



*International Civil Aviation Organization*

**Fourth Meeting of the South Asia/Indian Ocean ATM Coordination Group (SAIOACG/4) and the Twenty-First South East Asia ATM Coordination Group (SEACG/21)**

Hong Kong, China, 24 – 28 February 2014

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**Agenda Item 4: Implementation of CNS/ATM Systems**

**SEPARATION MINIMA AND AIRSPACE CAPACITY**

(Presented by the Secretariat)

**SUMMARY**

This paper presents information on separation standards applicable in airspace served by ATS surveillance, and their contribution to improvements in airspace capacity and efficiency. It includes references to ICAO Standards and Recommended Practices as defined in ICAO Doc 4444 (PANS/ATM), and the Asia/Pacific Region's expectation of the application of appropriate separation minimums as agreed by APANPIRG in its adoption of the Asia/Pacific Seamless Air Traffic Management (ATM) Plan.

**1. INTRODUCTION**

1.1 The expansion of ATS surveillance coverage in the Bay of Bengal and South China Sea as a result of ADS-B implementation will provide the opportunity for significant improvements in airspace capacity while simultaneously reducing ATC workload and task complexity. ADS-B coverage will supplement the existing radar coverage and provide backup coverage in the event of failures or other outages of SSR installations.

1.2 Applicable separation standards are defined in PANS/ATM and the Seamless ATM Plan, which defines categories of airspace in which surveillance-based separation standards should be applied.

**2 DISCUSSION**

Benefits of Extended Surveillance Coverage and Surveillance-Based Separation

2.1 Extension of ATS surveillance coverage brings a number of significant capacity, efficiency and safety benefits.

2.2 Safety benefits include the improvement in ATC situational awareness from highly accurate, high update rate aircraft position and trajectory information, extension of ATM system safety net alerts for cleared level and route adherence, dangerous area and minimum safe altitude warnings and conflict alerts, display of aircraft generated emergency status and enhanced search and rescue alerting services through accurate real-time update of last observed aircraft position.

2.3 Significant airspace capacity and efficiency improvements are achieved through the implementation or extension of ATS surveillance services, *where accompanied by implementation of surveillance based separation standards*. Using the example of en-route airspace, such capacity and efficiency improvements are the result of:

- horizontal separation minimum of 5 nautical miles (NM), rather than, for example, horizontal separations of 30 NM or 50 NM or longitudinal minima of 10 and 15 minutes (approx. 80 to 120NM) commonly applicable in oceanic airspace;
- significant reduction in spacing required between ATS routes, permitting capacity and efficiency improvement in ATS route networks; and
- substantial reduction in ATC workload and task complexity due to:
  - removal of requirement for position reports from identified aircraft;
  - replacement of a complex suite of horizontal separation standards based on aircraft COM/NAV capability with a single surveillance-based standard; and
  - increased monitoring of separation, with tactical intervention only where required, rather than formulation of often complex clearance requirements and restrictions to achieve and maintain non-surveillance separation.

#### PANS/ATM Surveillance-Based Separation Standards

2.4 ICAO Doc 4444 – *Procedures for Air Navigation Services/Air Traffic Management (PANS/ATM)* specifies horizontal separation minima based on ATS surveillance systems, as described in the following excerpt:

##### **8.7.3 Separation minima based on ATS surveillance systems**

8.7.3.1 *Unless otherwise prescribed in accordance with 8.7.3.2 (with respect to radar), 8.7.3.3 or 8.7.3.4, or Chapter 6 (with respect to independent and dependent parallel approaches), the horizontal separation minimum based on radar and/or ADS-B shall be 9.3 km (5.0 NM).*

8.7.3.2 *The radar separation minimum in 8.7.3.1 may, if so prescribed by the appropriate ATS authority, be reduced, but not below:*

- a) *5.6 km (3.0 NM) when radar capabilities at a given location so permit; and*
- b) *4.6 km (2.5 NM) between succeeding aircraft which are established on the same final approach track within 18.5 km (10 NM) of the runway end. A reduced separation minimum of 4.6 km (2.5 NM) may be applied.....*

2.5 It should be noted that surveillance-based separation minima of 5NM and 3NM have been in wide use globally for several decades, including in a number of Asia/Pacific States, in many cases using early generations of primary and/or secondary radar systems and ATC displays which have long since been retired. The implementation of these separation minima provided a quantum leap in airspace capacity and efficiency, improved opportunity for flight at optimal, fuel-efficient flight levels, and reduced ATC workload and task complexity. The introduction of advanced ATM automation systems has further improved ATC capacity, where supported by appropriate separation standards.

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SAIOCG/3&SEACG/20 Outcomes

2.6 In February 2013 the Combined 3<sup>rd</sup> Meeting of the South Asia/Indian Ocean ATM Coordination Group (SAIOCG/3) and 20<sup>th</sup> Meeting of the South-East Asia ATS Coordination Group (SEACG/20) considered issues of ATS surveillance and surveillance based separation. Relevant separation-related discussions included *inter alia*:

- where surveillance was used for separation (rather than monitoring non-surveillance separation standards) longitudinal separation minimums of 30, 40 or 50NM were currently applied within ATS surveillance coverage;
- implementation of 30 NM longitudinal surveillance-based separation (reduction from the current 50 NM) was being considered for specified routes;
- radar handoff procedures, or the lack thereof, resulted in the application of large longitudinal separation requirements at FIR boundaries, in some cases 50 or even 80 NM, with no link to the smaller surveillance-based separation minima that may exist in either or both of the concerned FIRs;
- the preference for a defined airspace, rather than specific routes to be designated, in order to reduce the possibility of human error in applying different standards within the same ATC sector.
- it was recalled that the implementation of ATS surveillance-based separation was a focus of the Asia/Pacific Seamless ATM Plan;
- with respect to large-scale weather deviations (LSWD), Hong Kong China, Singapore and Thailand should consider appropriate ATFM measures distributed via A-CDM ensuring maximum utilization of airport and en-route capacity during LSWD contingency procedures on specified high density ATS routes; with the results reported to SEACG/21 (SEACG Task List); and
- ATS Routes M771 and L462 were to be monitored, with a view to working through the logistical issues and planning for implementation of ATS surveillance-based 20NM separation (SEACG Task List).

*Note: 30NM horizontal separation between Required Navigation Performance - 4 (RNP4) capable aircraft and 20 NM longitudinal separation between same-track aircraft utilizing DME and/or GNSS are current PANS/ATM non-surveillance separation standards within Very High Frequency (VHF) communications coverage.*

2.7 The above discussion outcomes demonstrate that overly-conservative separation minimums are both applied and planned within surveillance coverage in some critical areas of Asia/Pacific airspace, thus failing to fully utilize current and planned surveillance and ATM system capability and restricting airspace capacity.

Asia/Pacific Seamless ATM Plan

2.8 The 24<sup>th</sup> Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/24, Bangkok, Thailand, June 24 – 26 2013) adopted, *inter alia*, the following Conclusions relating to the Asia/Pacific Seamless ATM Plan:

***Conclusion 24/54: Asia/Pacific Seamless ATM Plan***

*That, the Asia/Pacific Seamless ATM Plan Version 1.0 attached as Appendix B to the Report on Agenda Item 3.6 be endorsed, and made available on the ICAO Asia/Pacific Regional Office web site.*

**Conclusion 24/55: State Seamless ATM Planning**

*That, given the urgency and priority of Seamless ATM planning for the Asia/Pacific as acknowledged by the 46<sup>th</sup> Conference of Directors General of Civil Aviation (DGCA, Osaka, Japan, 12-16 October 2009) and APANPIRG/22 (05-09 September 2011), States should be urged to:*

- a) *review Version 1.0 of the Asia/Pacific Seamless ATM Plan and **utilise the Plan to develop planning for State implementation of applicable Seamless ATM elements**;*
- b) *ensure relevant decision-makers are briefed on the Seamless ATM Plan;*
- c) *submit the first Regional Seamless ATM Reporting Form to the ICAO Regional Office by 01 March 2014; and*
- d) *where possible, participate and contribute to Seamless ATM system collaborative training and research initiatives.*

2.9 The Seamless ATM Plan was developed to facilitate Asia/Pacific Seamless ATM operations by developing and deploying ATM solutions capable of ensuring safety and efficiency of air transport throughout the Asia/Pacific Region, and to provide a framework for a transition to a seamless ATM environment in order to meet future performance requirements. The objective of Seamless ATM was agreed as follows:

*The objective of Seamless ATM is the safe and interoperable provision of harmonized and consistent air traffic management service provided to a flight, appropriate to the airspace category and free of transitions due to a change in the air navigation service provider or Flight Information Region.*

2.10 The Seamless ATM Plan and supporting documents including Draft Implementation Guidance, State Implementation Plan Template, Regional Seamless ATM Reporting Form and Template for Comments on Implementation Guidance are available on the ICAO Asia/Pacific Regional Office Website at <http://www.icao.int/APAC/Pages/edocs.aspx>.

**Seamless ATM Plan – Categories of Airspace**

2.11 The Seamless ATM plan does not use the terms ‘continental’, ‘remote’ and ‘oceanic’ to refer to an assumed geographical application area, as many Asia/Pacific States have islands or archipelagos that can support a higher density of Communications, Navigation, Surveillance (CNS) systems than in a purely ‘oceanic’ environment. In accordance with the principles of the Asia/Pacific Air Navigation Concept of Operations (CONOPS), the Seamless Plan defines airspace categories according to its CNS capability or *potential* capability:

- a) **Category R**: remote en-route airspace within Air Traffic Services (ATS) communications and surveillance coverage dependent on a third-party Communication Service Provider (CSP); or
- b) **Category S**: serviced (or potentially serviced) en-route airspace – by direct (not dependent on a CSP) ATS communications and surveillance; or
- c) **Category T**: terminal operations serviced by direct ATS communications and surveillance.

### Seamless ATM Plan – Separation Standards

2.12 The Seamless ATM Plan specifies Preferred ATM Service Levels (PASL) in two Phases. PASL Phase I, with expected implementation by 12 November 2015, includes the following:

#### ATM Systems

7.1 *The delivery of CNS/ATM services should be based primarily on the CNS/ATM capability. All ATC units should authorise the use of the horizontal separation minima stated in ICAO Doc 4444 (PANS ATM), or as close to the separation minima as practicable, taking into account such factors as:*

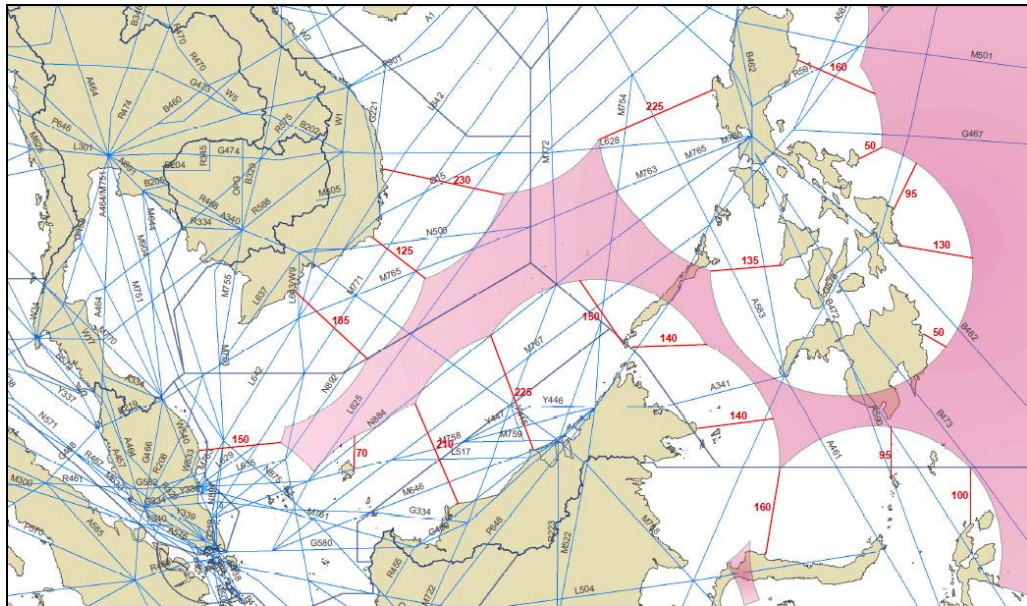
- a) *the automation of the ATM system;*
- b) *the capability of the ATC communications system;*
- c) *the performance of the ATS surveillance system, including data-sharing or overlapping coverage at TOC points; and*
- d) *ensuring the competency of air traffic controllers to apply the full tactical capability of ATS surveillance systems.*

### Seamless ATM Plan – Current Situation

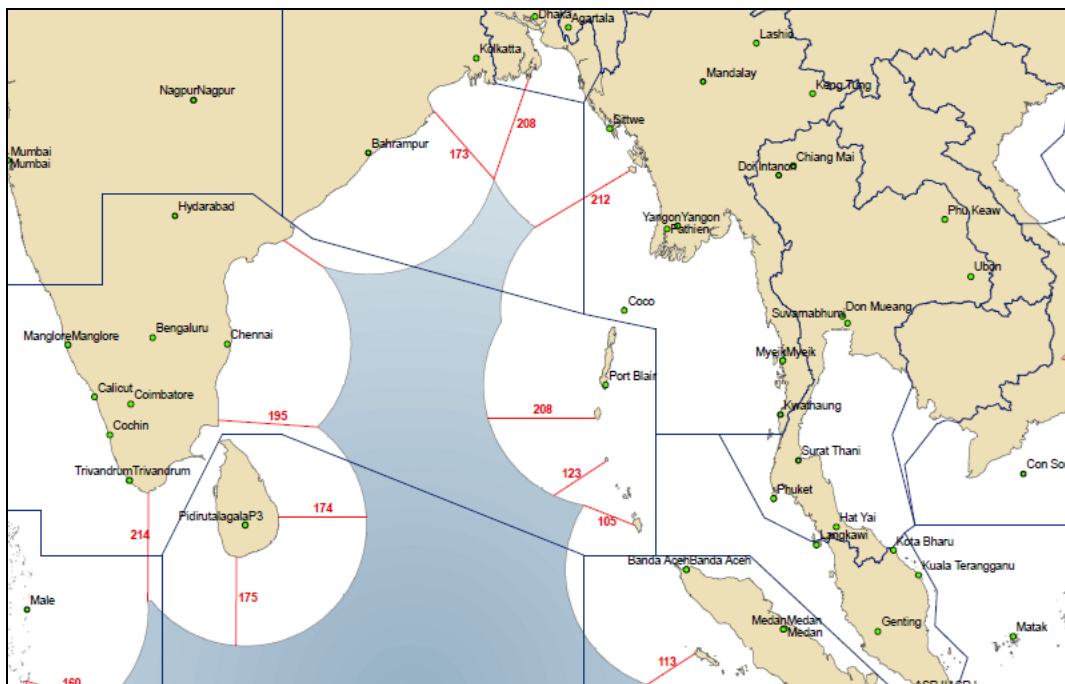
2.13 The Asia/Pacific Region Seamless ATM Planning Group (APSAPG) conducted a study of Major Traffic Flow (MTF) and busy city pair routes, and noted *inter alia* the following:

- The capacity of ANSP infrastructure and airspace had not kept up with traffic growth.
- Airspace and Route design and capacity –
  - crossing tracks with and without ATS surveillance, whereby States mainly rely on the use of FLAS for procedural flight level separation;
- ATS surveillance and communications capability –
  - Non- existent or unreliable surveillance or communications capability in critical locations (**Figures 1 and 2**);
  - Capability not fully utilised to provide appropriate level of service; and
  - Hand-off procedures not aligned to ATM facilities and capabilities.
- Compatibility between FIRs –
  - Unnecessarily conservative separation requirements at TOC points (it was not clear if this is due to lack of confidence in adjacent FIRs capability to adhere to agreed procedures, or for other operational reasons).
- ATC standards –
  - Apparent reluctance in applying ICAO standard separation minima (it was not clear if this is due a lack of confidence in ATM competence or capability).

2.14 The Seamless ATM Plan identifies the main areas of the Asia/Pacific region lacking ATS surveillance and communication coverage which need to be rectified due to traffic density, weather deviations and contingency responses, and accorded the highest priority for rectification to the South China Sea Airspace between Viet Nam, Brunei Darussalam and the Philippines.



**Figure 1: South China Sea ATS surveillance gaps (as at June 2013)**



**Figure 2: Bay of Bengal ATS Surveillance Gaps (As at June 2013)**

Air Traffic Flow Management (ATFM)

2.15 It was noted at the combined SAIOCG/3&SEACG/20 meeting that the lack of coordinated ATFM processes in the region often resulted in procedural separation standards being applied as pseudo ATFM measures.

2.16 The practice of applying a one-size-fits-all procedural separation standard for ATFM purposes results not only in poor quality ATFM outcomes, but also artificially restricts ATC capacity and adds significant workload and complexity to the ATC sectors involved. This includes not only those sectors at the transfer-of-control point where the spacing is demanded, but also those upstream sectors, terminal units and aerodrome control towers that may themselves use appropriate PANS/ATM surveillance-based separations but have to do the bulk of the work to achieve the pseudo ATFM spacing.

2.17 The combined SAIOCG/3&SEACG/20 meeting recognized the pressing need for ATFM solutions, and formulated a Draft Decision reconvening the Asia/Pacific Regional Air Traffic Flow Management Steering Group (ATFM/SG) for APANPIRG's consideration. APANPIRG/24 subsequently adopted the following Conclusion:

***Conclusion 24/15: Asia/Pacific ATFM Steering Group***

*That, States participate in, and support the Asia/Pacific ATFM Steering Group to develop a common Regional ATFM framework, which addresses ATFM implementation and ATFM operational issues in the Asia/Pacific region.*

2.18 ATFM/SG/2 (Hong Kong, China, 1 – 4 October 2013) agreed to a schedule of work that will culminate in the final draft of the Regional Framework for Collaborative ATFM, which is expected to be presented for adoption by APANPIRG/26 in September 2015.

2.19 In parallel with the development of the Regional ATFM framework a tri-partite program being conducted by Hong Kong China, Singapore and Thailand will work towards implementation of a sub-Regional collaborative ATFM solution for ATS routes between Bangkok, Hong Kong and Singapore.

SEA/BOB ADS-B WG/9 meeting

2.20 Separation minima for ATS Routes L642 and M771 were discussed at the Ninth Meeting of the SEA/BOB ADS-B Working Group (October 2013). The meeting concluded that information and outcomes of discussions by the meeting need to be provided to SEACG for further consideration of the separation standard to be applied. The meeting discussed the reasons why minimum surveillance separation standards were not always used within surveilled airspace, such as the incidence of non-compliance with clearances in or approaching boundary areas, ATC coordination deficiencies, traffic demand and ATC system and display limitations requiring reconfiguration of airspace, ATC sectors and ATM systems.

2.21 IATA observed that there was a significant difference between minimum separation derived by ATM capability, and that required to manage traffic for various reasons; thus setting separation at conservative distances in all circumstances, regardless of traffic demand, penalized aircraft when there was no need. The Chair of the ADS-B WG pointed out the need for the meeting to support States and their economies by improving capacity to meet the demand with the current traffic demand and scale of traffic growth in the Asia/Pacific Region.

2.22 The meeting discussed the purpose of ADS-B being to provide surveillance not only for safety enhancement and data sharing, but also for service delivery outcomes.

Separation in South Asia and South East Asia

2.23 There are clearly a number of factors affecting the application of appropriate surveillance-based separation standards and consequently limiting airspace capacity and flexibility in an environment of surging air traffic demand.

- 2.24 Factors affecting airspace capacity may be summarized as follows:
- surveillance coverage gaps as illustrated in **Figures 1 and 2**;
  - existing radar surveillance and supporting communications system reliability and availability;
  - ATM competency and/or capability; and
  - pseudo-ATFM measures in the absence of coordinated, collaborative ATFM solutions.
- 2.25 In determining how best to address these issues and implement the systems and processes necessary to improve airspace capacity to meet current and expected demand, States should consider:
- Targeted implementation of ADS-B, supporting communications systems and ATM system capability in areas currently without surveillance coverage, and in any areas where radar system performance may not meet the reliability and availability requirements for surveillance-based separation;
  - ADS-B mandates specific to airspace volumes rather than specific routes; and
  - an implementation schedule for surveillance-based separation minimum aligned with:
    - the Region’s expectations expressed in the Seamless ATM Plan (November 2015); and
    - the planned finalization of the Regional Framework for Collaborative ATFM (September 2015).

#### ADS-B Mandates

- 2.26 Several Asia/Pacific States had previously indicated their intention to mandate ADS-B equipage from December 2013. There were a number of issues arising from some of these proposed mandates.
- Route-specific mandates, rather than airspace volume-specific. This results in differing separation standards applicable within surveillance coverage in individual sectors, adding to ATC task complexity and negating efficiency gains in such cases as the frequent weather deviations experienced in South Asia and South East Asia.
  - Mandates being imposed before such critical project activities as *inter alia* human factors and technical requirements identification, equipment procurement, standards and procedures development, operational testing and evaluation, regulatory approvals and ATC training delivery.
  - Mandates being imposed before any operational ADS-B services are provided, resulting in significant cost penalty for airspace users with no associated safety or efficiency benefit.



2.27 The imposition of an ADS-B mandate should be the final step in any ADS-B implementation process. The meeting is invited to consider the following Draft Conclusion:

**Draft Conclusion SAIOACG4/SEACG21-X: ADS-B Airspace Mandates**

That, States considering airspace mandates for aircraft Automatic Dependent Surveillance-Broadcast (ADS-B) equipage are urged to ensure that the effective date of any such mandate is determined in consideration of the following:

- a) appropriate consultation with affected airspace users had been conducted;
- b) the area of airspace requiring carriage and operation of ADS-B has been coordinated with all affected Air Traffic Control (ATC) units, including those adjacent to the ADS-B airspace;
- c) a safety case has been completed, which includes, *inter alia*, a human factors review;
- d) training for the provision of ADS-B surveillance-based separation has been conducted; and
- d) the ADS-B airspace has been promulgated with appropriate notice, and in accordance with the provisions of Annex 15.

2.28 Further ADS-B implementation guidance is available in The Asia/Pacific Region *ADS-B Implementation and Operations Guidance Document* (AIGD), available on the ICAO Regional Office web-site at [http://www.icao.int/APAC/Documents/edocs/cns/ADSB\\_AIGD6.pdf](http://www.icao.int/APAC/Documents/edocs/cns/ADSB_AIGD6.pdf), and in ICAO Circular 326 – *Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation*, available through the ICAO Secure Portal.

**ACTION BY THE MEETING**

3.1 The meeting is invited to:

- a) note the information contained in this paper, and discuss:
  - i. reasons for the use of overly-conservative horizontal separation standards within current surveillance coverage;
  - ii. the Regional expectation that PANS/ATM surveillance separation minima be implemented in Category S airspace by November 2015; and
  - iii. the need for PANS/ATM surveillance separation minima for improved safety and optimum airspace capacity during LSWD events;
  - iv. the need for ADS-B surveillance, supporting communications capability and mandated aircraft equipage to facilitate the implementation of PANS/ATM surveillance-based separation standards in the South China Sea area;
  - v. the need for in-parallel development and implementation of collaborative ATFM solutions;
  - vi. State implementation plans for ADS-B coverage and supporting communications capability to fill gaps in or support current radar surveillance coverage;
  - vii. defining ADS-B mandates for airspace volumes rather than for specific ATS routes;
  - viii. the proposed **Draft Conclusion SAIOACG4/SEACG21-X: ADS-B Mandates**; and
  - ix. any other relevant matters as appropriate.

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