International Civil Aviation Organization
CAR/SAM Regional Planning Implementation Group (GREPECAS)
First Meeting of the Communications, Navigation and Surveillance / Air Traffic Management Subgroup (CNS/ATM/SG/1)
(Lima, Peru, 15 to 19 March 2010)

Agenda Item 4: **Review to pending matters of the ATM/CNS/SG, ATM/COMM, CNS/COMM and respective Task Forces, for consideration in the CNS/ATM Subgroup work programme**

REPORT OF THE PERFORMANCE BASED NAVIGATION TASK FORCE (PBN/TF/1)

(Presented by the PBN/TF Rapporteur)

SUMMARY

This working paper presents a report on the implementation tasks in the CAR/SAM Regions, as well as the need to develop a PBN airspace concept for the CAR/SAM Regions.

References:

- Global Air Navigation Plan (Doc 9750);
- ATM Operational Concept (Doc 9854);
- PBN Manual (Doc 9613);
- Sixth Meeting of the ATM/CNS/SG (Boca Chica, Dominican Republic, 30 June - 4 July 2008);
- GREPECAS/15 meeting report.

ICAO Strategic Objectives:	A – Safety D - Efficiency

1. Background

1.1 The last meeting of the PBN Task Force was carried before the sixth meeting of the ATM Committee (Boca Chica, Dominican Republic, 30 June - 4 July 2008). Since the PBN/TF has not held another meeting since then, Appendices A and B to this working paper include the PBN implementation activities (RNAV/RNP) carried out in the CAR/SAM Regions, as part of harmonization tasks pertaining to this matter.

1.2 It should be recalled that GREPECAS noted the convenience that the planning of PBN tasks be harmoniously developed between the CAR and SAM Regions, recognizing at the same time that the implementation should be carried out in accordance with the operational needs of each Region. PBN implementations with the related specifications adjust to the PBN roadmap approved by GREPECAS.

2. **Analysis**

2.1 GREPECAS/15, upon examining the work programme and terms of reference of GREPECAS and its contributory bodies and, particularly, those related with PBN implementation, approved that the ATM/CNS/SG work programme align itself with the following performance objectives:

a) Optimization of the ATS routes structure in the en-route airspace;
b) Optimization of the ATS routes structure in the terminal airspace; and
c) Implementation of RNP approaches.

Optimization of the ATS routes structure in the en-route airspace

2.2 As of 2000, when the ATS routes implementation process started, the implementation of many RNAV routes in the CAR/SAM upper airspace was achieved, as per GREPECAS recommendations, plus many other new ones which had not been foreseen. These implementations have been carried out by identifying the particular needs of the users, operators and ATS services providers. The implementation programme has generated important operational and economical benefits.

2.3 Upon evaluating the operational results of the most direct flight trajectories, as well as the savings in flight distances and time obtained through the implementation of RNAV routes, it can be concluded that the air operators requirements to obtain operational and economical advantages has been satisfied in great measure. Nevertheless the benefits obtained, the possibility of implementing new RNAV routes has been identified.

2.4 In addition, the traffic increase forecast for the next years, the great demand of direct trajectories outside the airway and the possible implementation of additional routes could lead to a saturation in the various airspaces, which would complicate the airspace management.

2.5 Therefore, it would be convenient to carry an overall review to the upper airspace, considering the possible implementation of new RNAV routes and the elimination of those conventional routes of low use, whose trajectory coincides or is similar to the fixed RNAV or random routes.

Optimization of the ATS routes structure in the terminal airspace

2.6 GREPECAS recommended the implementation of trunk routes that might link the upper airspace RNAV routes with the arrival and exit routes implemented in the terminal areas. To improve the ATS routes network in the terminal areas, for years focused on the need of implementing and improving the SIDs and STARs.

2.7 With this approach in mind, SIDs and STARs have been implemented and improved in the terminal areas and international airports of many CAR/SAM States. Nevertheless, considering the current aircraft navigation capacity, it becomes necessary to evaluate other alternatives that permit linking the upper airspace routes structure with the terminal area routes; one of these alternatives is the implementation of continuous descent operations (CDO).

2.8 The CDO can include the arrival route of an optimum trajectory calculated by the aircraft flight management computer (FMC) from the initial top of descent point (TOD), or another operationally defined point, up to a point where the approach procedure to the airport is started.

2.9 The CDO concept permits adjusting an aircraft's arrival trajectories and designate the speed necessary to maintain the separation and the order that the air traffic control (ATC) provides and can provide a substantial improvement in operational forecasting. The CDO also maximizes the advantages for each flight in terms of less fuel consumption, less gas emissions and less noise, as well as better forecasting possibilities for the flight crew and the aircraft user.

2.10 The implementation of CDOs entails a review to the organization of the lower airspace and improving air traffic management, where operational advantages can be obtained. The implementation tasks and advantages of CDO also have impact on other air navigation areas, such as the need of improving ATM automation, airspace and airport demand and capacity, meteorological information provision and publication of information in the AIP, etc.

Implementation of RNP approaches

2.11 In conformity with ICAO Assembly Resolution A36-23, CAR/SAM States have completed a PBN implementation plan that includes implementation during 2010 of vertical guide approach procedures (APV) (BARO-VNAV and/or augmented GNSS), be it as primary approach or as support for precision approaches.

2.12 Currently, PBN procedures have been implemented in many CAR/SAM airports. Nevertheless, the general implementation results will be able to be obtained towards the end of 2010, as per the implementation horizon established in the aforementioned Resolution. These implementation tasks are carried out by the States, Territories and International Organizations, as per the action plan model developed by the PBN/TF.

Conclusion

2.13 As can be noted in the PBN/TF work programme, many tasks have been complied with, plus there are other implementation tasks in charge of CAR and SAM States, Territories and International Organizations.

2.14 Nevertheless, with the aim of optimizing the ATS routes network, it would be convenient to carry out an overall evaluation of the upper and lower airspace, considering:

a) The review and implementation of routes, or the elimination of others, and introduction of the amendments that were necessary;
b) Analyzing the ATS routes structure, on the basis of statistical data on traffic movement;
c) Optimizing the routes network design and the ATS airspace on the basis of traffic flows and expectations of the ATS users;
d) Describing a new ATS routes network proposal, upon the analysis of:
   - The implementation of PBN requirements for en-route and terminal area flights;
   - One- or two-way routes;
   - Random routes;
   - The development of a performance monitoring and measuring programme; and
e) Analyzing the operational use of GNSS;
f) Describing in detail the routes interface between the CAR and SAM Regions;
g) Proposing the application of continuous descent operations (CDO), where possible; and

h) Proposing regional ATS routes that should be realigned, eliminated or replaced by RNAV routes.

2.15 This vision originates the need of developing an airspace concept as per the PBN Manual, Doc 9613, which could be adopted gradually in the short- and medium-terms by CAR and SAM States, Territories and International Organizations, with the aim of determining and justifying the future implementations to improve the airspace organization and management (AOM).

2.16 With this ATM improvement integral vision, it would be advisable that the CNS/ATM/SG examine the finalized PBN tasks and recommend other possible new tasks with implementation dates and people responsible, under a performance based approach.

3. **Action suggested**

3.1 The Meeting is invited to:

a) Take note of the information provided in this working paper;

b) Examine the contents in Appendices A and B;

c) Propose the development of a PBN airspace concept for the CAR/SAM Regions, as specified in paragraphs 2.14 and 2.15; and

d) Propose other actions that the Meeting might deem pertinent.

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APPENDIX A

SUMMARY OF PBN IMPLEMENTATION IN CAR REGION

With regard to PBN implementation, CAR Subregional Meetings have recalled Assembly Resolution 36-23 on the implementation of RNAV/RNP procedures, which resolved that States should implement approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS) for all instrument runway ends either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 percent by 2010 and 70 percent by 2014.

In order to support these works, the ICAO NACC Regional Office coordinated a PBN Design course (Havana, Cuba, 8 to 19 June 2009)to assist the CAR States to undertake activities aimed at PBN implementation.

Many of the navigational advances enabled by PBN are compatible with the avionics technology currently installed in most of the world's major commercial aircraft fleets— meaning minimal or no new equipment requirements for major aircraft operators or Air Navigation Service Providers (ANSPs). However, a new airspace concept and determining requirements call for a multi-disciplinary team and includes factors such as airspace organization and management, listing airworthiness and operational approvals, etc.

All CAR States/Territories will issue PBN regulations and procedures so as to allow operational enhancements to the airspace capacity and benefits for aircraft operators in the near term. It is also necessary to review the ATS routes network, assign particular RNAV or RNP navigation specification to the ones already implemented and publish related information in the AIP as soon as practicable.

The foreseen over 4% traffic growth in the next years in the CAR Regions, the great demand of direct flight paths out of airways and the possible implementation of additional routes may lead to saturation in the different airspaces, which would complicate airspace management.

This situation originates the need to develop an Airspace Concept in accordance with the *Performance-based Navigation (PBN) Manual*, Doc 9613, which can be gradually adopted by CAR/SAM States/Territories/International Organizations, in order to determine future operational improvements in Airspace Organization and Management (AOM) in the short and medium terms.

The PBN airspace concept provides air navigation solutions based on regional harmonization across homogeneous areas to satisfy short and medium term, and is scalable to meet specific requirements.

- The PBN airspace concept allows operational benefits for users and ATS providers.

- This means facilitate the movement of aircraft through regions or States with little or no change to equipment or procedures.

This approach includes assessing the upper airspace route structure link with terminal areas routes, through the implementation of continuous descent operations (CDO).

CDO encompasses the arrival route in an optimum path calculated by the flight management computer (FMC) of the aircraft from the descent starting point, or any other point operationally defined, until the point where the airport approach procedure begins.

CDO concept allows adjusting the aircraft arrival paths and necessary speed allocations to keep the separation and order provided by Air Traffic Control (ATC) and can provide a substantial improvement to operational forecast. CDO also maximizes advantages for each flight in terms of less fuel consumption, less gas emissions and less noise, as well as better forecast possibility for the flight crew and the aircraft operator.

CDO implementation entails a review of the lower airspace organization and improving air traffic management where operational advantages may be obtained. Implementation tasks and CDO advantages will also impact other air navigation areas such as ATM automation, airspace and airports demand and capacity, meteorological information service and publication of information in the AIP.

Since several airports have implemented GNSS procedures, there are still pending additional tasks that should be developed in the near future such as:

- methodologies for traffic forecast and cost benefit analysis;
- air operations simulation in different scenarios;
- ATC personnel training;
- uniform upper airspace classifications
- RNAV/RNP application in SIDs and STARs;
- new RNAV routes implementation;
- FPL processing and automation updates;
- WGS-84 implementation;
- analyze navigation infrastructure and GNSS operational applications;
- application of continuous descent operations (CDOs) in terminal areas wherever possible;
- development of a monitoring and performance measurement programme; and
- AIS support for PBN publications.

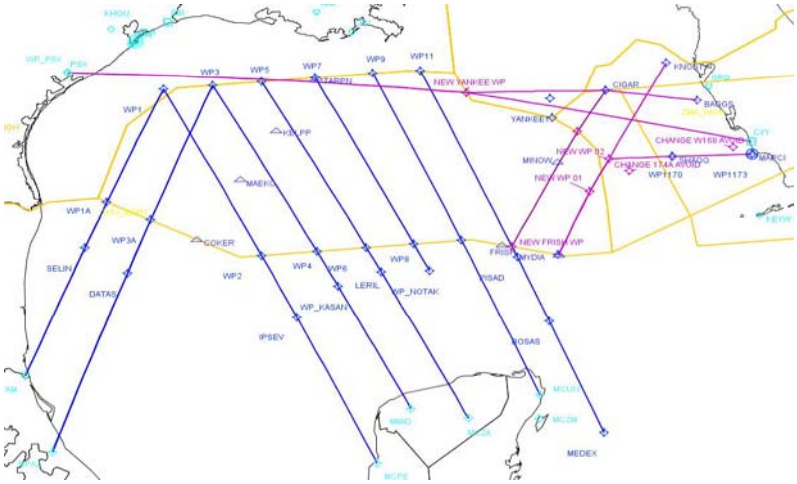
The PBN operational scenario is adaptable to all CAR States. The PBN airspace concept contains details on an expected planning and evolutionary process, within the ICAO framework for the following three years. The PBN airspace concept will be in accordance with the Global Air Navigation Plan, the ATM operational Concept and the PBN Manual.

The implementation of the PBN airspace concept will be supported by strategic regional plan and State implementation plans, which also describe the progressive intermediate steps to achieve global and regional harmonization and interoperability.

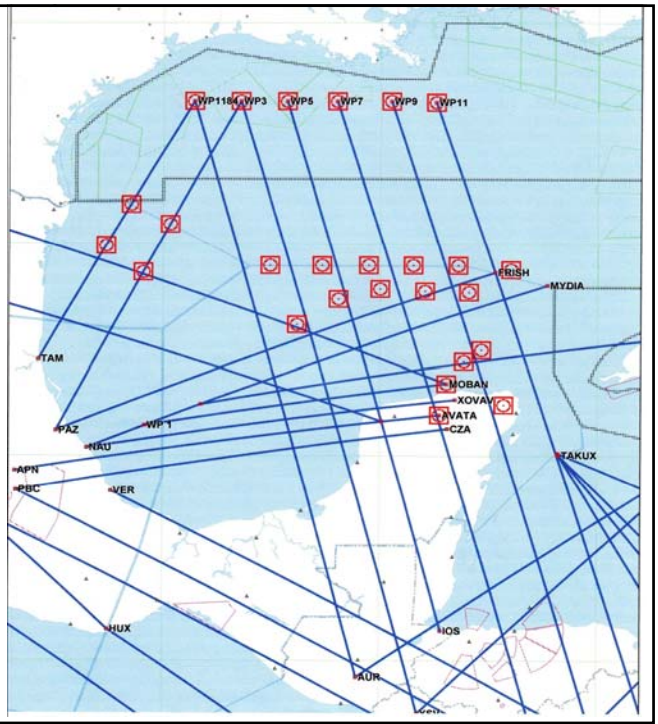
The implementation plans of all CAR States will be aligned to ensure harmonization and integration, and do not unnecessarily impose multiple equipment carriage requirements in the air components of the ATM system, or multiple systems on the ground.

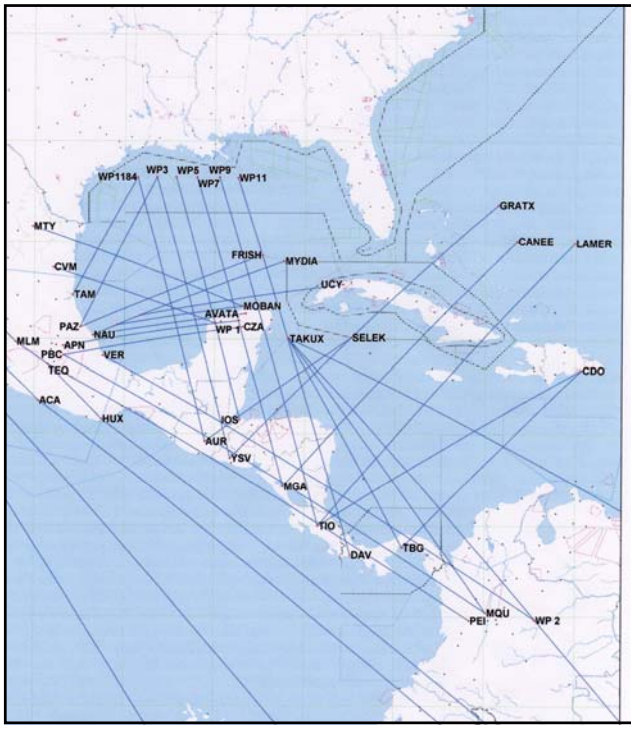
The Secretariat will assist CAR States in PBN implementation. ICAO NACC Office web page (http://www.mexico.icao.int) includes ICAO guidance material and points of contact for the coordination of works.

Proposed RNAV Routes Gulf Of Mexico



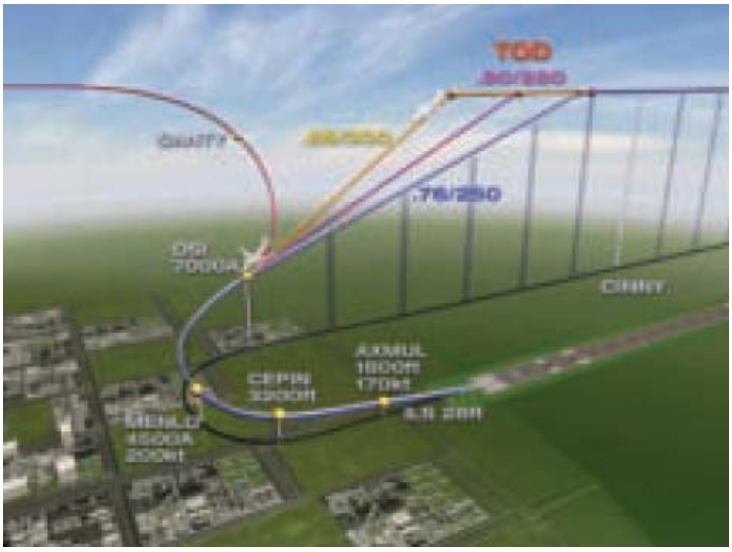
Extend RNAV Routes in the CAR Region





Extend RNAV Routes in the CAR/SAM Regions

Continue Descend Operations (CDO)



APPENDIX B

PBN IMPLEMENTATION IN SOUTH AMERICA

Working system

1.1. The experience acquired in AP/ATM Meetings in RVSM implementation, and in RNAV routes, as well as in the development of the PBN Roadmap and other guidance material proved to be a significant success in the CAR/SAM Regions, leading air navigation in the regions to a new safety and efficiency scope. However, the development of the above-mentioned material depended on the isolated initiative of some participants of the AP/ATM meetings. The complexity of PBN implementation tasks has not permitted the continuity of this working model, keeping in mind that experts involved in the regions do not have exclusive dedication to a particular project, and normally are in charge of other activity in their State. Therefore, the most complex PBN implementation tasks are being executed through the SAM Implementation Group (SAMIG) and the hiring of experts on this matter, through the support of Regional Project RLA/06/901.

1.2. Keeping in mind the complexity that tasks which are developed by the SAM Implementation Group for PBN implementation, the creation of a SAM Region PBN implementation group was necessary (SAM/PBN/IG), with the main objective to assist States in the development of its activities, to evaluate guidance material developed by experts hired by Regional Project RLA/06/901 and to survey that the activities described in the corresponding action plans are complied. In the development of their works, the SAM/PBN/IG is taking into account the PBN Roadmap and the PBN Manual (Doc 9613), with a view to ensure harmonization of PBN implementation between CAR and SAM Regions.

PBN RNAV-5 en-route implementation programme

1.3. The SAM/PBN/IG recognized that PBN implementation for en-route operations shall demand a wide participation of SAM States and shall depend on the development of specific tasks, many of which are in charge of Regional Project RLA/06/901. In this connection, taking into account the need for a harmonization and an accurate interpretation of each one of the tasks related with PBN implementation, a text explaining the PBN en-route implementation tasks was developed, so as to permit a best understanding of the activities and expected results. The objective was to clearly define the products to be delivered, in order to break down the great volume of work in specific activities. These activities are being used as a foundation for eventual adjustments in the project schedule.

1.4. In this connection, the PBN Implementation Programme was developed, which established a detailed RNAV-5 action plan, adapting the results on the PBN Seminar (Lima, 17-20 June 2008) and to the PBN Manual (Doc 9613), which tentative date of implementation is 18 November 2010. In this connection, SAM States published an AIC, on 9 April 2009, for RNAV-5 en-route operations implementation reporting, permitting users to initiate the aircraft and users approval process.

PBN Implementation Model in TMA and Approach

1.5. In the same manner, the SAM/PBN/IG, with the support of Regional Project RLA/06/901 a PBN implementation model in TMA and Approach with a detailed description of each task to be developed by States, in order to enable a better understanding of the activities and expected results. The objective was to clearly define the products to be delivered so as to break down the great amount of work in specific activities. These activities were used for the preparation of a schedule of programmes and also for National PBN Implementation Plans.

National Action Plans for PBN implementation

1.6. The SAM/PBN/IG deemed pertinent that national PBN implementation plans that should be delivered in December 2009 to the SAM Regional Office, were presented at the SAM/IG/4 Meeting, so as to enable the harmonization of such plans in the South American Region. The SAM/PBN/IG evaluated national plans presented by Argentina, Bolivia, Brazil, Chile, Colombia, Paraguay, Perú and Uruguay and it could be noted that, in spite of the existing differences among PBN national plans, the same contain basic information required. However, the SAM/PBN/IG was of the opinion that, to ensure the above-mentioned harmonization, the minimum content of PBN plans of SAM States should be the following:

a) En-route operations – Action Plan for RNAV-5 implementation

b) TMA operations – State Planning for PBN SID/STAR implementation in the main TMA.

c) Approaches – Planning to ensure compliance of goals established in Resolution A36/23, for APV procedures.

To date, definitive national PBN plans are available for Argentina, Bolivia, Brazil, Chile, Colombia, Guyana, Paraguay, Perú, Uruguay and Venezuela.

Training

1.7. The SAM/PBN/IG indicated that there are some areas deserving special attention, with a view to States' experts training, keeping in mind that they are a key element for PBN implementation. In this connection, ICAO South American Office, with the support of a Special Implementation Project (SIP) financed by ICAO and Regional Project RLA/06/901 has made necessary coordination to dictate two courses on RNAV/RNP and RNP AR APCH procedures design were carried out in September and October 2009, in which experts in procedures of 9 States of the SAM Region in each course. In April 2010, the holding, in the same format, of an APV/BARO-VNAV procedures design course is foreseen for April 2010.

1.8. In the same manner, and taking into consideration that SAM Region operations and airworthiness inspectors require training on approval requirements contained in PBN Advisory Circulars in order to continue with the implementation agreed, the ICAO South American Office is making the necessary coordination hold an RNAV approval course and other RNP approvals course, respectively, during March and May 2010.

Activities related with aircraft and users approval (OPS/AIR)

1.9. PBN short and mid-term implementation requires development of guidance material to carry out aircraft and users approval for the different navigation specifications which have been included in the PBN Roadmap.

1.10. When the works of the SAM/PBN IG were initiated, it was verified that Regional Project RLA/99/901 was preparing the Latin American Regulations and corresponding Manuals for operations and airworthiness inspectors, with a view to establish requirements and common procedures in the region.

1.11. Within this context, and with a view to avoid duplicity of efforts between Regional Project RLA/99/901 and Regional Project RLA/06/901, the Regional Project RLA/99/901 Technical Committee of Regional Cooperation System for Surveillance and Safety (SRVSOP) was responsible for the development of Advisory Circulars (CA) and Work Aids for aircraft and users approval for the different RNAV and RNP specifications. The following working programme was established to facilitate preparation of Advisory Circulars with the corresponding Working Aids.

Advisory Circulars and Working Aids			
Navigation Specification	**Number**	**Title**	**Date**
RNAV 10 (RNP 10)	AC 91-001	RNAV-10 Aircraft and users approval for Operations	V
RNAV 5	AC 91-002	RNAV-5 Aircraft and users approval for Operations	Completed
RNAV 1 e 2	AC 91-003	RNAV-1 and 2 Aircraft and users approval for Operations	Completed
RNP 4	AC 91-004	RNP 4 Aircraft and users approval for Operations	SAM/IG/5 May 2010 Draft available
RNP 2*	AC 91-005	RNP 2 Aircraft and users approval for Operations	SAM/IG/6 Oct 2010
RNP 1 – Básica	AC 91-006	Basic RNP 1 Aircraft and users approval for Operations	Completed
RNP 1 – Avanzada*	AC 91-007	RNP 1 Advanced Aircraft and users approval for Operations	SAM/IG/6 Oct 2010
RNP APCH	AC 91-008	RNP APCH Aircraft and users approval for Operations	Completed
RNP APCH AR	AC 91-009	RNP APCH AR Aircraft and users approval for Operations	Completed
APV/Baro-VNAV	AC 91-010	APV/Baro-VNAV Aircraft and users approval for Operations	Completed

* Under development phase in the Air Navigation Commission PBN Study Group

ATS Routes Network Optimisation Programme in the SAM Region

1.12. The SAM/PBN/IG, with the support of Regional Project RLA/06/901 has developed a feasibility study for the optimisation of the ATS routes network in the SAM Region, in order to:

a) Establish planning criteria that were used for the assessment of the ATM SAM routes network;

b) Analyse and present a general diagnosis on the SAM ATS routes network; and

c) Propose a new ATM SAM routes network in phases, with the aim to establish a methodology for modifications of such routes network, leading to obtaining gradual improvements in the regional airspace structure.

1.13. In general terms, the analysis and diagnosis of the SAM ATS routes network reached the conclusion that the main problem is that its development was always based on specific requirements of isolated routes, without a global analysis, to take into consideration the most wide operational requirements, in which a functional inter-relationship were sought among several elements of the airspace structure, such as ATS routes, control sectors, control areas TMA, etc.

1.14. Another important matter is that the result of the work carried out by States, with the support of RLA/98/003 project, resulted in the implementation of 77 RNAV routes, the modification in the trajectory of 58 routes, and the elimination of only 7 routes. In spite that the work carried out has met the airspace users operational requirements, the increase of RNAV routes to the current airspace structure has resulted, in some cases, in an increase in the complexity of the airspace.

1.15. On the basis of planning criteria and in the analysis/diagnosis of the SAM ATS route network, a SAM routes network optimization programme was developed, which has been divided into three phases, with the aim of achieving corresponding operational benefits as soon as possible. Phase 1 will correspond to the implementation of RNAV-5. As of Phase 2, the routes network versions concept would be incorporated, taking into account that the structure of the airspace is ever changing, on the basis of air traffic movement growth, the moving of air traffic demand from one region or airport to another, of the available technology, among other aspects. The use of route network versions reflects the need for its periodical review in an integrated manner, with the aim of always guaranteeing the better airspace structure possible.

Interface between the CAR and SAM Regions ATS routes network

1.16. One of the most complex aspects of the SAM routes network optimization programme, with views to draft the first version of the routes network, is the interface between the CAR and SAM Regions. The better option for the development of that task would be a joint work between both regions, following the model of the AP/ATM meetings. Nevertheless, if said joint work were impossible, the following operations are being evaluated:

a) Propose the link between the SAM routes network Version a with the points that might be considered the most appropriate as, for example, the WATRs airspace, and request the CAR Region to evaluate the proposal, as per mechanisms established between the SAM and NAC Offices, with the support of the CNS/ATM Subgroup.

b) Use the existing boundary points between the FIRs adjacent to the two regions, as a basis for the development of the first version of the SAM routes network.

Documentation

1.17. The material developed within the SAM/PBN/IG, including the SAM PBN implementation programme, the SAM routes network optimization programme and the advisory circulars/aids for the approval of aircraft and users, can be obtained from the reports of the SAM/IG/1, SAM/IG/2, SAM/IG/3 and SAM/IG/4 meetings, in the ICAO South American Region website.

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