International Civil Aviation Organization
UNDP/ICAO Regional Project RLA/98/003
Transition to CNS/ATM Systems in the CAR and SAM Regions

Tenth Meeting/Workshop of ATM Authorities and Planners of the CAR/SAM Regions (AP/ATM/10)

(Lima, Perú, from 10 to 14 May 2005)

Agenda Item 1: RNAV Routes Implementation Program in the CAR/SAM Regions

c) RNAV Routes Implementation in the TMAs of the CAR/SAM Regions

(Presented by the Rapporteur of RNAV/RNP Task Force)

Summary

This Working Paper presents the results of the four first meetings of the Required Navigation Performance and Special Operational Requirements Study Group (RNPSORSG) of the Air Navigation Commission (ANC) of ICAO and its consequences in the RNAV/RNP implementation Program in the CAR/SAM regions, mainly in the RNAV route implementation in TMA.

1 Introduction

1.1 The WP 04, presented by the Secretariat, has made a summary of the current situation of the RNAV/RNP Implementation Program of the CAR/SAM Regions.

1.2 The results of the four first meetings of the Required Navigation Performance and Special Operational Requirements Study Group (RNPSORSG) of the Air Navigation Commission (ANC) of ICAO shall influence significantly the RNAV/RNP application all over the world, taking into consideration the changes into RNP concept.

2 Results of the RNPSORSG meetings

2.1 The main objective of RNPSORSG is the development of a common understanding of the RNP concept and the relation between RNAV and RNP functionalities. Moreover, the discussions of the group will carry out a new strategy of RNAV/RNP implementation, which avoid the need to multiple operational approvals for the flight in airspaces with similar requirements.

2.2 The revised RNP Concept distinguishes the navigation standards that do not require containment integrity and continuity and the ones that require these kinds of containment. Those that do not require containment integrity and continuity will be designated as “X-RNAV”, whence “X” is a letter of the Roman alphabet. The ones that require containment integrity and continuity will be designated as RNP-X, whence “X” is a navigation precision value. In the **Appendix A (English only)** is shown the memorandum sent by ATM Section of ICAO for the Regional Offices, which contains the details of the new RNP concept.

2.3 Other aspect considered by RNPSORSG is that the RNAV Implementation will take into consideration the precision values of the navigation system, as nowadays employed by RNP (95% of the total flight time). On the other hand, RNP will keep that precision requirement of the navigation system and will add other requirements, such as the containment integrity and continuity.

2.4 Nevertheless, there are exceptions to the new application criteria of RNAV/RNP: RNP 10 and RNP 4, in oceanic or remote airspaces, already implemented or in implementation phase, in order to avoid the need of modification of already existent documentation.

2.5 Thus, it is possible to notice that there will be a clear distinction between RNAV/RNP concepts, from the application or not of containment integrity and continuity requirements. From the Airspace Planner point of view, it is important to point out that RNP shall only be applied in airspaces where it is not possible to attend to the users' requirements with RNAV operations, taking into account the on board aircraft requirements for RNP applications will demand more modern equipment, which, for example, are able to monitor the Actual Navigation Performance of the Aircraft (ANP). The RNP Application in airspaces without very well defined requirements, mostly due to air traffic demand, will exclude, without need, some users of the airspace (exclusive airspaces) or turn the operations more complex (not exclusive airspaces).

2.6 Taking into consideration that the requirements for the RNAV Implementation do not demand the ANP monitoring by the on board aircraft system, the implementation of these types of RNAV will oblige the use of a Surveillance Tool (radar or ADS), which shows to the air traffic controller the visualization of an eventual deviation of an aircraft due to problems in the navigation system. The only exception is RNP10. Thus, in principle, the use of the RNAV types proposed would be applicable only for radar environments.

2.7 Besides, it is still important to notice that the precision values, applied to RNAV operations, will have as aim the definition of separation standards, as well as to define parameters to the aircraft and operator approval.

2.8 A summary of the RNAV Types and RNP Values can be observed in the following tables:

RNAV			
Airspace	**RNAV Types**	**Document of Aircraft and Operators Approval**	**Associated Precision Value**
Oceanic/Remote	RNP 10	Doc. 9613 (FAA Order 8400.12A)	10 NM
	RNP 4	Doc. 9613	4 NM
Continental/Terminal	BRNAV*	EUROCONTROL TGL 02	5 NM
	CRNAV*	FAA AC 90-100 (USRNAV Type A)	2 NM
	TRNAV*	*Advanced RNAV (EUROCONTROL TGL 10 or FAA AC 90-100 – USRNAV Type B)	1 NM

BRNAV = Basic RNAV, CRNAV = Continental RNAV, TRNAV = Terminal RNAV
* Advanced RNAV = PRNAV + USRNAV Type B

RNP	
Airspace	**RNP Values**
Continental/Terminal	RNP 2
	RNP 1
Approach	RNP 0.3/0.2/0.1

3 Process for Global Harmonization of the Navigation Standards

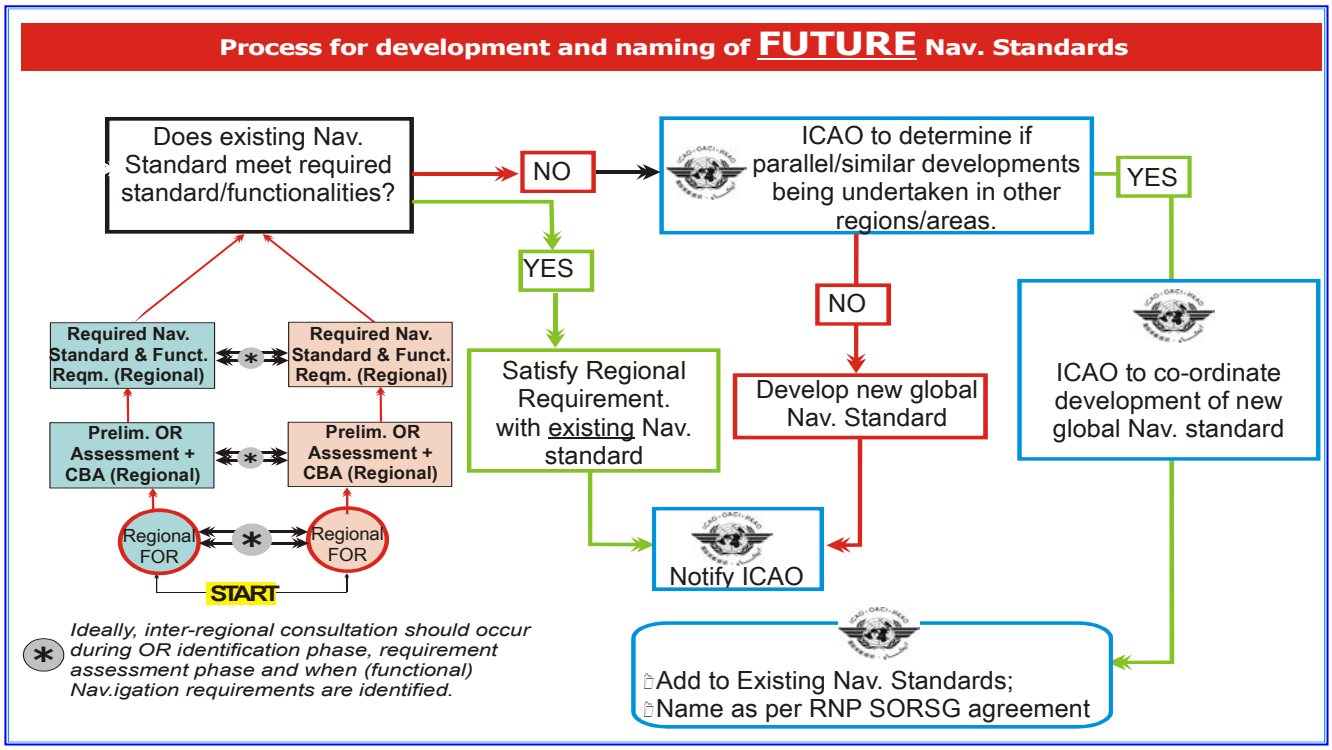
3.1 During the RNPSORSG's Meetings was made a proposal for the harmonization of the navigation standards, with the goal of reducing the number of operator and aircraft approvals/certificates, through an only criterion/document application to the airspaces with similar requirements. Thus, for example, the BRNAV Application in Brasília, Curitiba, and Montevideo FIR should employ the document TGL 02 of EUROCONTROL. In a certain way, it will be possible to employ the same process used in Europe, avoiding the need to two approvals for the aircraft that fly from Brazil/Uruguay to Europe.

3.2 Moreover, this strategy stimulates the document application that proceeds from FAA/EUROCONTROL in other airspaces. Such application is common all over the world, as it was observed in the RVSM Implementations (Interim Guidance 91- FAA), RNP 10 implementation (Order 8400.12 – FAA) and BRNAV in Asia (TGL 02 – EUROCONTROL).

3.3 Nevertheless, it is import to point out that the implementation strategy mentioned includes only the harmonization of approvals/certification criteria of the aircraft and operators. Moreover, other exigencies should be analyzed to verify if it is possible the application of certain navigation standard to an specific airspace, such as: CNS infrastructure, Air Traffic Service, Flight Plan requirements, Safety Assessment, etc.

3.4 If there is not an adequate RNAV or RNP application criterion for the application in certain airspace, the application strategy of these concepts, suggested by RNPSORSG, offers the possibility of the development of a new criterion. That would be, for example, the development of a

RNAV type applicable in no radar environments. The figure bellow presents the summary of the RNAV RNP application strategy proposed by RNPSORSG.



4 RNAV/RNP for Approach Operations

4.1 RNPSORSG concluded that approach procedures always require containment integrity and continuity. Thus, RNP is the adequate concept to the application for the approach procedures.

4.2 The RNPSORSG group, however, did not get to definite conclusions about precision approach. However, the group came up with some preliminary conclusions that can offer guides to the employment in the CAR/SAM regions. The first aspect is that the probable non-application of the RNP concept for the final precision approach track, taking into account that, at the present, there have only two equipments been applied in this track: ILS and MLS. MLS have limited application to some Europe airports. In a predicable horizon, GNSS will be the main navigation system applicable to the precision track. There's no application foresight of other equipments/technologies to attend to the precision approach track which justify the RNP application.

4.3 With regard to the non-precision approach procedures, one of the main problems discussed by the RNPSORSG was that the present DOC. 8168 (PANS-OPS) format foresee lots of different criteria for RNAV operations, based on the several existent equipment types, such as Basic GNSS, VOR/DME, DME/DME, including new criteria in development to GBAS e SBAS. Even so,

it is obvious the advantage of the RNP concept application, precisely because other application must be inserted in the ICAO Doc., such as IRU/DME, IRU/GNSS and others, becoming impracticable the elaboration of a criterion and a corresponding chapter in the DOC. 8168, for each possible combination. Thus, the group recommended the RNP application to these cases, including in the existent GNSS procedures the possibility of its utilization per aircraft RNP 0,3.

4.4 The future discussions shall be determined for the necessity of flexibleness of the RNP concept for approach through the application of design criteria that allows the airspace planner an enlarge series of options for each specific situation. Just so, The RNP values will be applied with increments of 0,1 NM (RNP 0.1, 0.2, 0.3, etc), making possible the application of a RNP value near the operational need of each specific airspace, according to the existent obstacle, the separation between aircraft, the navigation capacity of the fleet, the configuration of the runway of the airport, etc.

5 RNAV and RNP Application in the CAR/SAM, based on the RNPSORSG conclusions

5.1 Taking into consideration that there will be no change in the criteria applicable in the RNP 10, it will not be necessary any alteration in the application of the RNP 10 in the EUR/SAM Corridor and in the routes between Santiago de Chile and Lima.

5.2 In the Action Plan for the RNP 5 implementation in the Brasilia, Curitiba and Montevideo FIRs, it shall be modified to the BRNAV application and its expansion to the most import TMA of these FIRs.

5.3 However, taking into account that the most important international traffic flow of the CAR/SAM Regions is from/to NAM Region, the feasibility of CRNAV application should be also analyzed, in order to guarantee the harmonization of the applicable criteria and to avoid the users to be obliged performing two types of different operational approval. This shall assist the progress of the RNAV route implementation from CAR/SAM Region to the NAM Region. It shall be already considered, navigation capacity of the fleet and the possible application of the CRNAV, without radar coverage and navigation radio aids in some parts of the CAR/SAM Regions.

5.4 Another aspect that shall be kept in view is the necessity of establishing a precision value to the RNAV routes already implemented, and its expansion until the TMA, so that allowing the application of separation criteria between aircraft and the implementation of a harmonized criterion for aircraft and operator approval.

5.5 Considering the existent air traffic demand in the CAR/SAM Regions, it is not expected the application of RNP values to the route operations and in TMA. However, in some airports, where there is an special operational requirement for separation between aircraft and obstacles, the feasibility of application of a specific RNP values must be analyzed. An example that can be observed is the application project of the RNP 0,3 or 0,15, nevertheless not defined, to Rio de Janeiro / Santos Dumont Airport, which will permit the straight approach to Runway 02 and IMC departure from Runway 20. This will be possible through an agreement between DECEA and FAA, based in FAA - N 8000.287 - Airworthiness and Operational Approval for Special Required Navigation Performance (RNP) Procedures with Special Aircraft and Aircrew Authorization Required (SAAAR). An example of the Approach Procedure Project and IFR Departures applicable to Rio de Janeiro/Santos Dumont Airport is attached as **Appendix B** to this working paper.

6 Suggested Actions

6.1 The meeting is invited to:

a) Take note of the information provided in this Working Paper;

b) Consider the need of application of a precision value to the routes already implemented and its expansion to the main TMA, including non-radar environment;

c) Consider the airports that could have operational benefits with the RNP application to IFR approach procedures.

6.2 Administrations of Brazil and Uruguay are invited to analyze the feasibility of the application of the BRNAV or the CRNAV in the Brasilia, Curitiba and Montevideo FIRs and its expansion to the main TMA.

Appendix A

Guidelines for uniform implementation of RNP operations

1. Introduction

Many different perspectives within the international civil aviation community and among individual States on several aspects of required navigation performance (RNP) and, in particular, the naming convention associated with it, have led to some confusion regarding concepts, terminology and definitions. Consequently, a divergence of implementation resulted in a lack of harmonization between RNP applications. Without immediate action, the danger exists that increasing disparity with implementation will continue.

Therefore, the Secretariat, with the assistance of a study group, developed these guidelines in order to ensure a common understanding of RNP and the relationship between RNP and area navigation (RNAV) system functionality, thereby facilitating global harmonization of existing implementations and creating a basis for harmonization of future operations. The guidelines still need to be further developed for the approach phase of flight.

Development of amendment proposals to relevant ICAO provisions will be accomplished later in the year with an applicability date of November 2006. The RNP Manual (Doc 9613) is also being updated by the Secretariat with the assistance of the study group. In the meantime, these guidelines may be used with States and within the planning and implementation regional groups (PIRGs) in anticipation of expected approval so as to avoid further proliferation of RNP implementation.

2. Description

At its highest level, RNP refers to the definition of navigation performance and functional requirements for an operation and thus applies to and affects both the airspace and the aircraft**.** This concept is realized and used in clearly defined navigation applications. A navigation application consists of a navigation standard and an associated operating environment.

While the differences between the existing RNP Concept and its present implementation in demanding operating environments are significant, these differences are not as apparent in less demanding operating environments. Mindful that most existing continental area navigation applications are currently used in demanding operating environments and that it is reasonable to assume that such environments will need to be addressed in many of the expected future en-route and terminal airspace applications, the existing RNP Concept has been elaborated upon with a view to ensuring the maximum coherence between existing navigation standards and future navigation applications.

As such, the revised RNP Concept distinguishes between navigation standards that **do not** require containment integrity and continuity, which are to be designated as “X-RNAV” where “X” is a letter of the Roman alphabet*,* and those navigation standards requiring containment integrity and continuity, which are to be designated as “RNP-x”, where “x” corresponds to the navigation accuracy.

There will be an increasing demand for navigation applications that take advantage of the higher performance capabilities of aircraft (including containment continuity and integrity requirements), and that will allow for future developments, including the ability to rely upon such navigation capability for critical applications such as reduced separation minima in high-density airspace and for approach procedures.

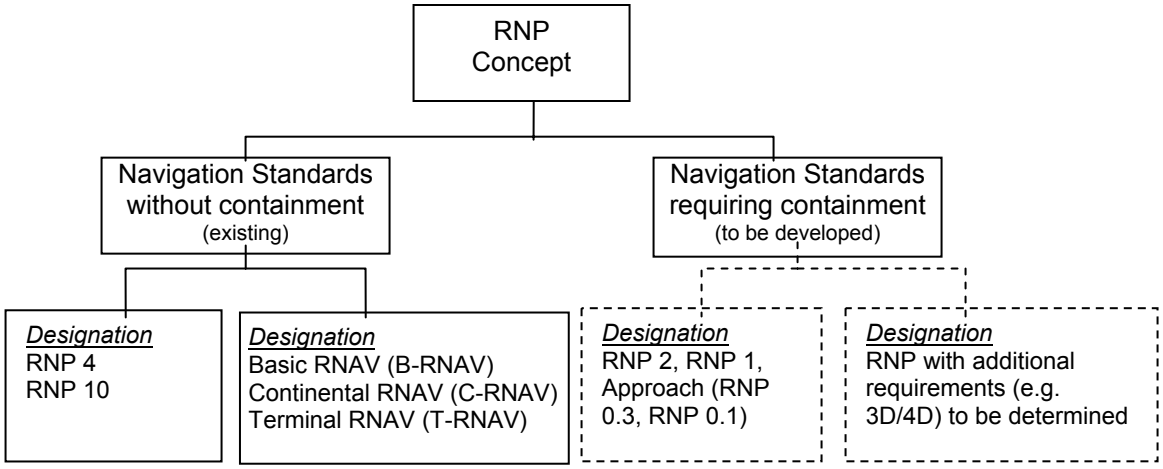


Figure 1. Overview of revised ICAO RNP Concept

3. Areas of Application of the revised approach to RNP

En route-oceanic or En Route-Remote Continental. For these areas of application, existing RNP-10 and RNP-4 navigation standards, requiring long-range navigation functionalities, fulfill operational requirements. Currently, it is not anticipated that new navigation standards for this area of application will be required.

En Route-Continental. Currently, two regional navigation applications without containment requirements have been established, one in Europe, called Basic-RNAV and one in the Middle East, called RNP-5. As RNP-5 is fully based on Basic-RNAV, and taking into consideration the agreement by the group that operations without containment should not be designated RNP, continental navigation applications requiring 5 NM accuracy should be designated Basic-RNAV.

The navigation application in the Middle East will therefore be revised. It is envisaged that this will have little impact on operations.

Terminal - Arrivals and departures. To satisfy terminal airspace requirements, several regional implementations of navigation standards are currently in existence or under development (USRNAV type B and European P-RNAV). In order to ensure global interoperability, the study group agreed to harmonize these regional navigation standards under one global standard to be called Terminal-RNAV (T-RNAV). Aircraft certified to this T-RNAV navigation standard will be able to operate in airspace currently requiring either P-RNAV or US RNAV Type B. Similarly, a new navigation standard to be known as Continental RNAV (C-RNAV) is being developed for applications requiring 2 NM accuracy, that may be applied in continental en-route as

well as in terminal airspace. It is expected that this navigation standard will be based on US RNAV type A.

Table 1. Operations under current situation and under new RNP concept.

Area of Application	RNP value	Designation of navigation standard: Current situation	Designation of navigation standard: new RNP concept
Oceanic/Remote	10	RNP 10	RNP 10
	4	RNP 4	RNP 4
En Route-Continental	5	RNP 5 Basic RNAV	Basic RNAV
En Route - Continental and Terminal	2	USRNAV type A	Continental RNAV
Terminal	1	USRNAV type B P-RNAV	Terminal RNAV

The United States and Eurocontrol have agreed to identify ways by which it will be possible to migrate over time towards the T-RNAV standard. With immediate effect, however, any State excluding the United States or one of the ECAC member states that seeks to implement operations in their airspace using the equivalent of either the United States or European Terminal navigation standard as described in Table 1 should use the T-RNAV navigation standard which will be published in the revised RNP manual (Doc 9613). The United States and Eurocontrol have agreed that aircraft and operators approved for T-RNAV operations by their State of registry will also meet the requirements for operation in the United States USRNAV type B and European P-RNAV airspace.

Terminal - Approach operations. To date, approach navigation applications are sensor specific, requiring separate design for an increasing number of RNAV applications (VOR/DME, DME/DME, Basic Global Navigation Satellite System (GNSS), Satellite-Based Augmentation System (SBAS), Ground-Based Augmentation System (GBAS), etc.). This is not desirable, as it requires extensive commitment of resources for procedure development and publication, and results in operational inflexibility. Therefore, it will be required to apply the RNP concept to the approach phase of flight. Considering the criticality of this phase of flight these types of navigation applications will all require containment if operational benefits are to be achieved. The RNPSORSG is in the process of developing relevant operational requirements.

Appendix B

Project of IFR Approach and Departures Procedures
RNP 0,3 or RNP 0,15
Rio de Janeiro/Santos Dumont Airport