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SECOND WORKSHOP/MEETING OF THE SAM IMPLEMENTATION GROUP (SAM/IG/2)
REGIONAL PROJECT RLA/06/901

Lima, Peru, 3 to 7 November 2008

Agenda Item 1: **Optimization of the ATS routes structure in Terminal and en-route airspace and implementation of performance based navigation (PBN) in the SAM Region.**

OPTIMIZATION OF THE SAM REGION ATS NETWORK ROUTES

(Presented by the Secretariat)

Summary

This working paper makes an assessment of the process carried out up to date in South American Region, in order to increase airspace structure and proposes the creation of a task group and hiring of experts through Project RLA/06/901 with the purpose that this group analyses and proposes additional measures that, in case adopted, could increase even more the operations efficiency in route and in terminal areas, allow the use in an optimum level of the aircraft capacity to conduct the flight as closer as possible to their preferred trajectory; increase the airspace capacity, facilitate the use of advanced technologies and ATC decisions support tools, and also have a significant impact in the environment improvement.

References:

- RAN/CAR/SAM/3 (Buenos Aires, Argentina, 1999)
- GREPECAS/11 (Manaus, Brazil, December, 2002)
- RNAV Task Group of GREPECAS ATM Committee
- SAM/IG/1 Meeting (April 2008)
- Doc. 9689 –AN/953 "Airspace planning Methodology Guide to determine separation minima"

Strategic Objective A	*Safety*
Strategic Objective C	*Environmental Protection*
Strategic Objective D	*Efficiency*

1 Background

1.1 As it may be recalled, after the CAR/SAM/3 RAN Meeting (Buenos Aires, Argentina, 1999), an optimisation process on the ATS routes network was initiated in the CAR/SAM Regions, which had the aim to design and implement a network of trunk routes, connecting the main pair of cities in the upper airspace from/to the most important aerodromes, taking into consideration inter-regional harmonization.

1.2 GREPECAS/11 (Manaus, Brazil December 2002) analysed the status of implementation of the RNAV routes network, and in order to harmonize implementation national plans with RNAV regional planning, the Meeting deemed it pertinent that civil aviation administrations take the appropriate measures to prepare an implementation programme of RNAV routes where real implementation needs be determined and pertinent coordination be established, enabling an integral regional harmonious and timely implementation. In the light of the above, the meeting formulated Conclusion 11/21 "RNAV Routes Implementation Programme".

1.3 As an element of assistance to States, the RNAV Task Force of the GREPECAS ATM Committee prepared a guidance manual for RNAV routes implementation, where some advantages regarding other manners of traditional air navigation as well as factors must be considered during the implementation process. For ease of reference, this guidance material is presented in **Appendix A** to this working paper.

1.4 The result of this process has been the implementation of 77 RNAV routes, the trajectory of 58 routes was modified and 7 routes were eliminated (lower and upper airspace), and therefore ICAO Council has approved the corresponding amendments to the CAR/SAM ANP ATS routes network. This has enabled a more appropriate airspace structure before the beginning of the programme. The improvement of the routes network continues and there are several RNAV routes that are in process of implementation.

1.5 As a general comment received with regard to ATS routes restructuring by States and reflected in the SAM/IG/1 Report (April 2008), diverse situations have been detected, among which the following are found:

a) Some of the routes have not complied with the expectations as regards its utilisation by some of the operators; notwithstanding they insisted in their implementation.

b) It was observed that, even though they are duly implemented, some routes are barely used, and the operators prefer to use ATS routes which are not so direct, which involves more operational costs and in some cases less capacity and airspace flexibility.

1.6 Other aspects could be analysed that have hindered a better routes network structure. As clearly expressed in the RNAV routes implementation guidance material attached, one of the dilemmas found for the implementation of RNAV routes joining pairs of cities, has been the definition of end points. Most of the airports are located in Terminal Control Areas in which the trajectories to straighten up air traffic flows, IFR, VFR, National and International are already established. The selection of these points definitely determines the real trajectory of the route. It should also be recalled that work has been made on an airspace structure designed during the 60s or 70s when the fleet navigation capacity operating in the Region was very different from that currently used, and therefore, the best trajectory has not been always achieved, or the trajectory preferred by users.

2 **Discussion**

2.1 States of the South American Region, supported by the ICAO regular programme and Regional Project RLA/06/901, have focused their attention to achieve an inter-functional air traffic management system, at the disposal of all users during all flight phases, to comply with the safety levels agreed, to economically provide optimum operations, be sustainable with regard to the environment and satisfy national aviation safety requirements.

2.2 An effective airspace management is fundamental to increase the capacity of the air traffic services system providing an optimal response to the different users needs. In order to achieve this, it will be necessary an even more flexible use of the airspace and consequently the optimisation of the ATS routes network, therefore improving the airspace structure. One of the key elements within these improvements is the implementation of RNAV routes with navigation specifications that respond to users requirements.

2.3 In view of the above, the meeting will analyse the possibility to carry out an important and thorough revision of the current ATS routes network of the Region, starting from the beginning, to take into account cooperative planning among al parties interested, service providers, military and civil users, stating a methodology for the planning and optimization of present ATS route network, based in a general systematic approach, through the assignment by States of specialists of States, to plan, validate and implement a new ATS route network at a regional level.

2.4 This will be a very ambitious task that could be supported by Regional Project RLA/06/901, which would allow, if necessary, the hiring of experts that could, first of all, propose a group of principles and criterions and clearly establish process objectives and measures that could be applied. But for this purpose, it is necessary to obtain the commitment of all States involved in order to achieve the objective suggested through a national programme attached to the regional plan for the optimization of route network.. National plan must include the necessary institutional measures, as well as financial ones, for managing the South American Region ATS network Optimization Program.

2.5 It is necessary a significant grade of commitment by States, since at the beginning of the process, the definition of TMAs in and out points is of great importance and will determine the route(s) trajectory.

2.6 The results of this activity will –without doubt- improve operations efficiency in route as well as in terminal areas, allowing using aircrafts capacity at an optimum level to conduct the flight as closer as possible to their preferred trajectories.; will increase airspace capacity, facilitate the use of advanced technologies (v.g., arrivals based in FMS) and ATC decision support tools (v.g., separation and sequence), therefore, same increase the efficiency. The reduction in fuel consumption will also have a significant impact in the environment.

2.7 As guidance material for the development of this task, Doc. 9689-AN/953 “Airspace planning Methodology Guide to determine separation minima”, could be used, among others.

3 **Suggested action**

3.1 The meeting is invited to:

a) Analyse information provided in this working paper;

b) If considered pertinent, establish a task group to assess the possibility to thoroughly review the South American ATS route networks; and

c) Possible faculties for related Group and some general guidelines, as guidance material, are shown in **Appendix B** to this working paper.

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APPENDIX A

RNAV OPERATIONS

1.1 RNAV operations allow flying in any region of the airspace without the need to fly over the ground base navigation facilities. RNAV techniques applied in several parts of the world have proved that they have advantages over other traditional forms of navigation and that they give certain benefits, among which are:

- establishment of more direct routes;
- reduction of flight distances;
- establishment of deviation routes for aircraft flying over high traffic density areas;
- establishment of double or parallel routes to fit a larger amount of en-route traffic; and
- reduction of ground base navigation facilities.
- a better design or the airspace and the routes network.

1.2 The planning and implementation of RNAV routes demands an extensive analysis of all related issues that could affect such a process. The general guidelines for the analysis needed for this process are hereby presented.

2 PLANNING PRINCIPLES

2.1 Airspace planners must be take into account the following planning principles:

a) Air traffic volume in existing routes and proposed routes
b) Establishment of the shortest routes possible for most of flights
c) Prioritize planning of areas with greater volume of air traffic
d) Comply with the civil and military users needs
e) Integration of the RNAV routes network and sectorization of back-up in the initiation of planning.
f) Integration of RNAV routes network and arrival and departure (SID/STAR) of TMAs

Air Traffic volume in existing and proposed routes

2.2 Keeping in mind the advantages of RNAV routes and the growing number of users capable to fly RNAV, normally the implementation of a RNAV route absorbs most of the air traffic in one or more “conventional” routes. Thus, through an analysis of the air traffic volume of each one of the routes involved, either RNAV or non-RNAV, it should be evaluated if any of the existing “conventional” routes should be eliminated. It is important to recall that, in maintaining “conventional” routes, in function of a small amount of non-RNAV users, does not necessarily mean that there is an increase of the airspace complexity, keeping into account that this complexity is due to the amount of existing flights in each route, and not by the additional crossing points that aeronautical charts would show.

Establishment of the shortest possible trajectories for the majority of flights

2.3 Keeping in mind the need to attend most of the users in their optimum flight profiles, the establishment of direct routes as close as possible, should be prioritized, over those departure/arrival

trajectories. Taking into consideration that normally the RNAV route absorbs most of the air traffic it is very likely that the implementation of the RNAV route will have preference over the "conventional" route. It is important to emphasize that it may be necessary to maintain routes for users which aircraft do not have RNAV capacity.

2.4 Taking into account that it is not always feasible to establish a route between the origin and destination, the need to implement specific one-way routes for arrival and departure to a TMA, must be considered, using departure and arrival control sectors. The airspace planning must consider the requirement to establish a new air-space sectorization at the beginning of the RNAV implementation process.

Prioritize the planning of areas of greater air traffic volume

2.5 In order to achieve the objective, to have trajectories as short as possible for most of the users, airspace planning should depart from those airspace regions with greater air traffic volume over those of lesser volume, prioritizing flows of greater air traffic volume.

RNAV routes integration and supporting sectorization at the planning initial stage.

2.6 Since the inception of the planning of the process it is necessary to guarantee an adequate sectorization of the air space. In addition, the planning should not consider the FIR boundaries, aimed at constituting a "seamless" air space, including, if the case requires, the delegation of air traffic service.

RNAV routes integration and the TMA arrival/departure trajectories

2.7 At the initial stage planning for the RNAV routes implementation, the RNAV routes network integration, as well as the TMA arrival/departure trajectories, must be considered, noting the need for pilots and air traffic controllers workload reduction, mainly through the most effective use of the Flight Management Systems (FMS) and ground/air/ground communications load.

3. Issues to consider during the implementation process

3.1 During the implementation process, the following issues must be taken into account:

a) Start/end points of the proposed RNAV routes;
b) The existing traffic flows and trajectories in the TMAs where the airports are located from the start/end points of the RNAV route;
c) The incorporation of traffic coming from intermediate cities;
d) The conventional ATS routes that are near the proposed RNAV routes;
e) The fleet that is not RNAV equipped;
f) The forbidden and restricted airspaces, which affect the RNAV route;
g) The adjacent FIRs airspaces, mainly CTRs and TMAs, that could affect or be affected by the RNAV routes;
h) The mountainous areas located near airports and along the RNAV route.

Start/end points of the RNAV routes

3.2 One of the dilemmas for the implementation of RNAV routes that will join city pairs is to determine which reference to use in order to define the end points. Most airports are located in the terminal control areas that have already established the trajectories to order the traffic flows, IFR and VFR, National and International.

3.3 The selection of these points, either existent or new, shall determine definitively the real trajectory of the route, and therefore, the FIRs, ATS conventional routes and RNAV routes, and prohibited and restricted airspaces, etc., involved in the same.

3.4 The analysis for the selection of these points will have to contemplate all factors involved in order to avoid further modifications to the proposed trajectory and consequently to repeat the whole process, which would delay the implementation.

Traffic flows and trajectories in the TMAs

3.5 Traffic conditions at the TMA of airports could determine that traffic that flies over the proposed RNAV routes comes in through a different trajectory in order to maintain the great circle or to not interfere with the established trajectories. The complexity of the TMA, the importance of the traffic flows and/or the ATC workload have to be considered and incorporated into the traffic flows.

3.6 During the RNAV routes implementation process that is being carried out in the CAR/SAM Regions, some FIRs, especially the FIRs whose airports are located in the ends of the routes, have the tendency to establish a sole entrance or exit point to/from the FIR for all the routes proceeding from a same sector. In some cases, this point is located at a distance of hundreds of nautical miles from the exit/destiny aerodrome.

3.7 This happens due to the existence of forbidden and restricted airspaces as well as the preference to incorporate new RNAV routes to the existing arrival and exit trajectories. If the tendency is maintained without alterations, the flight distance may be significantly increased and it would impede the implementation of the parallel routes that will allow the optimum use of the airspace, alleviate the traffic congestion or make possible for the aircraft to fly at optimum flight levels.

3.8 Furthermore, the traffic from/to the TMAs at intermediate airports may be incorporated to the RNAV routes through SIDs/STARs and/or through RNAV auxiliary routes that allow maintaining the proposed RNAV routes in the great circle. The need to have RNAV routes arriving to intermediate cities is to be thoroughly analysed in order to avoid the separation of the great circle trajectory routes and to avoid the consequences mentioned in the last paragraph.

3.9 In this regard, it is necessary to use all necessary efforts and to establish the pertinent coordination to implement more direct RNAV routes, which will benefit air operations and the economy of air transport.

Conventional ATS Routes

3.10 It is necessary to have an analysis of the existing conventional ATS routes that coincide or are near the proposed RNAV routes. Considering that there will be numerous aircraft that will not have the area navigation equipment, there is the option to redirect to the conventional ATS routes and to move them far from the proposed RNAV routes. This will require the redesign of the airspace or they could be kept as they are and then establish maximum flight levels for these routes and minimum flight levels from RNAV routes.

3.11 During the transition stage, it seems most convenient to choose the second option, which is to segregate the use of the airspace, and for this end, there should be an extensive analysis to determine the real needs and the establishment of minimum operation requirements as well as specific ATS procedures for each block of airspace that allows the application and unequivocal compliance on behalf of the ATC and the users.

3.12 On the other hand, the analysis of traffic density in a particular traffic flow could make an RNAV route insufficient to meet the demands, considering that there are existing areas and route segments in which the aircraft are not operating at their optimum flight levels and it might be necessary to analyse establishing parallel RNAV routes to solve this situation.

Restricted and prohibited zones

3.13 Conceptually, the Airspace Management (ASM) assumes that civil and military users should dynamically share the airspace. In an integrated ATM system, the airspace management is not limited to the tactical aspects of sharing airspace; it is also directed to bring strategic planning capabilities by taking into account the necessary harmonization that should exist when airspace is shared.

3.14 In this regard, special attention should be given to the geographic location of forbidden and restricted airspaces, including the lateral and vertical boundaries and their impact on the implementation of more direct RNAV routes for the use of civil aviation.

3.15 The existence of restricted and forbidden zones affects the proposed trajectories of RNAV routes and will significantly increase the distances to be flown. Therefore, in order to accomplish the implementation of more direct RNAV routes, the corresponding authorities are required to take the necessary measures in order to have harmonized civil/military coordination.

Mountainous Areas

3.16 The existence of mountainous areas along the boundaries of an airport may force a proposed RNAV route to be redirected in order to allow the SIDs/STARs design to be compatible with the aircraft performance during the corresponding ascent and descent.

3.17 The presence of mountainous areas along a route may affect the aircraft operations during the en-route phase and consequently may cause a redirection of the proposed RNAV route in order to comply with Annex 6 requirements, as far as oxygen provision in certain altitude and pressure conditions is concerned.

APPENDIX B

TERMS OF REFERENCE OF THE SOUTH AMERICA ATS ROUTE NETWORK OPTIMIZATION (SAMATSRO/WG)

The terms of reference for the review are:

a) review of the ATS route structures depicted in the CAR/SAM ANP;

b) identify deficiencies in the existing ATS route structures, and make recommendations, as may be required, for the early implementation of improvements in the route structures that provide improvements in the environment and in addition:

1) further opportunities for industry to achieve optimum performance, through exploitation of the capabilities of modern aircraft systems,

2) further opportunities to implement:

i) laterally separated one-way routes, and
ii) flexible or dynamic tracking,

3) efficiencies for ATS, by taking account of present and future airspace management arrangements, including ATC sectorization, ATS system capabilities and separation minima, and

4) an opportunity to rationalize the existing route structure and provide an improved chart presentation;

c) consult with industry consultative forums, international and domestic operators, the Department of Defense concerned, relevant divisions within States administration (e.g. facilities and engineering divisions), the regulatory authority, and industrial organizations; and

d) consider recommendations on route structure demand and capacity, together with the applicability of air route and airspace management initiatives being pursued by forums such as GREPECAS and others.

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