



International Civil Aviation Organization

**The Fourth Meeting of the Regional Airspace Safety Monitoring Advisory Group
(RASMAG/4)**

Bangkok, Thailand, 25 – 28 October 2005

Agenda Item 3: Airspace safety monitoring documentation and regional guidance material

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

(Presented by Australia and the United States of America)

SUMMARY

It was agreed by RASMAG/2 and documented in Appendix C to the Report as Task 15 that a Safety Monitoring Agency (SMA) Handbook should be developed. This working paper presents an initial draft SMA Handbook.

1 Introduction

- 1.1 The Second Meeting of the RASMAG agreed that a Safety Monitoring Agency (SMA) Handbook should be developed. This was documented as Task 15 in Appendix C to the Report.
- 1.2 Australia and the United States agreed to develop a draft handbook

2 Discussion

- 2.1 This working paper presents an initial draft SMA Handbook, based on the principles of the Regional Monitoring Agency handbook, which was developed for monitoring reduced vertical separation minimum (RVSM).

3 Recommendation

- 3.1 The meeting is invited to:
 - a. Consider the draft SMA handbook presented in this working paper; and
 - b. Make appropriate changes to the handbook.

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Part 1

1 Introduction

1.1 Background

1.1.1 The Regional Airspace Safety Monitoring Advisory Group (RASMAG) was established by the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) to achieve a regional approach for coordination and harmonization of airspace safety monitoring activities, and to provide assistance to States. The RASMAG noted that requirements for monitoring aircraft height-keeping performance and the safety of reduced vertical separation minimum (RVSM) operations had been more comprehensively developed than for other air traffic management (ATM) services, such as reduced horizontal separation based on required navigation performance (RNP), and monitoring of air traffic services (ATS) data link systems. For RVSM, a handbook with detailed guidance on the requirements for establishing and operating Regional Monitoring Agencies (RMA) was at an advanced stage of development by the ICAO Separation and Airspace Safety Panel (SASP). There was no comparable document under development by ICAO for the continued safe use of a horizontal-plane separation minimum where RNP is applied.

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

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

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

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

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

1.2 Purpose of Handbook

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

1.3 SMA Duties and Responsibilities

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

- 1.3.1.1 establish and maintain a database of aircraft approved by the respective State authorities for RNP operations and other required aircraft capabilities;
- 1.3.1.2 coordinate monitoring of horizontal-plane navigational performance and the identification of large horizontal-plane errors;
- 1.3.1.3 to receive reports of those large horizontal-plane errors of non-compliant aircraft; to take the necessary action with the relevant State and operator to determine the likely cause of the horizontal-plane error and verify the approval status of the relevant operator;
- 1.3.1.4 to analyze data to detect horizontal-plane error trends and, hence, to take action as in the previous item;
- 1.3.1.5 to undertake data collections as required by the regional planning group to:
- 1.3.1.6 investigate horizontal separation performance of the aircraft in the core of the distribution;
- 1.3.1.7 establish or add to a database on the horizontal separation performance of:
 - 1.3.1.7.1 the aircraft population
 - 1.3.1.7.2 aircraft types or categories
 - 1.3.1.7.3 individual airframes
- 1.3.1.8 archive results of navigational performance monitoring and contribute to conduct of annual risk assessment in light of agreed regional safety goals;
- 1.3.1.9 monitor compliance of operators with State RNP approval requirement after implementation of RNP-based horizontal-plane separation minimum;
- 1.3.1.10 contribute to regional database of monitoring results;
- 1.3.1.11 initiate necessary remedial actions and coordinate with specialist groups as necessary in light of monitoring results;
- 1.3.1.12 to monitor the level of risk as a consequence of operational errors and in-flight contingencies as follows:
 - 1.3.1.12.1 determine, wherever possible, the root cause of each deviation together with its size and duration;

- 1.3.1.12.2 calculate the frequency of occurrence;
- 1.3.1.12.3 assess the overall risk in the system against the overall safety objectives; and
- 1.3.1.12.4 initiate remedial action as required.
- 1.3.1.13 to initiate checks of the “approval status” of aircraft operating in the relevant airspace where RNP is applied, identify non-approved operators and aircraft using the airspace and notify the appropriate State of Registry/State of the Operator accordingly; and
- 1.3.1.14 to submit annual reports to the regional planning group.
- 1.4 In order to effectively carry out the duties and responsibilities of horizontal separation SMA, certain prescribed standards shall be met. These standards include competence as demonstrated by:
 - a) previous monitoring experience;
 - b) participation in ICAO technical panel or other bodies which developed horizontal separation requirements or criteria for establishing separation minima based on RNP; and
 - c) establishment of a formal relationship with organization qualified under (a) or (b).
- 1.5 Once competence has been demonstrated, the SMA should receive a formal recommendation by a State or group of States within Region; and/or receive approval from APANPIRG
- 1.6 List of Definitions

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

Collision risk.

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

Horizontal separation.

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

Occupancy.

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

Operational Approval.

The process of assuring the State authority that an operator meets all the requirements for operating aircraft in airspace where RNP has been implemented.

Overall risk.

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

Passing frequency.

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

Target level of safety (TLS).

A generic term representing the level of risk which is considered acceptable in particular circumstances.

PART 2

2 Working Principles Common to all Safety Monitoring Agencies

2.1 Review of operational concept

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

2.1.2 An RMA should review carefully the operational concept agreed by the body overseeing implementation of the RVSM with a view to identifying any features of airspace use which may influence risk. An SMA should inform the oversight body of any aspects of the operational concept which it considers important in this respect.

2.2 Establishment and Maintenance of an RNP Approvals Database

2.2.1 The experience gained through the introduction of RVSM has shown that the concept of a monitoring agency is essential to ensure safety in the region. It has a significant role to play in all aspects of the safety monitoring process. One of its functions is to establish a database of aircraft approved by their respective State authorities for RNP operations in the region for which the SMA has responsibility. This information is of vital importance in effectively assessing the risk in the airspace.

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

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

2.2.4 It is important to note that, in general, the aircraft operating in airspace where RNP-based separation introduction is planned can be categorized into two classes. Some aircraft operate solely within the airspace targeted for introduction of RNP-based separation standards, and others operate both within that airspace and other portions of airspace. It is the responsibility of the SMA supporting introduction of RNP-based separation to gather State approvals for the former category of aircraft from authorities issuing those approvals. To do so requires that the SMA establish a communication link with each such State authority and provide a precise description of the approvals information required. Appendix C provides the pertinent forms, with a brief description of their use, that an SMA should supply to a State authority to obtain information on aircraft RNP approval status.

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

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

2.3 Monitoring of Horizontal-Plane Navigation Performance

2.3.1 An SMA must be prepared to collect the information necessary to monitor horizontal-plane navigational performance as part of the risk assessment. It must institute procedures for the collection of information descriptive of large navigation errors within the ATC system.

2.3.2 An SMA must enlist the cooperation of States and ATS providers in monitoring horizontal-plane navigational performance through the use of secondary surveillance radar. States and ATS providers have the responsibility to cooperate with the SMA and supply any requested data that will contribute to the evaluation of navigational performance.

Monitoring the Occurrence of Large Navigation Errors

2.3.3 Experience has shown that large navigation errors – errors of 25 NM or more in magnitude – have had significant influence on the outcome of safety assessments before and after implementation of RNP-based separation in a portion of airspace. Accordingly, a principal duty of an SMA is to ensure the existence of a program to collect this information and assess the importance of such occurrences.

2.3.4 Section **x** provides direction to an SMA for action in the event that this program uncovers the occurrence of a large navigation error.

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

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

k) Crew comments when notified of error

l) Remarks from ATC unit making report

- 2.3.6 Other sources for reports of large navigation errors should also be explored. An SMA is encouraged to determine if operators within the airspace for which it is responsible are willing to share pertinent summary information from internal safety oversight databases. In addition, an SMA should enquire about access to State databases of safety incident reports which may be pertinent to the airspace. An SMA should also examine voluntary reporting safety databases, such as the Aviation Safety Reporting System administered by the U.S. National Aeronautics and Space Administration, as possible sources of large navigation error incidents in the airspace for which it is responsible.
- 2.3.7 While an SMA will be the recipient and archivist for reports of large navigation errors, it is important to note that an SMA alone cannot be expected to conduct all activities associated with a comprehensive program to detect and report large navigation errors. Rather, an SMA should enlist the support of the ICAO regional planning group, the relevant ICAO regional office, appropriate implementation task forces, or any other entity that can assist in the establishment of such a program.

2.4 Conducting Safety Assessments and Reporting Results

- 2.4.1 A safety assessment consists of estimating the risk of collision associated with the horizontal-plane separation standard and comparing this risk to the TLS. An SMA will need to acquire an in-depth knowledge of the use of the airspace within which the horizontal-plane separation has been implemented. Experience has shown that such knowledge can be gained through acquisition of charts and other material describing the airspace, and through periodic collection of samples of traffic movements within the airspace. Currently, there is no standard collision risk model (CRM) that is applicable to all airspace. In order to take account of regional variations, it is necessary to obtain regional agreement on existing CRMs to be used by all SMAs.

Safety Assessment

- 2.4.2 A principal duty of an SMA is to conduct a safety assessment associated with the implementation of a horizontal-plane separation standard.
- 2.4.3 The regional planning group will determine the safety reporting requirements for the SMA..

Establishing the Competence Necessary to Conduct a Safety Assessment

- 2.4.4 Conducting a safety assessment is a complex task requiring specialized skills which are not practiced widely. As a result, prior to receiving regional approval to operate as an SMA, the organization will need to demonstrate the necessary competence to complete the required tasks.
- 2.4.5 Ideally, an SMA will have the internal competence to conduct a safety assessment. However, recognizing that personnel with the required skills may not be available internally, an SMA may find it necessary to augment its staff, either through arrangements with another SMA or with an organization possessing the necessary competence.
- 2.4.6 If it is necessary to use an external organization to conduct a safety assessment, an SMA must have the internal competence to judge that such an assessment is done properly. This competence could be acquired through an arrangement with an SMA which has conducted safety assessments.

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

Assembling a sample of traffic movements from the airspace

- 2.4.8 Samples of traffic movement data should be collected for the entire airspace where horizontal-plane separation will be implemented. As a result, ATC providers within the airspace are required to cooperate in providing this data.
- 2.4.9 In planning the timing and duration of a traffic movement data sample, an SMA should take into account the importance of capturing any periods of heavy traffic flow which might result from seasonal or other factors. The duration of any traffic sample should be at least 30 days, with a longer sample period left to the judgment of an SMA.
- 2.4.10 The following information should be collected for each flight in the sample:
- a) date of flight
 - b) flight identification or aircraft call sign, in standard ICAO format
 - c) aircraft type conducting the flight, as listed in the applicable edition of ICAO Doc 8643, Aircraft Type Designators
 - d) aircraft registration mark, if available
 - e) origin aerodrome, as listed in the applicable edition of ICAO Doc 7910, Location Indicators
 - f) destination aerodrome, as listed in the applicable edition of ICAO Doc 7910, Location Indicators
 - g) entry fix or latitude/longitude into the airspace
 - h) time at entry fix
 - i) flight level at entry fix
 - j) exit fix or latitude/longitude leaving the airspace
 - k) time at exit fix
 - l) flight level at exit fix
 - m) additional fix/time/flight-level combinations that the SMA judges are necessary to capture the traffic movement characteristics of the airspace

- 2.4.11 Where possible, in coordinating collection of the sample, an SMA should specify that information be provided in electronic form, for example, in a spreadsheet. **Appendix x** contains a sample specification for collection of traffic movement data in electronic form, where the entries in the first column may be used as column headings on a spreadsheet template.
- 2.4.12 Acceptable sources for the information required in a traffic movement sample could include one or more of the following: ATC observations, ATC automation system data, automated air traffic management system data and secondary surveillance radar (SSR) reports.

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

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

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

- 2.5.1 The overall intent of post-implementation SMA activities is to support continued safe use of the horizontal-plane separation. One important post-implementation activity is carrying out periodic checks of the approval status of operators and aircraft using airspace where RNP-based separation is applied. This activity is especially vital if RNP-based separation is applied on an exclusionary basis, that is, if State RNP approval is a prerequisite for use of the airspace. This activity is termed as monitoring operator compliance with State approval requirements. The regional planning group should consider whether the SMA needs to conduct an annual safety assessment as a means to determine whether the TLS continues to be met.
- 2.5.2 An SMA will require two sources of information to monitor operator compliance with State approval requirements: a listing of the operators, aircraft and registration marks conducting operations in the airspace; and the database of State RNP approvals.
- 2.5.3 Ideally, this compliance monitoring should be done for the entire airspace on a daily basis. Difficulties in accessing traffic movement information may make such daily monitoring impossible. As a minimum, an SMA should conduct compliance monitoring of the complete airspace for at least a 30-day period annually.
- 2.5.4 When conducting compliance monitoring, the filed RNP approval status shown on the flight plan of each aircraft movement should be compared to the database of State RNP approvals. When a flight plan shows an RNP approval not confirmed in the database, the appropriate State authority should be contacted for clarification of the discrepancy. An SMA should use a letter similar in form to that shown in **Appendix x** for the official notification.
- 2.5.5 An SMA should keep in mind that the State authority has the responsibility to take any action should an operator be found to have filed an incorrect declaration of State RNP approval.

2.6 Remedial Actions

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

- a) failure of an aircraft to comply with RNP requirements
 - b) aircraft operating practices resulting in large navigational errors
 - c) operational errors
- 2.6.2 An SMA should review monitoring results periodically in order to determine if there is evidence of any recurring problems.
- 2.6.3 As a minimum, an SMA should conduct an annual review of reports of large navigational errors with a view toward uncovering systematic problems. Should such a problem be discovered, an SMA should report its findings to the organization overseeing RNP-based separation implementation, or to the organization that authorized the establishment of the SMA. An SMA should include in its report the details of large navigation errors suggesting the existence of a systematic problem.
