal separation policy/procedures~~	~~26 Sep 07~~	~~7 Mar 08~~	~~On-going~~Completed	~~STATES~~
~~22~~	~~Assess need for NOTAM~~	~~13 Mar 06~~	~~Jun 08~~	~~On-going~~Completed	~~STATES~~
~~23~~	~~Review inter-facility coordination procedures~~	~~26 Sep 07~~	~~Jun 08~~	~~On-going~~Completed	~~STATES~~
~~24~~	~~Finalize changes to Letters of Agreement~~	~~26 Sep 07~~	~~Jun 08~~	~~On-going~~Completed	~~STATES~~
	Approval of Aircraft & Operators				
~~25~~	~~Establish approved operations readiness targets~~	~~13 Mar 06~~	~~13 Mar 06~~	Completed	~~N/A~~
~~26~~	~~Assess operator readiness~~	~~13 Mar 06~~	~~13 Mar 06~~	Completed	~~N/A~~
	Develop ATC Procedures				
~~27~~	~~Develop procedures for handling non-compliant aircraft in ATS documentation~~	~~13 Mar 06~~	~~13 Mar 06~~	Completed	~~N/A~~
	ATC Training				
28	Complete training for air traffic controllers on the application of 50 NM horizontal separation	13-Mar-06	Jun-08	On-going	STATES
	Complete Safety Assessment				
~~29~~	~~Review and accept safety assessment~~	~~13 Mar 06~~	~~Jun 08~~	~~On-going~~Completed	~~RNP SEA TF~~
	Final Implementation Decision				
~~30~~	~~Go/No-Go Decision~~	~~Jun 08~~	~~Jun 08~~	~~On-going~~Completed	~~RNP SEA TF~~
31	Implementation	Jul-08		On-going	

SN	Activity	Start	Complete	Present Status	Group Responsible
	Post Implementation Review				RNP-SEA TF
~~32~~	~~RNP-SEA/TF/3~~	~~Jun-08~~		~~On-going~~Completed	~~RNP-SEA TF~~
33	RNP-SEA/TF/4	Nov-08		On-going	RNP-SEA TF